IROS 2014 Conference Digest

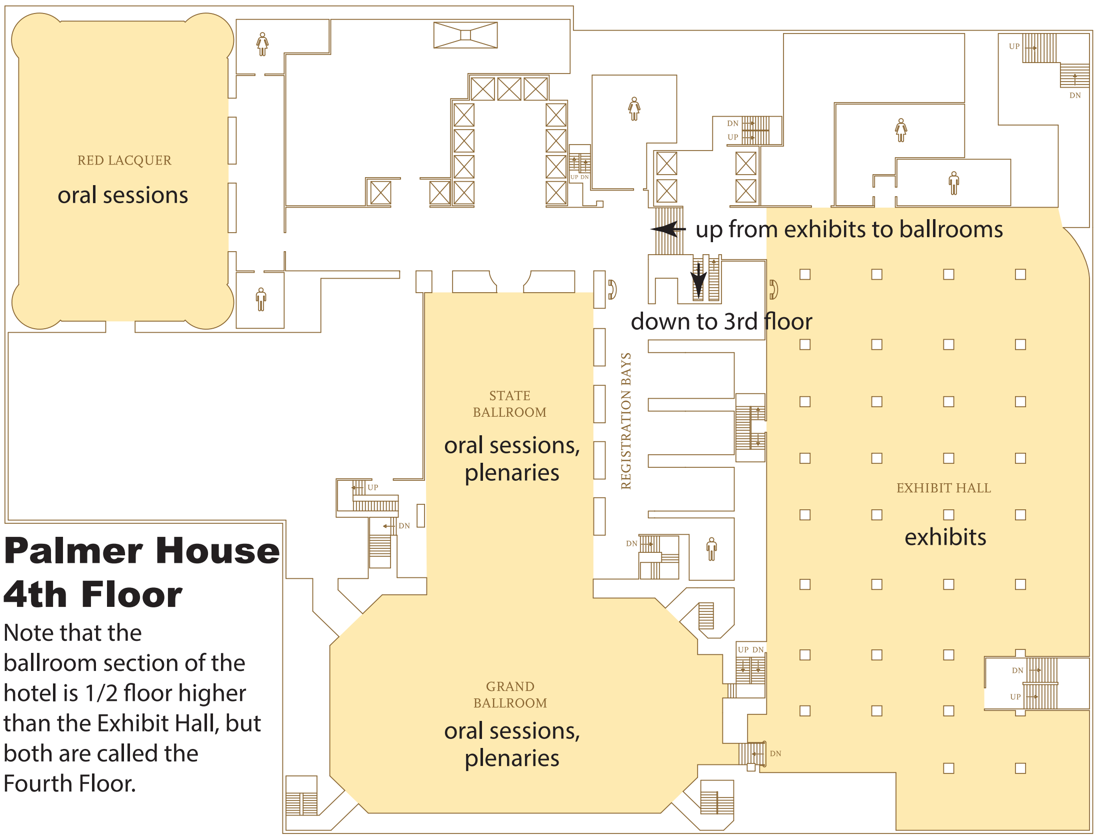
IEEE/RSJ International Conference on Intelligent Robots and Systems
September 14-18, 2014
Palmer House Hilton Hotel
Chicago, Illinois, USA
www.iros2014.org

IROS 2014 Program Summary

	Track 1 Grand Ballroom	Track 2 State Ballroom	Track 3 Red Lacquer Room	Interactive Salons	Crystal Room	Exhibit Hall
Sunday September 14						
8:30-17:00	Workshops and Tutorials					Setup
18:00-19:30	**Welcome Reception**					
Monday September 15						
8:00-8:20	Conference Welcome					
8:20-9:10	Plenary I: Peter Corke					
9:20-10:40	MoA1	MoA2	MoA3			Exhibits
10:40-11:10	**Coffee Break**					
11:10-12:30	MoB1	MoB2	MoB3	MoA Talks		
12:30-13:50	**Lunch; RSJ Power Lunch**					
13:50-15:10	MoC1	MoC2	MoC3	MoB Talks	Government Forum	
15:20-16:40	MoD1	MoD2	MoD3	MoC Talks		
Evening	***Explore Chicago* Social Events**					
Tuesday September 16						
8:00-8:50	Plenary II: Todd Kuiken					
9:00-10:20	TuA1	TuA2	TuA3	MoD Talks	Industry Forum: Perspectives on Entrepre-neurship in Robotics and Automation	Exhibits
10:20-10:50	**Coffee Break**					
10:50-12:10	TuB1	TuB2	TuB3	TuA Talks		
12:10-13:30	**Lunch; IEEE RAS Women in Engineering Lunch**					
13:30-14:50	TuC1	TuC2	TuC3	TuB Talks		
15:00-16:20	TuD1	TuD2	TuD3	TuC Talks		
16:20-16:50	**Coffee Break**					
16:50-17:55	TuE1	TuE2	TuE3	TuD Talks		
18:30-21:30	**Banquet at the Art Institute of Chicago, 111 S Michigan Ave**					
Wednesday September 17						
8:00-8:50	Plenary III: Andrew Davison					
9:00-10:20	WeA1	WeA2	WeA3	TuE Talks		Exhibits
10:20-10:50	**Coffee Break**					
10:50-12:10	WeB1	WeB2	WeB3	WeA Talks		
12:10-13:10	**Lunch; IEEE RAS Young Professional Lunch and Lunch with Leaders**					
13:10-13:50	Awards Ceremony					
14:00-15:20	WeC1	WeC2	WeC3	WeB Talks		
15:20-15:50	**Coffee Break**					
15:50-17:10	WeD1	WeD2	WeD3	WeC Talks		
17:20-19:00	**Farewell Party and WeD Interactives in the Interactive Salons**					
Thursday September 18						
8:30-17:00	Workshops and Tutorials					Navigation Contest

Palmer House 4th Floor

Note that the ballroom section of the hotel is 1/2 floor higher than the Exhibit Hall, but both are called the Fourth Floor.



3rd Floor

Note that the Crystal Room section of the hotel is 1/2 floor higher than the Interactive Salons, but both are called the Third Floor.

Lower-numbered papers in an oral session can be found in lower-numbered salons during the subsequent interactive sessions. For example, papers 2 and 3 in Track 3 (Red Lacquer Room) can be found in Salon 7, while papers 19 and 20 can be found in Salon 12.

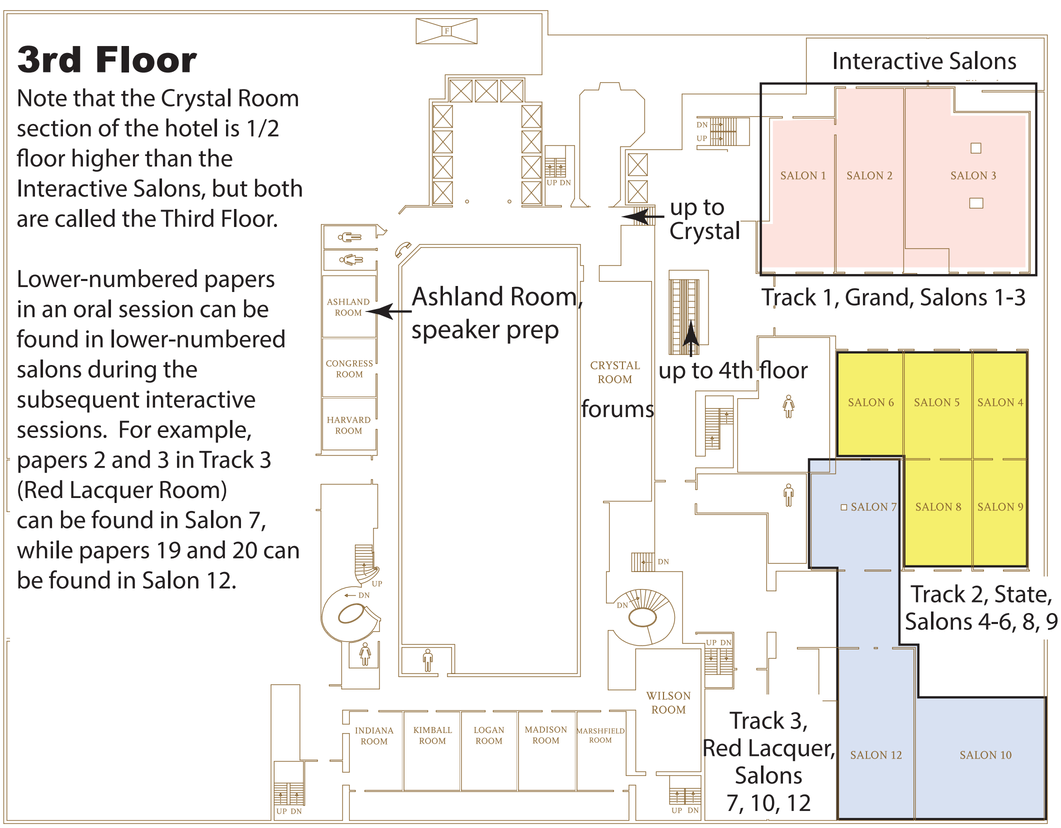


Table of Contents

Welcome from the General and Program Chairs

Dear IROS 2014 Attendees,

Welcome to Chicago! We are honored to host you at the 2014 IEEE/RSJ International Conference on Intelligent Robots and Systems. We hope you enjoy the technical excellence and innovation on display at IROS 2014.

We received over 1600 paper submissions and nearly 50 workshop and tutorial submissions. Ultimately 750 papers and 27 workshops and tutorials were selected for the final program, with authors from nearly 50 countries from around the world.

This year, for the first time, IROS is experimenting with a new format, where each paper is assigned a 3-minute oral presentation and an 80-minute interactive presentation. Each oral session consists of up to 20 3-minute presentations along with one session keynote. In the session immediately following an oral presentation, the presenter presents the work in an interactive session, with the aid of their laptop and an LCD screen, to any attendee whose interest was piqued by the oral presentation. This format allows the number of parallel oral sessions to be shrunk to three, potentially providing larger audiences for the oral presentation, while creating an opportunity for more significant interaction with attendees with related interests.

This "pitch plus interactive" format has been used with success in the smaller, single-track RSS conference. It was also experimented with for a subset of papers at IROS 2011. At ICRA 2012 and ICRA 2013, some papers were chosen for purely interactive presentations (no oral presentations) while others were purely oral presentations. As the robotics community continues to experiment with formats to best serve conference-goers, we decided to try the experiment of treating all papers identically, as "pitch plus interactive." This contrasts with ICRA 2014, which used up to 19 parallel sessions in the "traditional" format. Feedback on the merits of these approaches will be sought from the robotics community, and this feedback will influence future conference organization.

Potential benefits of the "pitch plus interactive" format include a conference that is more physically compact and easier to navigate; potentially wider exposure for presenters' work; encouraging concise and effective presentations; a possibility to see a wider cross-section of current work in robotics; and greater opportunity for significant interaction and networking, particularly for more junior researchers. It also allows each paper to be treated identically, instead of some papers being selected for interactive presentations and some for oral presentations. Challenges include greater A/V support and technical and timing requirements; less in-depth technical presentations on topics that are of interest to you; moving between rooms during talks; and predicting attendance at oral vs. interactive presentations.

In addition to the new conference format, IROS 2014 features 39 session keynotes by leaders in the field; three plenary speeches; a vibrant industrial exhibition and talks from sponsors; special forums and panels on industry and entrepreneurship and government policy as it relates to robotics; and a number of other special events including lunches sponsored by the Robotics Society of Japan and the IEEE Robotics and Automation Society.

Time to socialize with colleagues and potential collaborators is also vital to a good conference, and IROS 2014 provides plenty of opportunities. In addition to the welcome and farewell receptions, the coffee breaks in the Exhibit Hall, and the banquet at the Art Institute of Chicago, the Monday night *Explore Chicago* social events allow attendees to customize their Chicago experience to their own interests. You can experience one of a variety of uniquely Chicago events: a river and lake architecture cruise, a Chicago Cubs baseball game, a show at the Second City Comedy Club, a blues show at Buddy Guy's Legends, or a bicycle ride along the Chicago lakefront, among others.

Putting together an event like this requires a tremendous amount of volunteer effort. We are fortunate to have an outstanding Organizing Committee. If you see one of them, please thank them for their effort!

Special recognition must go to the Conference Paper Review Board, which handled over 5000 reviews of the submitted papers and helped the Senior Program Committee pick the very best contributions for IROS 2014. The technical expertise of the CPRB was invaluable. Our deepest gratitude goes to Wolfram Burgard, the Editor-in-Chief of the CPRB, for his ethical, efficient, and professional handling of the entire review process.

Again, welcome to Chicago. We hope you find IROS 2014 both professionally and personally rewarding!

Kevin Lynch
Northwestern University
IROS 2014 General Chair

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IROS 2014 Venue

Chicago

Chicago was founded in 1837 at the geographically important location between the navigable waterways of the Great Lakes (Lake Michigan) and the Mississippi River. After its founding, it was the fastest growing city in the world for several decades due in large part to its location. The Chicago flag, four stars between two blue stripes, reflects the importance of Chicago's location: the stars represent important events in Chicago's history and the two blue stripes represent the Great Lakes and the Mississippi River.

The Great Chicago Fire broke out in 1871 destroying an area of about 12 square kilometers, a major percentage of the city at the time. The fire gave birth to an urban architectural renewal that included legendary architects such as Daniel Burnham, Louis Sullivan, Frank Lloyd Wright, and Ludwig Mies van der Rohe. The first skyscrapers in the world, built using steel-skeleton construction, also appeared in Chicago soon after the fire. Chicago is now an architectural mecca and boasts the tallest building in the US not counting spires (the Willis Tower) and four of the seven tallest in the US (Trump Tower, Aon Center, and the John Hancock Center). The world's tallest building, the Burj Khalifa, was designed by the Chicago firm of Skidmore, Owings, and Merrill.

In 1893, Chicago hosted the World's Columbian Exposition (the "White City"), where the first Ferris wheel was unveiled. The Chicago Museum of Science and Industry is the only major building remaining from the Columbian Exposition. The University of Chicago is built largely on the site of the Exposition.

The Chicago River, which runs through the center of downtown Chicago, originally flowed into Lake Michigan. Pollution from the city found its way to water intakes in Lake Michigan, fouling the drinking water for Chicagoans. In 1900 a major public works project was completed to reverse the flow of the Chicago River using a series of locks. The river now flows from Lake Michigan toward the Mississippi River. This achievement was named a "Civil Engineering Monument of the Millennium" by the American Society of Civil Engineers.

Today, Chicago is the third largest city in the US, after New York and Los Angeles, with 2.7 million people in the city itself and nearly 10 million in the surrounding "Chicagoland" area. O'Hare International Airport is the second busiest in the world. Chicago is home to several major universities, including Northwestern University, the University of Chicago, the University of Illinois at Chicago, and the Illinois Institute of Technology. It is home to a thriving sports, arts, theater, improvisational comedy, and music scene. Chicago's nicknames include the “Second City” (due to its relationship to New York City; this nickname was also adopted by the famed comedy troupe), the “Windy City” (thought to be due to the weather or perhaps the windbag politicians), and the “City of Big Shoulders” (from a poem by Carl Sandburg).

The Palmer House Hilton

The first Palmer House, known simply as "The Palmer," was built as a wedding present from Potter Palmer to his wife Bertha Honore Palmer. It opened on September 26, 1871, but burned down just 13 days later in the Great Chicago Fire.

Potter Palmer began construction on the second Palmer House immediately after, completing the seven-story building in 1875. It was one of the most lavish hotels in the world at the time.

As business in Chicago continued to boom, supporting a larger hotel, a third Palmer House was built on the site of the second. It was built in stages so that the hotel was never closed. Construction of the 25-floor building was completed in 1925. In 1945 the Palmer House was acquired by Conrad Hilton, becoming the Palmer House Hilton. Today the Palmer House Hilton is well known for its prime location in the Chicago Loop and its extravagant Beaux Arts ceiling mural in the lobby.

The Loop

"The Loop" refers to the central business and arts district of Chicago where the Palmer House Hilton is located. It is believed that the name of "the Loop" derives from the fact that Chicago L trains (elevated trains) run in a loop around this area.

Things to Do

For information on things to do in Chicago, check out the conference website www.iros2014.org, the Choose Chicago website http://www.choosechicago.com/, or tripadvisor.com. The Palmer House Hilton is in a prime location for many Chicago attractions. Attractions within walking distance or a short taxi ride include the Art Institute of Chicago, the Field Museum of Natural History, the Shedd Aquarium, the Adler Planetarium, Navy Pier, the Cloud Gate sculpture (affectionately known as "the Bean") at Millennium Park, shopping on State Street or the Magnificent Mile (North Michigan Avenue), many theaters, the Lyric Opera, the Chicago Symphony Orchestra, the Chicago Cultural Center, boat cruises of the river and lake, and famous architecture such as the Willis Tower, John Hancock Center, the Tribune Tower, the Trump Tower, the Wrigley Building, and the Rookery.

Safety

The area around the Palmer House Hilton is popular with tourists and is safe to walk at all hours. You may encounter panhandlers requesting coins, but they should not be aggressive.

Transportation

By Air

Chicago is served by two major airports, O'Hare International Airport (ORD) and Midway International Airport (MDW). O'Hare is the second-busiest airport in the world with direct connections to many cities nationally and internationally. To get from the airport to the Palmer House, you can take a taxi or the less-expensive Chicago train system (the 'L'). See more information below.

By Taxi

Taxis are available at almost any time at almost any location in the downtown Chicago area. Simply raise your hand to hail a taxi. It is customary to tip the taxi driver 10-20% of the fare for good service.

At O'Hare and Midway, follow the signs from the baggage claim area to the taxi stand. Never accept a ride from a taxi that has not been selected for you by the person working at the taxi stand. A taxi from O'Hare to the Palmer House, 17 East Monroe St, Chicago, costs $40-50 and can take 30 minutes in light traffic and up to 90 minutes in heavy traffic, such as rush hour. A taxi from Midway costs $30-40 and takes 20 minutes to an hour depending on traffic.

Taxis in Chicago are required to accept credit cards in addition to cash.

By the CTA Elevated Train (the 'L')

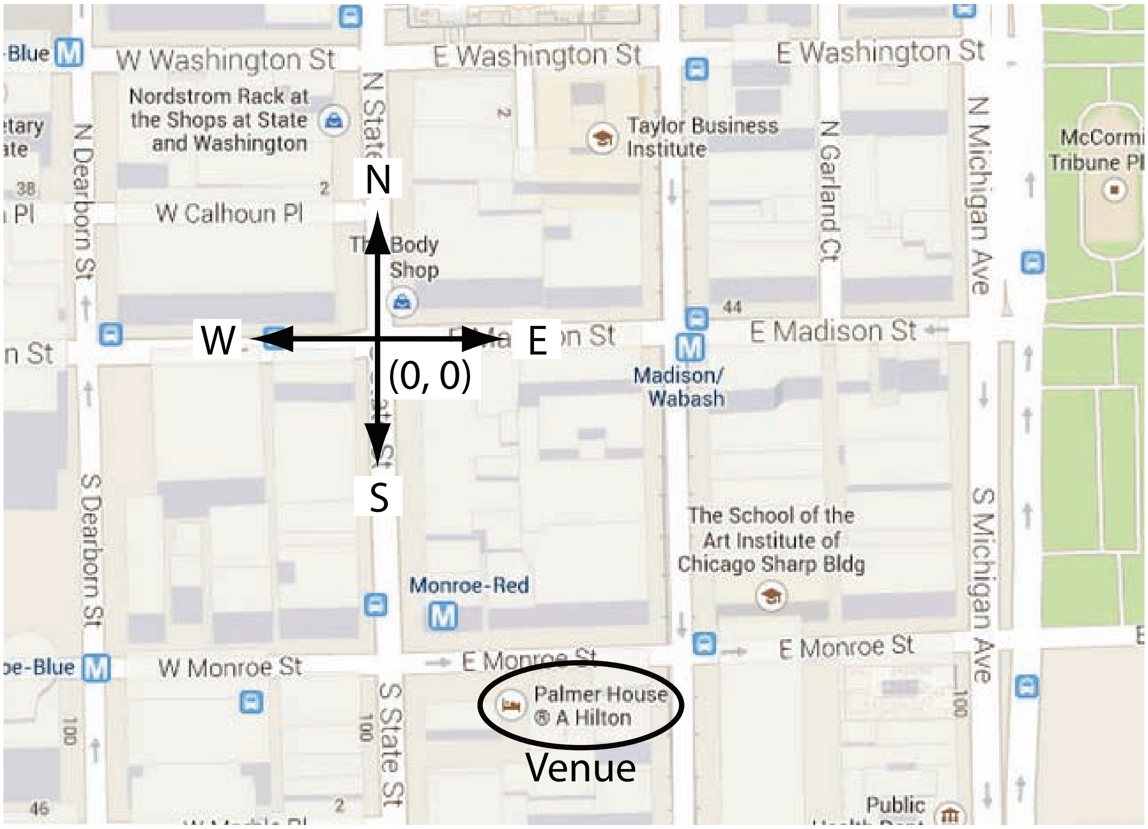
The Chicago Transit Authority (CTA) operates buses and trains. The most convenient is the elevated train system, or 'L.' The L train system serves both major airports and has stops very close to the Palmer House. At the airports, follow the signs for trains to the city. From O'Hare, take the Blue Line 18 stops (about 41 minutes) to the Monroe (Blue Line) station. Walk one block east on Monroe St to the Palmer House. From Midway, take the Orange Line 8 stops (about 24 minutes) to the Harold Washington Library station. Walk three blocks north on State St and turn right (east) on Monroe St to reach the Palmer House.

ALERT: *The Blue Line between O'Hare and Monroe is experiencing occasional periods of construction. You may have to transfer to a bus for part of the ride, then get back on the train to complete your trip. The transfer is free (you just need to use your card again), but this may add 10-20 minutes to your trip. You can check the CTA website as to whether any construction will be occurring when you arrive. If you prefer to avoid the hassle, take a taxi.*

To ride the L, buy a single-ride ticket at a machine at the L station by paying $3.00 (or $5.00 from O'Hare). When you enter the gates to reach the platform, touch your ticket to the card reader. You don't need the card at the exit. The L is an inexpensive alternative to taxis. You can find the L system map and other information at the Chicago Transit Authority website http://www.transitchicago.com/maps.

Walking

The conference location (17 E Monroe St) is in a busy financial, shopping, and arts district, and is in easy walking distance of many attractions and restaurants. Most Chicago streets run east-west or north-south and use a coordinate system, with State St (a north-south street) serving as the zero axis for east-west, and Madison St (an east-west street) serving as the zero axis for north-south. Addresses that differ numerically by 800 in the east-west direction or north-south direction are 1 mile (1.6 km) apart; for example, 800 N Michigan Ave and 400 S Michigan Ave are separated by 1.5 miles (2.4 km). See the coordinate grid below.



Bicycling

Chicago is a bike-friendly city. The easiest biking is along the Lakefront Trail, which runs 18 miles (29 km) along Lake Michigan from the north end of the city to the south end. This is also the best way to see the city. There are also numerous bike lanes within the downtown area. The closest place to rent a bike for an extended bike ride is at the Millennium Park location of Bike and Roll, 239 E Randolph St. For shorter rides, the Chicago Divvy bike system allows you to pay $7.00 for 24-hour use of bikes at convenient locations across the city. As these bikes are intended for transportation from one site to another, each ride must be less than 30 minutes to avoid incurring extra charges. Learn more at the Divvy website.

Social Events

Welcome Reception

Sunday September 14, 18:00-19:30
Grand/State Ballrooms
Meet some friends, have a drink, and kickoff IROS 2014 in style.

Coffee Breaks

Most coffee breaks will take place in the Exhibit Hall. Thanks to SCHUNK for their sponsorship of the coffee breaks.

RSJ Power Lunch

Monday September 15
Grand, State, and Red Lacquer Rooms
Hear about new technologies and products from representatives of IROS 2014 exhibitors and sponsors while you eat lunch. Lunch is complimentary but first-come first-served. Limited quantities are available.

Explore Chicago Social Events

Monday evening September 15
More information on the Monday night *Explore Chicago* social events can be found on subsequent pages.

IEEE RAS Women in Engineering (WiE) Luncheon

Tuesday September 16
Chicago Room, 5th Floor
The WiE luncheon provides an opportunity for all female and male professionals who are interested to discuss the subjects of women's engineering education, career path, career/family choices, and other topics. $5 USD registration required; see http://www.iros2014.org/program/luncheons.

Conference Banquet

Tuesday September 16, 18:30-21:30
Art Institute of Chicago, 111 S Michigan Ave
The world-famous collection of the Art Institute of Chicago is just a two-block walk from the Palmer House Hilton. Several galleries will be open for viewing, and there will be multiple indoor and outdoor food and drink stations.

IEEE RAS Lunch with Leaders (LwL) – Student Luncheon

Wednesday September 17
Crystal Room
Lunch with Leaders (LwL) offers IEEE student members an opportunity to network with RAS leaders and get advice and mentoring on their career and research. $5 USD registration required; see http://www.iros2014.org/program/luncheons.

IEEE RAS Young Professionals Lunch

Wednesday September 17

Chicago Room, 5th Floor

This luncheon is open to recent IEEE graduates, so that they can network with peers and find out more about the benefits of RAS. $5 USD registration required; see http://www.iros2014.org/program/luncheons.

Farewell Party

Wednesday September 17, 17:20-19:00

Interactive Salons

The Farewell Party will be in conjunction with the final interactive session. Robots, beer, and wine, not bad!

Hops ‘n Bots at the Adler Planetarium

Thursday September 18, 18:30-22:30

Adler Planetarium, 1300 S Lake Shore Drive

In honor of IROS 2014, the Adler Planetarium will be holding an after-hours robot-themed craft beer party on Thursday night. This is part of the *Adler After Dark* series, a monthly social event popular with young Chicagoans. See the planetarium, listen to bands, try the featured craft beers, and get the best views of the Chicago skyline, while members of the IROS community participate in a panel discussion and other events. The Adler Planetarium sits on the easternmost point of the Museum Campus, right on Lake Michigan, and is a pleasant 3 km walk from the Palmer House through Grant Park. Tickets are $20 at the door. You can find more information at the Adler’s website http://www.adlerplanetarium.org/adler-after-dark/ .

Explore Chicago Social Events
Monday September 15

On Monday night, eight social events will be held at various spots around Chicago. Each conference registration comes with a ticket to one event. All transit to the social events will be by walking or public transportation (the L). To take the L, use a single-ride ticket when you enter (available for purchase at all stations for $3 if you don't have one); it's not needed at the exit.

It is highly recommended that you meet your group in the Palmer House lobby or near the registration desks at the times indicated below. Further information on the social event locations is given below in case you get separated from your group. Remember the Palmer House is at 17 E Monroe St, at the corner of Monroe St and Wabash Ave.

Bicycling the Lakefront Trail (meet at 5:00 PM in lobby): This is the best way to see the Chicago skyline and lakefront, and to get a little exercise at the same time. The IROS group will be led by several tourguides on a bicycling tour of the city's lakefront.

Bicycles will be leaving from the Bike and Roll storefront at 239 E Randolph St in Millennium Park. This is a 1 km walk from the Palmer House. Go east on Monroe St to Michigan Ave, north on Michigan Ave to Randolph St, and east on Randolph St to 239 E Randolph.

Blues Show at Buddy Guy's Legends (meet at 7:00 PM at the registration desks): Chicago is famous for the blues, the precursor of rock and roll. Buddy Guy, a Chicago blues legend and winner of the National Medal of Arts and the Kennedy Center Honors, runs Buddy Guy's Legends, just down the road from the Palmer House. You will have dinner and enjoy a show at this iconic Chicago club.

Buddy Guy's is at 700 S Wabash Ave, a 1 km walk from the Palmer House. Walk south on Wabash Ave. Dinner will be provided at the show.

Chicago Cubs Baseball Game at Wrigley Field (meet at 5:50 PM in lobby): Wrigley Field is the 100-year-old home of the Chicago Cubs. You will experience the excitement and party atmosphere of Wrigleyville and a game against the Cincinnati Reds. This is recommended for people who like rowdy fun crowds, big outdoor parties, or just want to learn a bit about baseball.

Wrigley Field is a 20-minute ride on the CTA L Red Line (10 km by taxi). Take the Red Line toward Howard from the Monroe station at the corner of State St and Monroe St (½ block west of the Palmer House) and get off at the Addison stop. To return, you can take the Red Line back from Addison, but the station may be very crowded at the end of the game. In that case, it is recommended you make a group of three or four people and take a taxi back to the Palmer House (approximately $20). You may need to walk east on Addison a couple of blocks to get away from the crowds to find an open taxi. Alternatively, leave before the end of the game or hit a Wrigleyville bar after the game until the crowds dissipate. Bars on Clark St are especially popular.

Chicago River and Lake Michigan Cruise (meet at 5:30 PM in lobby): Have a drink, relax, and enjoy the architecture of Chicago at sunset on this cruise of the Chicago River, through the lock, and out to Lake Michigan.

The cruise boats will leave from the dock east of the Trump Tower north of the Chicago River. It is a 1 km walk north on Wabash Ave. After crossing the river, go down to the walkway along the river and go east to the Wendella dock. Drinks will be provided on the boat, but no food.

Chocolate Tasting Tour of Chicago (meet at 5:10 PM in lobby): Take a fun and informative guided walking and tasting tour of Chicago chocolate shops, from secret treasures to famous favorites. The sweetest tour in town!

The tour will start at the Visitor Information Center in the lower level of the Macy's building at 111 N State St. Walk west a half block and then north on State St (less than ½ km).

Goose Island Brew Pub and Brewery Tour (meet at 6:20 PM in lobby): Chicago's original microbrewery. Enjoy some pub fare, a tasting of several of Goose Island's beers, and a tour of the brewery.

Goose Island is at 1800 N Clybourn Ave, 5 km from the Palmer House. To get there, take the CTA L Red Line toward Howard from the Monroe station at the corner of State St and Monroe St (½ block west of the Palmer House) and get off at the North/Clybourn stop. Walk ½ km northwest on Clybourn. Reverse the directions to get back.

Observation Deck at the Willis Tower (meet at 5:30 PM at the registration desks): The Willis Tower (formerly the Sears Tower) is the tallest building in the US (not counting spires) with the highest observation deck, and from the Ledge on the Skydeck you will get great views of Chicago and learn a bit about Chicago's history.

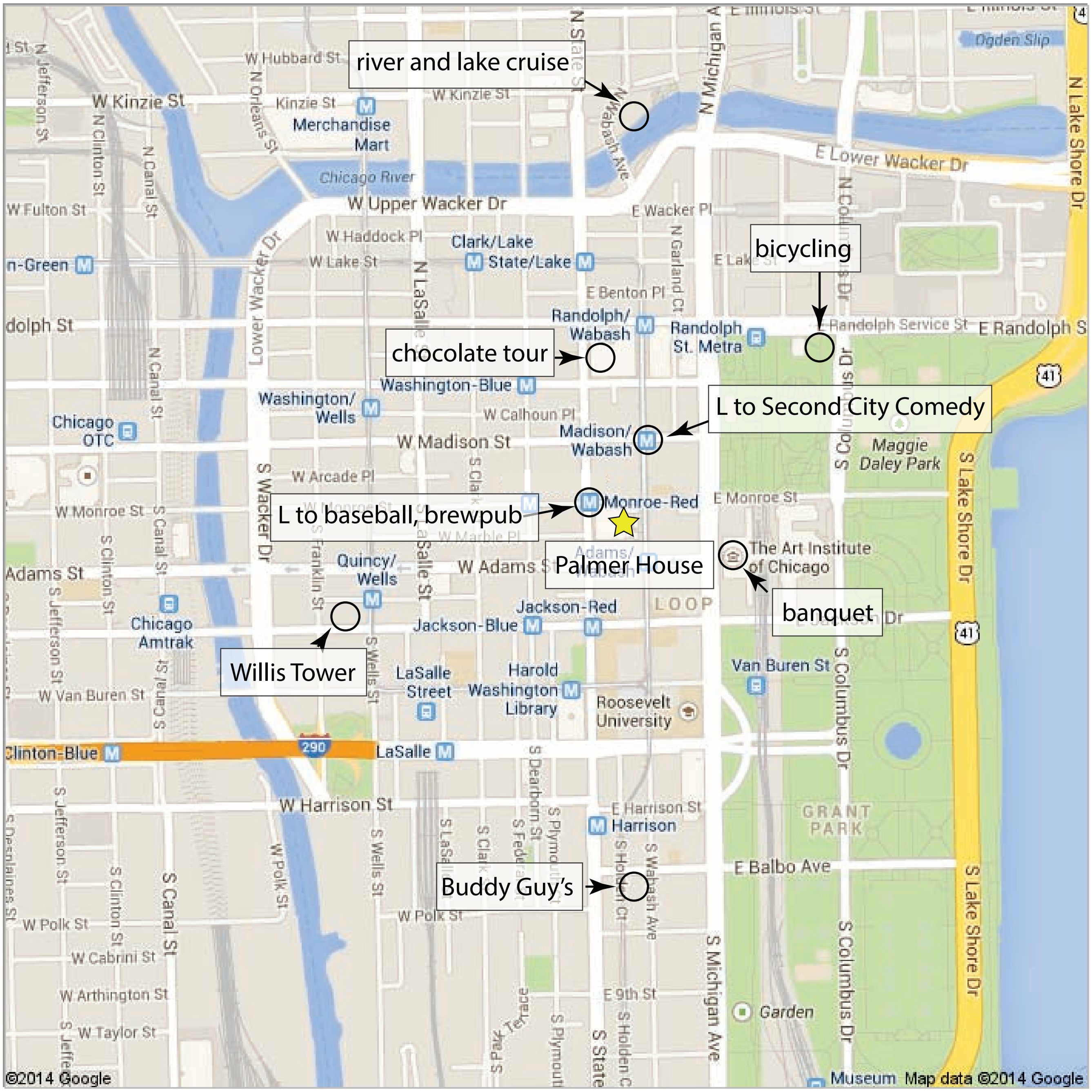
Enter the Willis Tower for the Skydeck on Jackson Ave between Franklin St and Wacker Dr, a 1 km walk. Go west on Monroe St to Franklin St, south on Franklin St, then west on Jackson Ave.

Second City Comedy Show (meet at 6:45 PM in lobby): The Second City Comedy Club is the legendary birthplace of comedians such as Bill Murray, John Belushi, Tina Fey, and Stephen Colbert. You will see a revue of the Best of Second City at a show reserved for IROS attendees.

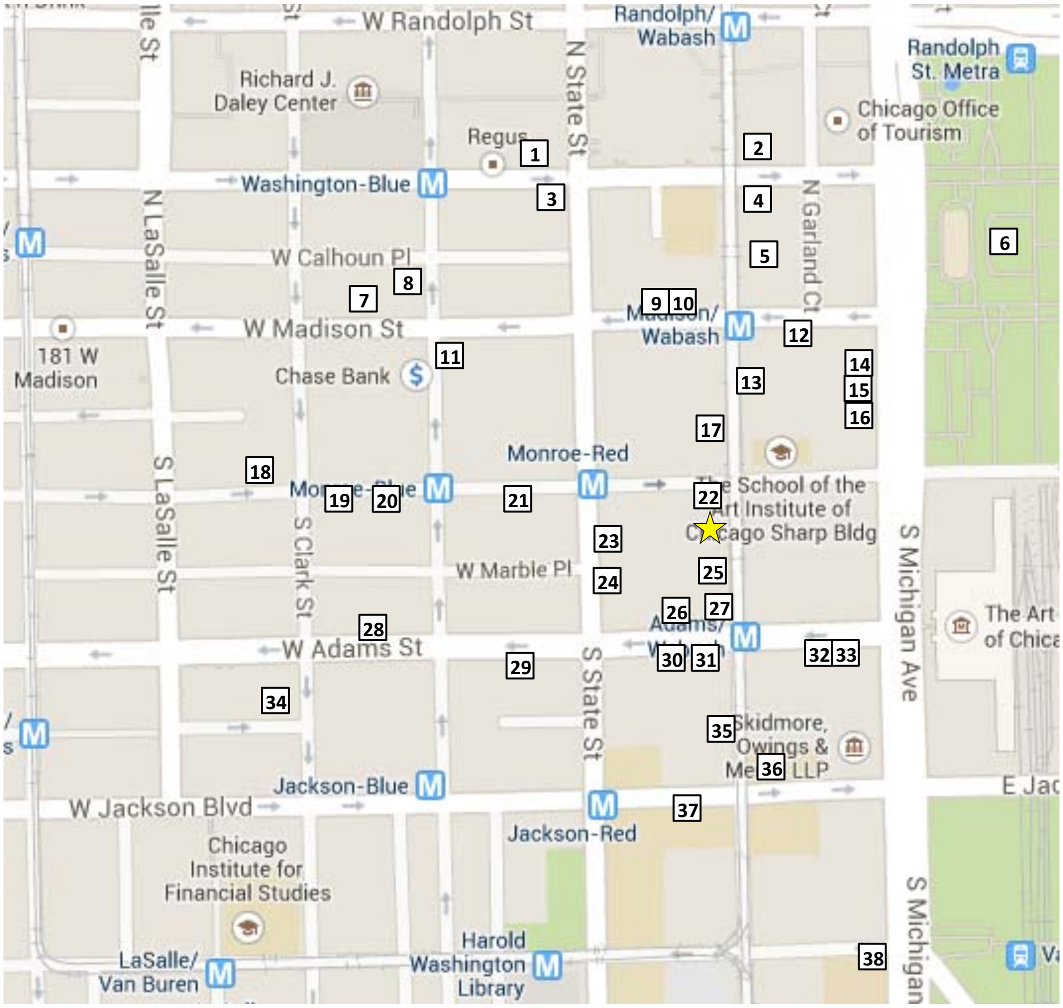
Second City is at 1616 N Wells St, 4.5 km from the Palmer House. Take the CTA L Brown Line toward Kimball from the Madison/Wabash station (1 block north on Wabash) to the Sedgwick station. Then walk 1 block north to North Ave, east on North Ave to Wells St, then north on Wells St (about a ½ km walk). To go back to the Palmer House, you can take the Brown Line in the other direction, but it will loop around the downtown Loop before returning to Madison/Wabash, adding 5 minutes to your trip.

Social Event Map

For the Monday night Explore Chicago events, please meet your group in the lobby or registration desk as indicated on the previous page; do not go directly to the event site.



IROS 2014 Nearby Dining



Inexpensive ($)

1. Which Wich (Sandwiches)
4. Pittsfield Café (Diner, Brunch)
5. Oasis Café (Mediterranean)
9. Jimmy John's (Sandwiches)
10. Chipotle (Mexican, Fast Food)
13. Popeye's (Chicken, Fast Food)
18. I Dream of Falafel (Middle Eastern)
19. Pret A Manger (Café, Sandwiches)
20. Potbelly Sandwich Shop (Sandwiches)
22. Corner Bakery Café (Café, Bakery)
26. Max's Take Out (Fast Food)
27. McDonalds (Fast Food)
28. Zoup! (Café, Sandwiches)
30. America's Dog (Hot Dogs, Fast Food)
31. Halo Asian Mix (Asian Fusion)
32. Panda Express (Chinese, Fast Food)
36. Abou Andre (Middle Eastern, Mediterranean)
38. Osaka Express (Japanese)

Moderate ($$)

2. Heaven on Seven (Southern, Cajun/Creole)
6. Park Grill (New American)
7. Rosebud Theater District (Italian)
12. Pizano's Pizza & Pasta (Pizza, Italian)
16. Hot Woks Cool Sushi (Japanese, Asian)
17. Flat Top Stir-Fry Grill (Asian Fusion, Grill)
21. The Grillroom (Steakhouse)
23. Freshii (Vegetarian, New American)
24. Beef and Brandy (Traditional American)
25. Miller's Pub (Pub, Traditional American)
29. Berghoff Restaurant (German)
34. Native Foods Café (Vegetarian)
35. Exchequer (Pub, Pizza, Steakhouse)
37. Pazzo's Cucina Italiana (Italian)

Expensive ($$$)

Lockwood Palmer House (New American)

3. Atwood Café (New American)
8. Trattoria No. 10 (Italian)
11. Rosebud Prime (Steakhouse)
14. Henri (French)
15. The Gage (New American, Gastropub)
33. Russian Tea Time (Russian)

	Restaurant Name	Price	Style	Address	Website	Phone Number
	Lockwood (Palmer House)	$$$	American (New)	17 East Monroe Street	www.lockwoodrestaurant.com	(312) 917-3404
1	Which Wich	$	Sandwiches	108 North State Street #002	www.whichwich.com	(312) 658-0030
2	Heaven on Seven	$$	Southern, Cajun/Creole	111 North Wabash Avenue	www.heavenonseven.com	(312) 263-6443
3	Atwood	$$$	American (New)	1 West Washington Street	www.atwoodcafe.com	(312) 368-1900
4	Pittsfield Cafe	$	Diner, Brunch	55 East Washington Street	www.pittsfield55.com	(312) 641-1806
5	Oasis Cafe	$	Mediterranean	21 North Wabash Avenue #11	www.oasiscafeone.com	(312) 443-9534
6	Park Grill	$$	American (New)	11 North Michigan Avenue	www.parkgrillchicago.com	(312) 521-7275
7	Rosebud Theater District	$$	Italian	70 West Madison Street	www.rosebudrestaurants.com	(312) 332-9500
8	Trattoria No. 10	$$$	Italian	10 North Dearborn Street #1	www.trattoriaten.com	(312) 984-1718
9	Jimmy John's	$	Sandwiches, Deli	6 East Madison Street	www.jimmyjohns.com	(312) 368-4444
10	Chipotle	$	Mexican, Fast Food	8 East Madison Street	www.chipotle.com	(312) 629-3662
11	Rosebud Prime	$$$	Steakhouse	1 South Dearborn Street	www.rosebudrestaurants.com	(312) 384-1900
12	Pizano's Pizza & Pasta	$$	Pizza, Italian	61 East Madison Street	www.pizanoschicago.com	(312) 236-1777
13	Popeye's	$	Fast Food, Chicken	17 South Wabash Avenue	www.popeyes.com	(312) 372-8855
14	Henri	$$$	French	18 South Michigan Avenue	www.henrichicago.com	(312) 578-0763
15	The Gage	$$$	American (New), Gastropub	24 South Michigan Avenue	www.thegagechicago.com	(312) 372-4243
16	Hot Woks Cool Sushi	$$	Japanese, Chinese, Thai	30 South Michigan Avenue	www.hotwokscoolsushi.com	(312) 345-1234
17	Flat Top Stir-Fry Grill	$$	Asian Fusion, Grill	30 South Wabash Avenue	www.flattopgrill.com	(312) 726-8400
18	I Dream of Falafel	$	Middle Eastern	112 West Monroe Street	www.idreamoffalafel.com	(312) 263-4363
19	Pret A Manger	$	Cafe, Sandwiches	73 West Monroe Street	www.pret.com	(312) 260-4301
20	Potbelly Sandwich Shop	$	Sandwiches, Deli	55 West Monroe Street	www.potbelly.com	(312) 577-0070
21	The Grillroom	$$	Steakhouse	33 West Monroe Street	www.grillroom-chicago.com	(312) 960-0000
22	Corner Bakery Cafe	$	Cafe, Bakery	35 East Monroe Street	www.cornerbakerycafe.com	(312) 372-0072
23	Freshii Palmer House	$$	Vegetarian, American (New)	17 East Monroe Street #10	www.freshii.com	(312) 419-1777
24	Beef and Brandy	$$	American (Traditional)	127 South State Street	www.beefbrandy.net	(312) 372-3451
25	Miller's Pub	$$	Pub, American (Traditional)	134 South Wabash Avenue	www.millerspub.com	(312) 263-4988
26	Max's Take Out	$	Fast Food	20 East Adams Street	www.maxstakeoutchicago.com	(312) 553-0170
27	McDonalds	$	Fast Food	144 South Wabash Avenue	www.mcdonalds.com	(773) 218-8516
28	Zoup!	$	Cafe, Sandwiches	62 West Adams Street	www.zoup.com	(312) 470-9797
29	Berghoff Restaurant	$$	German	17 West Adams Street	www.theberghoff.com	(312) 427-3170
30	America's Dog	$	Hot Dogs, Fast Food	21 East Adams Street	www.americasdog.com	(312) 786-0100
31	Halo Asian Mix	$	Asian Fusion	29 East Adams Street	www.haloasianmix.com	(312) 360-1111
32	Panda Express	$	Chinese, Fast Food	77 East Adams Street	www.pandaexpress.com	(312) 986-1043
33	Russian Tea Time	$$$	Russian	77 East Adams Street	www.russianteatime.com	(312) 360-0000
34	Native Foods Cafe	$$	Vegetarian	218 South Clark Street	www.nativefoods.com	(312) 332-6332
35	Exchequer	$$	Pub, Pizza, Steakhouse	226 South Wabash Avenue	www.exchequerpub.com	(312) 939-5633
36	Abou Andre	$	Middle Eastern, Mediterranean	60 East Jackson Boulevard	www.abouandre.com	(312) 386-1300
37	Pazzo's Cucina Italiana	$$	Italian	23 East Jackson Boulevard	www.pazzoscucina.com	(312) 386-9400
38	Osaka Express	$	Japanese	400 South Michigan Avenue	www.osaka2go.com	(312) 566-0118

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www.intuitivesurgical.com

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www.irobot.com

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www.kustar.ac.ae

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www.northwestern.edu

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Intelligent Supply Network Automation
www.symbotic.com

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www.toyota-global.com

WEISS ROBOTICS
www.weiss-robotics.de/en

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Harmonic Drive, LLC
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www.haption.com

Hokuyo Automatic Co, Ltd
www.hokuyo-aut.jp

IEEE Media Recruitment Services
careers.ieee.org

Kinova
kinovarobotics.com

Makerbot
www.makerbot.com

Mathworks
www.mathworks.com

MIT Press
mitpress.mit.edu

Natural Machine Motion Initiative
www.centropiaggio.unipi.it

Occam Vision Group
www.occamvisiongroup.com

OptoForce
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www.ptiphoenix.com

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Shadow Robot Company
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SimLab
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Technical Program

Plenary I

The Quest for Robotic Vision
Peter Corke
Queensland University of Technology, Australia
Monday September 15, 8:20-9:10
Grand/State Ballroom

Abstract

The technologies of robotics and computer vision are each over 50 years old. Once upon a time they were closely related and investigated, separately and together, in AI labs around the world. Vision has always been a hard problem, and early roboticists struggled to make vision work using the slow computers of the day — particularly for metric problems like understanding the geometry of the world. In the 1990s affordable laser rangefinders entered the scene and roboticists adopted them with enthusiasm, delighted with the metric information they could provide. Since that time laser-based perception has come to dominate robotics, while processing images from databases, not from robots, has come to dominate computer vision. What happened to that early partnership between robotics and vision? Is it forever broken, or is now the time to reconsider vision as an effective sensor for robotics? This talk will trace the history of robotics and vision, examine the state of the art and discuss what may happen in the future.

Biography

Peter Corke is Professor of Robotics and Control at Queensland University of Technology, and Director of the Australian Centre of Excellence for Robotic Vision. His research spans topics including visual servoing, high-speed hardware for machine vision, field robotics, particularly for mining and environmental monitoring, and sensor networks. He has written two books: "Robotics, Vision & Control" (2011) and "Visual Control of Robots" (1997); developed the Robotics and Machine Vision Toolboxes for MATLAB; was Editor-in-Chief of the IEEE Robotics and Automation magazine (2010-13); was a founding editor of the Journal of Field Robotics; is a member of the editorial boards of the International Journal of Robotics Research and the Springer STAR series; and is a Fellow of the IEEE. He received a Bachelor of Engineering (Electrical), Masters and PhD all from the University of Melbourne.

Plenary II

Development of Neural Interfaces for Robotic Prosthetic Limbs

Todd Kuiken
Rehabilitation Inst of Chicago and Northwestern University

Tuesday September 16, 8:00-8:50
Grand/State Ballroom

Abstract

The ability to control complex robot prostheses is evolving quickly. I will describe research at the Center for Bionic Medicine/Rehabilitation Institute of Chicago and Northwestern University to develop a neural-machine interface to improve the function of artificial limbs. We have developed a surgical technique called Targeted Reinnervation to use nerve transfers for improvement of robotic arm control and to provide sensation of the missing hand. By transferring the residual arm nerves in an upper limb amputee to spare regions of muscle it is possible to make new electromyographic (EMG) signals for the control of robotic arms. These signals are directly related to the original function of the lost limb and allow simultaneous control of multiple joints in a natural way. This work has now been extended by the use of pattern recognition algorithms that decode the user's intent, enabling the intuitive control of many more functions of the prostheses. Similarly, hand sensation nerves can be made to grow into spare skin on the residual limb so that when this skin is touched, the amputee feels like their missing hand is being touched. This is a potential port to providing physiologically correct sensory feedback to amputees. Our team is now also developing a neural interface for powered leg prostheses that enables intuitive mobility based on a fusion of residual limb EMG and sensors in the robotic leg.

Biography

Todd A. Kuiken received a B.S. degree in biomedical engineering from Duke University (1983), a Ph.D. in biomedical engineering from Northwestern University in Evanston, Illinois (1989) and an M.D. from Northwestern University Medical School (1990). He is a board-certified physiatrist at the Rehabilitation Institute of Chicago. He is the Director of the Center for Bionic Medicine at the Rehabilitation Institute of Chicago and a Professor in the Depts. of Physical Medicine and Rehabilitation, Bioomedical Engineering, and Surgery at Northwestern University. Dr. Kuiken is an internationally respected leader in the care of people with limb loss, both as an active treating physician and as a research scientist. He developed a novel surgical technique called Targeted Reinnervation which has now been successfully performed on over 100 people with amputations worldwide. His research is broadly published in journals including the New England Journal of Medicine, JAMA, Lancet and PNAS.

Plenary III

From Visual SLAM to Generic Real-time 3D Scene Perception
Andrew Davison
Imperial College London
Wednesday September 17, 8:00-8:50
Grand/State Ballroom

Abstract

I will argue that a coherent stream of research in robotics and computer vision is leading us from the visual SLAM systems of the past 15+ years towards the generic real-time 3D scene understanding capabilities which will enable the next generation of smart robots and mobile devices.

SLAM is the problem of joint estimation of a robot's motion and the structure of the environment it moves through, and cameras of a variety of types are now the main outward looking sensors used to achieve this. While early visual SLAM systems concentrated on real-time localisation as their main output, the latest ones are now capable of dense and detailed 3D reconstruction and, increasingly, semantic labelling and object awareness. A crucial factor in this progress has been how continuing improvements in commodity processing performance has enabled algorithms previously considered "off-line" in computer vision research to become part of real-time systems. But we believe this is far from the whole story: when estimation of qualities such as object identity is undertaken during a real-time loop together with localisation, 3D reconstruction and possibly even interaction or manipulation, the predictions and context continuously available should make things much easier; leading to robustness and computational efficiency which feeds back and is self-reinforcing. This in our view is what keeps progress towards generic real-time scene understanding firmly in the domain of the SLAM ways of thinking, where incremental, real-time processing is used to make globally consistent scene estimates by repeatedly comparing live data against predictions and update probabilistic models accordingly.

I will describe and connect much of the research that I and others have conducted in Visual SLAM over the recent years, with examples from my own work from MonoSLAM through systems like DTAM, KinectFusion and SLAM++.

Biography

Andrew Davison received the B.A. degree in physics and the D.Phil. degree in computer vision from the University of Oxford in 1994 and 1998, respectively. In his doctorate with Prof. David Murray at Oxford's Robotics Research Group he developed one of the first robot SLAM systems using vision. He spent two years as a post-doc at AIST, Tsukuba, Japan, where he continued to work on visual robot navigation. In 2000 he returned to the University of Oxford and as an EPSRC Advanced Research Fellow from 2002 he developed the well known MonoSLAM algorithm for real-time SLAM with a single camera. He joined Imperial College London as a Lecturer in 2005, held an ERC Starting Grant from 2008 to 2013 and was promoted to Professor in 2012. His Robot Vision Research Group continues to focus on advancing the basic technology of real-time localisation and mapping using vision, publishing advances in particular on real-time dense reconstruction and tracking, large scale map optimisation, high speed vision and tracking, object-level mapping and the use of parallel processing in vision. He maintains a deep interest in exploring the limits of computational efficiency in real-time vision problems. In 2014 he became the founding Director of the new Dyson Robotics Laboratory at Imperial College, a lab working on the applications of computer vision to real-world domestic robots where there is much potential to open up new product categories.

Special Events

Conference Welcome

Monday September 15, 8:00-8:20
Grand/State Ballrooms
Chair: Kevin Lynch
The official conference opening will precede Plenary I.

Government Forum

Monday September 15, 13:50-16:40
Crystal Room
Chair: Vijay Kumar, University of Pennsylvania
Policy makers from government and funding agencies in Asia, North America and Europe will talk about government funding priorities and government policy as it relates to robotics, and leaders in academia will outline new opportunities for engaging with government agencies to promote robotics research and development. The forum will consist of two sessions. Each session will consist of opening statements and a moderated question and answer session in which active audience participation is encouraged.

Panelists include Herman Bruyninckx (SPARC Initiative, Europe), Greg Hager (Computing Community Consortium, USA), Juha Heikkila (European Commission), Zexiang Li (Hong Kong University of Science and Technology), Atsushi Mano (NEDO, Japan), Sang-Rok Oh (KAIST, Korea), Jeff Trinkle (National Science Foundation, USA) , Richard Voyles (White House Office of Science and Technology, USA), and Alex Zelinsky (Chief Defense Scientist, Australia).

Industry Forum
Perspectives on Entrepreneurship in Robotics and Automation

Tuesday September 16, 9:00-17:55
Crystal Room
Chairs: Raj Madhavan, University of Maryland and Torsten Kroeger, Google
This forum brings together leading robotics companies and startups to formulate an action plan on the topic of entrepreneurship. With several high-profile robotics acquisitions in the past few years, robotics and automation technologies have been thrust into the crosshairs of the tech community's periscope.

This forum will provide a platform for stakeholders from academia, industry, government, and end-user communities to share their experiences, failures, suggestions, and wishlists. The forum will consist of 12-15 speakers, from startups, SMEs, large companies, and the venture capitalist community, followed by a panel discussion with participation from all attendees. The discussion will be captured in a white paper. The intended audience is graduate students, researchers, roboticists, and anyone interested in entrepreneurial topics in robotics and automation.

Speakers include Brandon Basso (3D Robotics, USA), Francois Boucher (Kinova, Canada), Guy Caverot (BA Systemes, France), Renaud Champion (Robolution Capital, France), Shahin Farshchi (Lux Capital, USA), Ryan Gariepy (Clearpath Robotics, Canada), SK Gupta (National Science Foundation, USA), Ayanna Howard (Zyrobotics, USA), Christopher Parlitz (SCHUNK, Germany), Michael Peshkin (Northwestern U, USA), Erwin Prassler (euRobotics TG Entrepreneurship), and Shafa Wala (Tarsier Inc., USA).

Awards Ceremony

Wednesday September 17, 13:10-13:50
Grand/State Ballrooms
IROS 2014 will present the following awards at a ceremony after lunch on Wednesday:

- IROS Harashima Award for Innovative Technologies
- NTF Award for Entertainment Robots and Systems
- JTCF Novel Technology Paper Award for Amusement Culture
- RoboCup Best Paper Award
- CoTeSys Cognitive Robotics Best Paper Award
- ICROS Best Application Paper Award
- ABB Best Student Paper Award
- Best Paper Award

The Harashima Award for Innovative Technologies honors Professor Fumio Harashima, the Honorary Founding Chair of IROS, by recognizing outstanding contributions of an individual of the IROS community who has pioneered activities in robotics and intelligent systems.

Paper awards are described on subsequent pages.

Kinect Autonomous Mobile Robot Navigation Contest

Thursday September 18, 8:00-17:00
Exhibit Hall
On Thursday September 18, the Exhibit Hall transforms into the site for this day-long mobile robot navigation contest, sponsored by Microsoft and Adept Mobile Robots. Ten pre-qualified teams will compete for navigation supremacy in a natural café-like environment.

Technical Tour
Rehabilitation Institute of Chicago and Northwestern University

Thursday September 18, 14:00-17:00
345 E Superior St
This tour will visit robotics labs of the Rehabilitation Institute of Chicago (RIC), which is closely tied to Northwestern University and its Neuroscience and Robotics Lab (NxR).

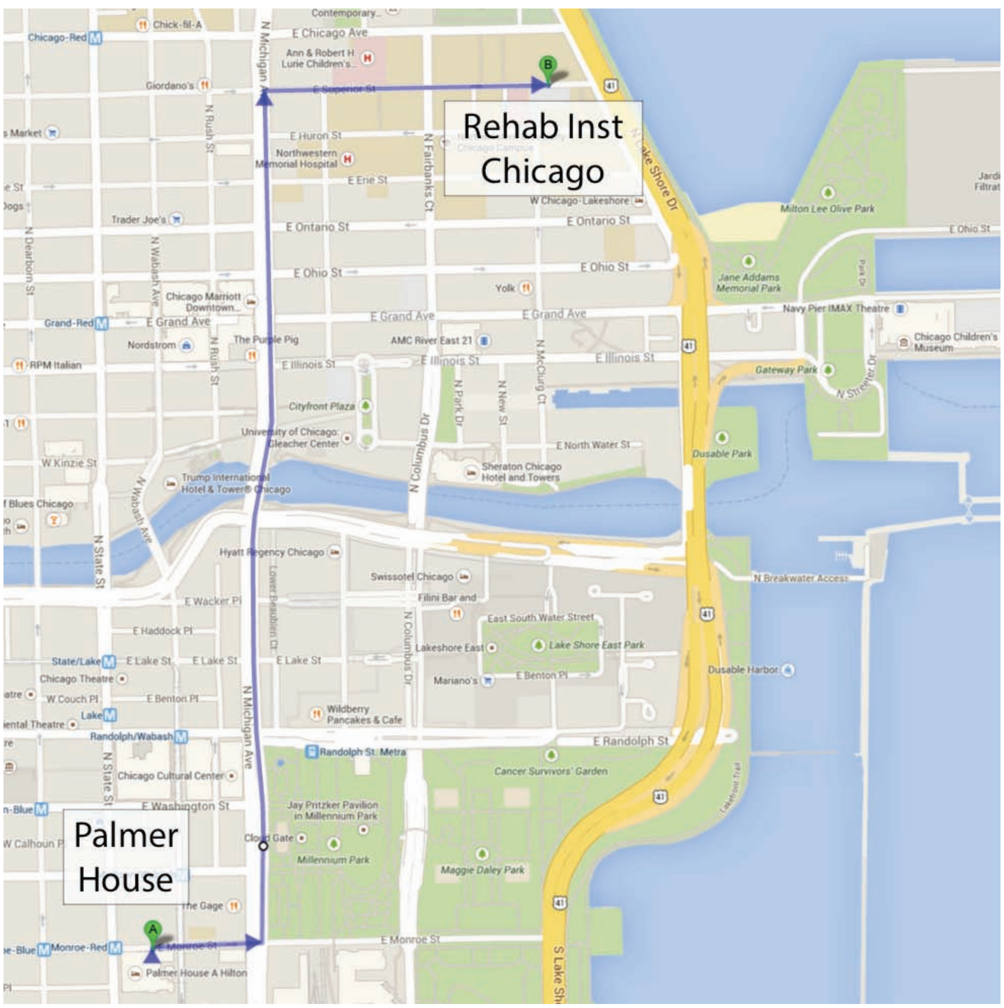
The Rehabilitation Institute of Chicago (RIC) is the world’s leading hospital and research enterprise in physical medicine and rehabilitation, ranked #1 by World & News Report for 23 consecutive years. Our mission is rooted in our dedication to providing the highest-quality patient care and outcomes through integrated research, scientific discovery, and education. Our patients drive our passion, and motivate us to continually improve, delivering better outcomes and achieving faster recoveries. No other rehabilitation hospital in the nation carries six research designations from U.S. government agencies, including the National Institute on Disability and Rehabilitation Research and the National Institutes of Health, to develop breakthrough treatments. RIC's research discoveries set new standards and protocols in rehabilitation hospitals around the world.

Northwestern University was founded in 1851, and has grown into one of the nation's premier research institutions. Two campuses are located on Lake Michigan, one in Evanston, the first suburb north of Chicago, and one in downtown Chicago. Northwestern has 12 schools and colleges, 10 of which offer graduate and professional programs, and is home to more than 8,000 full-time undergraduates and 8,000 full-time graduate students. The Neuroscience and Robotics Lab (NxR) at Northwestern University is a collaboration among faculty and students in Northwestern's Departments of Mechanical Engineering, Biomedical Engineering, Interdepartmental Neuroscience Program, and Electrical Engineering and Computer Science, as well as the Rehabilitation Institute of Chicago. Our research focuses on robotics, neuroscience, bio-inspired robotics, and robotics-inspired neuromechanics.

Tickets are purchased through the registration site.

Getting There: The tour will take place entirely at RIC (no trip to Northwestern's main campus in Evanston). Attendees are responsible for their own transportation to RIC.

RIC is located at 345 E Superior St, 2.5 km from the Palmer House. It is easily accessible by walking, taxi, bus, or subway. Walk east from the Palmer House to Michigan Ave, 1.6 km north on Michigan Ave to Superior St, then east on Superior St to the destination.



Paper Awards

At the Senior Program Committee (SPC) meeting, the Awards Chairs and the SPC intersected the set of highly-reviewed papers with the criteria for each of the seven paper awards. Papers were eligible to be considered in more than one category. Based on this intersection, a set of semifinalist papers for each award was chosen. These papers were then sent to subcommittees, one for each award. These subcommittees independently reviewed the papers to arrive at a set of finalists for each award. Award winners will be chosen by the subcommittees based on the quality of the paper and the presentation at IROS 2014.

NTF Award for Entertainment Robots and Systems Finalists

This award is to encourage research and development of "entertainment robots and systems" and new technologies for future entertainment. Sponsored by the New Technology Foundation.

A Gesture Recognition System for Mobile Robots that Learns Online
Alan Hamlet; Emami, Patrick
TuB2.2

A Solution to Pose Ambiguity of Visual Markers Using Moire Patterns
Tanaka, Hideyuki; Sumi, Yasushi; Matsumoto, Yoshio
TuD3.15

JTCF Novel Technology Paper Award for Amusement Culture Finalists

This award recognizes practical technology contributing to toys, toy models, and amusement culture. Sponsored by the Japan Toy Culture Foundation.

Multi-arm Robotic Swimming with Octopus-inspired Compliant Web
Sfakiotakis, Michael; Kazakidi, Asimina; Chatzidaki, Avgousta; Evdaimon, Theodoros; Tsakiris, Dimitris
MoA3.7

Design of paper mechatronics: Towards a fully printed robot
Shigemune, Hiroki; Maeda, Shingo; Hara, Yusuke; Hashimoto, Shuji
MoB2.3

An Untethered Jumping Soft Robot
Tolley, Michael Thomas; Shepherd, Robert; Karpelson, Michael; Bartlett, Nicholas; Galloway, Kevin; Wehner, Michael; Nunes, Rui; Whitesides, George; Wood, Robert
MoB2.7

RoboCup Best Paper Award Finalists

For work in localization, navigation, mobility, and teamwork technologies, with applications to areas such as team sports, search and rescue, personal and home robotics, education, and others. Sponsored by the RoboCup Federation.

Environment-independent Formation Flight for Micro Aerial Vehicles
Naegeli, Tobias; Conte, Christian; domahidi, alexander; Morari, Manfred; Hilliges, Otmar
MoC3.13

The Response Robotics Summer School 2013: Bringing Responders and Researchers Together to Advance Response Robotics
Sheh, Raymond Ka-Man; Collidge, Bill; Lazarescu, Mihai; Komsuoglu, Haldun; Jacoff, Adam
TuA3.2

Finding and Navigating to Household Objects with UHF RFID Tags by Optimizing RF Signal Strength
Deyle, Travis; Reynolds, Matthew; Kemp, Charlie
TuC2.12

CoTeSys Cognitive Robotics Best Paper Award Finalists

This award is for interdisciplinary research on cognition for technical systems (CoTeSys) and advancements of cognitive robots in industry, home applications, and daily life. Sponsored by the German Cluster of Excellence CoTeSys.

Learning Haptic Representation for Manipulating Deformable Food Objects
Gemici, Mevlana Celaleddin; Saxena, Ashutosh
MoB2.18

Online Interactive Perception of Articulated Objects with Multi-Level Recursive Estimation Based on Task-Specific Priors
Martin Martin, Roberto; Brock, Oliver
TuC1.19

Combining Top-down Spatial Reasoning and Bottom-up Object Class Recognition for Scene Understanding
Kunze, Lars; Burbridge, Christopher; Alberti, Marina; Thippur, Akshaya; Folkesson, John; Jensfelt, Patric; Hawes, Nick
TuD2.3

ICROS Best Application Paper Award Finalists

Sponsored by the Institute of Control, Robotics, and Systems (ICROS).

Workspace Characterization for Concentric Tube Continuum Robots
Burgner-Kahrs, Jessica; Gilbert, Hunter B.; Granna, Josephine; Swaney, Philip J.; Webster III, Robert James
MoD1.12

Toward Automated Intraocular Laser Surgery Using Handheld Micromanipulator
Yang, Sungwook; MacLachlan, Robert A.; Riviere, Cameron N.
MoD1.17

Study of Reconfigurable Suspended Cable-Driven Parallel Robots for Airplane Maintenance
Nguyen, Dinh Quan; Gouttefarde, Marc
TuA1.14

Preliminary Evaluation of a New Control Approach to Achieve Speed Adaptation in Robotic Transfemoral Prosthesis
Lenzi, Tommaso; Hargrove, Levi; Sensinger, Jonathon
TuB1.12

Soft Landing of Capsule by Casting Manipulator System
Arisumi, Hitoshi; Otsuki, Masatsugu; Nishida, Shin-Ichiro
TuB3.18

ABB Best Student Paper Award Finalists

This award recognizes the most outstanding paper authored primarily by, and presented by, a student. Sponsored by ABB.

Visual Localization within LIDAR Maps for Automated Urban Driving
Wolcott, Ryan; Eustice, Ryan
MoA2.8

Non-vector Space Stochastic Control for Nano Robotic Manipulations
Zhao, Jianguo; Song, Bo; Xi, Ning
MoC1.11

Remote Vertical Exploration by Active Scope Camera into Collapsed Buildings
Fukuda, Junichi; Konyo, Masashi; Takeuchi, Eijiro; Tadokoro, Satoshi
TuA3.5

An Estimation Model for Footstep Modifications of Biped Robots
Wittmann, Robert; Hildebrandt, Arne-Christoph; Ewald, Alexander; Buschmann, Thomas
TuC2.11

Online Interactive Perception of Articulated Objects with Multi-Level Recursive Estimation Based on Task-Specific Priors
Martin Martin, Roberto; Brock, Oliver
TuC1.19

Best Paper Award Finalists

This award recognizes the most outstanding paper presented at the conference.

Multi-arm Robotic Swimming with Octopus-inspired Compliant Web
Sfakiotakis, Michael; Kazakidi, Asimina; Chatzidaki, Avgousta; Evdaimon, Theodoros; Tsakiris, Dimitris
MoA3.7

Remote Vertical Exploration by Active Scope Camera into Collapsed Buildings
Fukuda, Junichi; Konyo, Masashi; Takeuchi, Eijiro; Tadokoro, Satoshi
TuA3.5

Simultaneously Powering and Controlling Many Actuators With a Clinical MRI Scanner
Becker, Aaron; Felfoul, Ouajdi; Dupont, Pierre
TuB1.7

An Estimation Model for Footstep Modifications of Biped Robots
Wittmann, Robert; Hildebrandt, Arne-Christoph; Ewald, Alexander; Buschmann, Thomas
TuC2.11

Online Interactive Perception of Articulated Objects with Multi-Level Recursive Estimation Based on Task-Specific Priors
Martin Martin, Roberto; Brock, Oliver
TuC1.19

Cogeneration of Mechanical, Electrical, and Software Designs for Printable Robots from Structural Specifications
Mehta, Ankur; DelPreto, Joseph; Shaya, Benjamin; Rus, Daniela
TuD1.19

IROS 2014 Workshops and Tutorials

Coffee breaks are at 10:00-10:30 and 15:00-15:30.

Sunday September 14			
SuAM1	8:30-12:00	Grand	An Open-source Recipe for Teaching (and Learning) Robotics with a Simulator: Setup a Laptop in 5 Minutes, Write a Control, Navigation, Vision or Manipulation Program in 100 Lines of Code *Renaud Detry, Peter Corke, Marc Andreas Freese*
SuAM2	8:30-12:00	State	Taxonomies of Interconnected Systems: Topology in Distributed Robotics *Ryan Williams, Andrea Gasparri, Gaurav Sukhatme*
SuPM1	13:30-17:00	Grand	How to Use MATLAB-ROS Interface to Prototype Robotics Algorithms for ROS-powered Robots *Yanliang Zhang*
SuPM2	13:30-17:00	State	Aerial Open Source Robotics *Lorenz Meier, Markus W. Achtelik, Brandon Basso*
SuFD3	8:30-17:00	Salon 1	Human-robot Collaboration in Standardization and R&D Activities *Gurvinder Singh Virk, Roger Bostelman, Seungbin B. Moon, Tamas Haidegger, Fabio Paolo Bonsignorio, Federico Vicentini, Paolo Barattini*
SuFD4	8:30-17:00	Salon 2	The 2014 IROS Workshop on AI and Robotics *Lorenzo Riano, Alessandro Saffiotti, Moritz Tenorth, George Dimitri Konidaris, Nick Hawes, Siddharth Srivastava*
SuFD5	8:30-17:00	Salon 3	Machine Learning in Planning and Control of Robot Motion Workshop *Maria Gini, Marco Morales, Angela P. Schoellig, Lydia Tapia, Aleksandra Faust, Farbod Farshidian*
SuFD6	8:30-17:00	Salon 5	Modular and Swarm Systems — from Nature to Robotics *Roderich Gross, Rico Moeckel, Michael Rubenstein, Kasper Stoy*
SuFD7	8:30-17:00	Salon 6	Micro-Nano Robotic Swarms for Biomedical Applications *Spring Berman, Sabine Hauert, Sangeeta Bhatia, Bradley Nelson, Vijay Kumar*
SuFD8	8:30-17:00	Salon 7	From Active Impedance to Intrinsically Compliant and Variable Impedance Actuators: Pros, Cons and Trade-offs *Nikolaos Tsagarakis, Bram Vanderborght, Luis Sentis*
SuFD9	8:30-17:00	Salon 8	Assistive Robots for Individuals with Disabilities: HRI Issues and Beyond *Hae Won Park, Momotaz Begum, Chung Hyuk Park*
SuFD10	8:30-17:00	Salon 9	Assistance and Service Robotics in a Human Environment *Anne Spalanzani, David Daney, Samer Mohammed, Yacine Amirat, Ren Luo, Rachid Alami, Christian Laugier*
SuFD11	8:30-17:00	Salon 10	Robot Manipulation: What Has Been Achieved and What Remains to Be Done? *Erol Sahin, Siddhartha Srinivasa*
SuFD12	8:30-17:00	Salon 12	6th Workshop on Planning, Perception and Navigation for Intelligent Vehicles *Philippe Martinet, Christian Laugier, Christoph Stiller, Urbano Nunes*

Thursday September 18			
ThAM1	8:30-12:00	State	3rd Workshop on Visual Control of Mobile Robots *Gonzalo Lopez-Nicolas, Youcef Mezouar*
ThPM1	13:30-17:00	State	Standardized Knowledge Representations and Ontologies for Robotics and Automation *Paulo Gonçalves, Craig Schlenoff, Edson Prestes, Tamas Haidegger*
ThFD2	8:30-17:00	Grand	Rehabilitation and Assistive Robotics: Bridging the Gap Between Clinicians and Roboticists *Brenna Argall, Siddhartha Srinivasa*
ThFD3	8:30-17:00	Salon 1	Towards Horizon 2020: Trends and Challenges in Micro/Nanorobotics *Michael Gauthier, Fumihito Arai, Metin Sitti, Bradley J. Nelson*
ThFD4	8:30-17:00	Salon 2	Real-time Motion Generation and Control — Constraint-based Robot Programming *Andrea Maria Zanchettin, Gianni Borghesan, Torsten Kroeger*
ThFD5	8:30-17:00	Salon 3	3rd Workshop on Robots in Clutter: Perception and Interaction in Clutter *Michael Zillich, Dejan Pangercic, Maren Bennewitz, Justus Piater, Maria Fox*
ThFD6	8:30-17:00	Salon 4	Community Consensus Benchmarks and Systems for Clinical Translation of Medical Robots *Nabil Simaan, Venkat Krovi, Peter Kazanzides, Simon P. DiMaio*
ThFD7	8:30-17:00	Salon 5	The Role of Human Sensorimotor Control in Surgical Robotics *Ilana Nisky, Tony Jarc*
ThFD8	8:30-17:00	Salon 6	Telerobotics for Real-Life Applications: Opportunities, Challenges, and New Developments *Dongjun Lee, Jordi Artigas, Shahin Sirouspour, Seiichiro Katsura*
ThFD9	8:30-17:00	Salon 7	Compliant Manipulation: Challenges in Learning and Control *Klas Kronander, Aude Billard, Etienne Burdet, Jonas Buchli*
ThFD10	8:30-17:00	Salon 8	Workshop on Active Touch Sensing in Robots and Animals *Yon Visell, Vincent Hayward, Mitra Hartmann, Nathan Lepora*
ThFD11	8:30-17:00	Salon 10	The Future of Multiple Robot Research and its Multiple Identities *Lorenzo Sabattini, Antonio Franchi, Dylan Shell, Nora Ayanian*
ThFD12	8:30-17:00	Salon 12	Whole-Body Control for Robots in the Real World *Federico Lorenzo Moro, Michael Gienger, Oussama Khatib, Eiichi Yoshida*

Sunday Workshops and Tutorials

Half-Day Tutorial: An Open-source Recipe for Teaching/Learning Robotics with a Simulator

Sunday Sept 14, 8:30-12:00, Grand Ballroom

Organizers: Renaud Detry (University of Liege, Belgium), Peter Corke (Queensland University of Technology, Australia), Marc Freese (Coppelia Robotics)

Website: http://teaching-robotics.org/trs2014/

Abstract: This tutorial is organized around a cross-platform robot development and simulation environment that can be installed in five minutes and that allows students to write control, navigation, vision or manipulation algorithms in a hundred lines of Matlab or Python code. The tutorial relies on the V-REP robot simulator, and on the Matlab Robotics Toolbox (RTB). The key feature of this combination is its ease of use – both tools are trivial to install. The tutorial is intended for teachers and students. Students will install the simulation environment on their laptop and learn everything they need to know to start implementing and testing robot algorithms. Teachers will return home with a ready-to-use recipe for organizing a master-level robotics project.

Speakers: Renaud Detry (University of Liege, Belgium), Peter Corke (Queensland University of Technology, Australia), Marc Freese (Coppelia Robotics)

Half-Day Workshop: Taxonomies of Interconnected Systems: Topology in Distributed Robotics

Sunday Sept 14, 8:30-12:00, State Ballroom

Organizers: R. Williams (University of Southern California), A. Gasparri (Università degli studi "Roma Tre"), and G. Sukhatme (University of Southern California)

Website: http://asimov.usc.edu/~rkwillia/ws/iros14/

Abstract: Given the fragmented nature of multi-robot research, we suggest that a taxonomic approach is necessary to study the topics that drive interconnected systems, and to identify properties that underlie crucial, and yet common, aspects of theory and application. In this first workshop of a series, we will focus on topology in distributed robotics, which dictates robotic interaction in a system. Properties such as graph connectivity and network rigidity will be highlighted, with emphasis on communicated, sensed, and physical robotic interaction. This workshop aims to identify the theoretical possibilities when topological assumptions are satisfied, the real-world barriers, and the current efforts to enforce topological properties in multi-robot theory and practice.

Speakers: Vijay Kumar (University of Pennsylvania), Gonzalo López-Nicolás (University of Zaragoza), Roberto Naldi (University of Bologna), Lorenzo Sabattini (University of Modena and Reggio Emilia), Gaurav Sukhatme (University of Southern California), and Daniel Zelazo (Technion)

Half-Day Tutorial: How to Use MATLAB-ROS Interface to Prototype Robotics Algorithms for ROS-powered Robots

Sunday Sept 14, 13:30-17:00, Grand Ballroom

Organizers: Yanliang Zhang (MathWorks)

Website: http://www.mathworks.com/company/events/tradeshows/tradeshow93505.html

Abstract: In this workshop, we will demonstrate how MATLAB® interacts with the Robot Operating System (ROS) using a new I/O Package. The package provides an API for creating ROS nodes in MATLAB that operate and communicate based on ROS's publisher/subscriber mechanism. The ROS I/O Package has the following key features: (1) Enable creation of ROS nodes, publishers, and subscribers directly from MATLAB; (2) Enable creation of ROS messages from MATLAB; (3) Enable publishers to publish MATLAB data to their advertised topics; (4) Enable subscribers to execute arbitrary, user-defined MATLAB functions when messages are received; (5) Enable launching of a ROS Master in MATLAB. In addition, we will also demonstrate how to develop robotics applications with TurtleBot, Husky from Clearpath Robotics and Baxter from Rethink Robotics inside MATLAB using this I/O.

Speakers: Ren Sang Nah (MathWorks), Remo Pillat (MathWorks) and Yanliang Zhang (MathWorks)

Half-Day Workshop: Aerial Open Source Robotics

Sunday Sept 14, 13:30-17:00, State Ballroom

Organizers: Lorenz Meier (ETH Zurich), Markus W. Achtelik (ETH Zurich), and Brandon Basso (3D Robotics)

Website: http://pixhawk.org/iros2014/

Abstract: With ever increasing levels of autonomy and system complexity, open source collaboration has become an important factor in robotics research. Whether structured in an environment with managed software packages like ROS or shared ad-hoc, the ability to push the boundaries of autonomous robots often depends on the availability of existing work to build on. Open source robotics is by now well established in ground robotics. As aerial robotics is moving from tackling relatively self-contained navigation tasks like the flight in GPS denied environments towards addressing dynamic scenes and more challenging dynamic obstacles, open source is equally important. This workshop is providing participants a solid overview of the current state of the art in aerial robotics research. It also provides examples of open source solutions ranging from SLAM packages for onboard computers to open hardware autopilots.

Speakers: Nathan Michael (CMU), Markus W. Achtelik (ETH Zurich), Elias Mueggler (University of Zurich) and Lorenz Meier (ETH Zurich)

Full-Day Workshop: Human-robot collaboration in standardization and R&D activities

Sunday Sept 14, 8:30-17:00, Salon 1

Organizers: GS Virk (Univ of Gävle, CLAWAR), R Bostelmann (NIST, USA), S Moon (Sejong Univ, Korea), T Haidegger (Obuda Univ, Hungary), F Bonsignorio (Heron Robots and SSSA, IT), F Vicentini (CNR, ITIA, Italy) and P Barattini (Kontor 46, Italy)

Website: http://www.clawar.org/WorkshopHRC/index.html

Abstract: The workshop aims to create closer links between robot standardization and robot R&D sectors for targeting rapid development of effective human-robot market driven solutions to meet mandatory regulations. The two communities will be brought together for fostering discussion in the context of mature robot sectors and new emerging robot domains to assist the development of definitive experimental scenarios and protocols for benchmarking the growing range of robot-human applications.

Speakers: C Heut (EC), SK Gupta (NRI, USA), T Wang (Beihang, CN), P Dario (SSSA, IT), Y Yamada (Nagoya, JP), C Han (Hanyang, KR), H Christensen (Georgia T, USA), N Elkman (F-IFF, DE), S Haddadin (Leibniz Hannover, DE), S Rhim (Kyung Hee, KR), F Bonsignorio (Heron Robots, SSSA, IT), P Davison (RIA, USA), GS Virk (CLAWAR, UK), C Herman (AAMI, USA), S Moon (Sejong, KR), W Qu (Ecovacs, CN), E Prestes (IEEE), B Matthias (ABB, DE), R Bishoff (KUKA, DE), A De Luca (Sapienza Roma, IT), F Xu (SIASUN, CN), S Park (Yujin Robot, KR), F Ferro (PAL, ES), and J Beer (Stryker, USA)

Full-Day Workshop: AI and Robotics

Sunday Sept 14, 8:30-17:00, Salon 2

Organizers: Lorenzo Riano (Bosch), Alessandro Saffiotti (Örebro University), Moritz Tenorth (Universität Bremen), George Konidaris (MIT CSAIL), Nick Hawes (University of Birmingham) and Siddharth Srivastava (UC Berkeley)

Website: http://people.csail.mit.edu/gdk/iros-airob14/

Abstract: The field of AI has fragmented into many challenging subfields that require and often reward isolation and specialization. Consequently, there is a lack of mainstream AI venues for publishing integrative research that combines techniques from multiple different fields to achieve a working robot system capable of complex behavior. This workshop aims to bring together a diverse and multidisciplinary group of researchers interested in designing intelligent robotic systems. Ample time will be left in the schedule for both spontaneous and guided discussions between presentations. A final open-floor discussion will aim at summarizing the main outcomes of the workshop around those questions, and planning the next steps for widening and consolidating the community.

Speakers: Tomas Lozano Perez (MIT), Stephen Hart (NASA / General Motors), Todd Hester (Nest Labs), Alper Aydemir (JPL), Malik Ghallab (LAAS-CNRS).

Full-Day Workshop: Machine Learning in Planning and Control of Robot Motion

Sunday Sept 14, 8:30-17:00, Salon 3

Organizers: Maria Gini (U. of Minnesota), Marco Morales (Instituto Tecnológico Autónomo de México), Angela P. Schoellig (U. of Toronto), Lydia Tapia (U. of New Mexico), Aleksandra Faust (U. of New Mexico), and Farbod Farshidian (ETH Zurich)

Website: http://www.cs.unm.edu/amprg/mlpc14Workshop/

Abstract: It is the goal of this workshop to explore methods and advancements afforded by the integration of Machine Learning for the planning and execution of robot motion. Because ML methods are often heuristic, issues such as safety and performance are critical to assess. Also, learning-based questions such as problem learnability, knowledge transfer among robots, knowledge generalization, long-term autonomy, task formulation, demonstration, role of simulation, and methods for feature selection define problem solvability. We will address these issues while discussing current and future directions for intelligent planning and execution of motions for robotics systems.

Speakers: Pieter Abbeel (UC Berkeley), Jan Peters (Technische Universitat Darmstadt), and Manuela Veloso (CMU)

Full-Day Workshop: Modular and Swarm Systems - from Nature to Robotics

Sunday Sept 14, 8:30-17:00, Salon 5

Organizers: R. Gross (The University of Sheffield), R. Möckel (Maastricht University), M. Rubenstein (Harvard University), K. Stoy (IT University of Copenhagen)

Website: https://sites.google.com/site/iros2014mss/

Abstract: This full-day workshop creates a forum to discuss the highly interdisciplinary fields of modular robotics and swarm robotics. Modularity is a concept well exploited by natural systems where relatively simple modules form highly complex structures. In swarm systems, physically independent entities or modules collaborate to perform common tasks. The fields of modular and swarm robotics have shown to be ideal playgrounds to study, for instance, self-organization, self-assembly, smart materials, self-repair, adaptation, collaboration, social interaction, and distributed intelligence in robotic and natural systems. State-of-the-art modular and swarm robot systems will be presented at the workshop's robot exhibition.

Speakers: N. Correll (University of Colorado at Boulder), D. Floreano (EPFL), S. Glotzer (University of Michigan), S. C. Goldstein (Carnegie Mellon University), D. L. Hu (Georgia Institute of Technology), M. D. Gross (Carnegie Mellon University & Modular Robotics Inc.), D. Rus (MIT), J. Werfel (Havard University), M. Yim (University of Pennsylvania)

Full-Day Workshop: Micro-Nano Robotic Swarms for Biomedical Applications

Sunday Sept 14, 8:30-17:00, Salon 6

Organizers: Spring Berman (Arizona State U.), Sabine Hauert (U. of Bristol), Sangeeta Bhatia (MIT), Bradley Nelson (ETH Zurich), and Vijay Kumar (U. of Pennsylvania)

Website: http://nanoswarm2014.org/

Abstract: Bioengineers are currently designing micro-nano systems for the treatment and monitoring of diseases. DNA machines, synthetic bacteria, nanoparticles, and magnetic materials are now able to move, sense and interact in a controlled fashion, an affordance that has led them to be called robots. These robots will need to be deployed in large numbers and operate predictably in highly complex biological environments. The challenge is to design swarm robotic strategies that produce collective behaviors that are useful for biomedical applications. In this interdisciplinary workshop, attendees will hear from experts in medicine, bioengineering, micro-nano robotics, and swarm robotics. The workshop includes two poster sessions and a closing panel discussion.

Speakers: Guillermo Ameer (Northwestern), Aaron Becker (Harvard Medical School), Spring Berman (ASU), Sabine Hauert (UoB), Vijay Kumar (UPenn), Sylvain Martel (EPM), Bradley Nelson (ETHZ), Daniela Rus (MIT), Taher Saif (UIUC), Metin Sitti (CMU), Mike Rubenstein (Harvard), Selman Sakar (ETHZ), Rob Wood (Harvard)

Full-Day Workshop: From Active Impedance to Intrinsically Compliant and Variable Impedance Actuators: Pros, Cons and Trade-offs

Sunday Sept 14, 8:30-17:00, Salon 7

Organizers: Nikos Tsagarakis (Italian Institute of Technology, IT), Luis Sentis (University of Texas at Austin, US), and Bram Vanderborght (Vrije Universiteit, BE)

Website: http://mech.vub.ac.be/IROSWSActuators/Index.htm
http://www.walk-man.eu/news/events/item/iros14-ws-on-actuators.html

Abstract: Emerging robots will need to operate within unstructured environments, collaborate with humans, and physically interact with them. To deal with these new application demands, robots should exhibit Natural Motion performance characterized by enhanced power, strength, efficiency and ultimately compliant and adaptable physical interaction capability. Novel actuation technologies are therefore needed to improve the performance of existing robots. This workshop attempts to cover the recent advancements in robotic actuation from the foundation principles to the implementation, control and application requirements aiming to answer tomorrow's needs.

Speakers: A. Bicchi (Uni. of Pisa, IT), M. Inaba (Uni. of Tokyo, JP), A. Albu. Schaeffer (DLR, DE), S. Kim (MIT, US), S. Stramigioli (Uni. of Twente, NL), J. Buchli (ETH Zurich, CH), J. Hurst (Oregon State Uni., US), Qbrobotics, IT), L. Sentis (Uni. of Texas, US), B. Vanderborght (Uni. of Vrije, Brussel, BE), N. Tsagarakis (Italian Inst. of Technology, IT)

Full-Day Workshop: Assistive Robotics for Individuals with Disabilities: HRI Issues and Beyond

Sunday Sept 14, 8:30-17:00, Salon 8

Organizers: Hae Won Park (Georgia Tech), Momotaz Begum (UMass Lowell), and Chung Hyuk Park (NYIT)

Website: http://www.haewonpark.com/IROS2014-ARHRI/

Abstract: Assistive robots (ARs) have huge potential in serving individuals with various physical and cognitive disabilities in their everyday lives, treatments, and therapies. By bringing together robotics researchers, cognitive scientists, clinicians, and entrepreneurs working with ARs, this workshop aims at discussing the issues that arise as we move forward to making ARs more acceptable and adaptable to the target population, irrespective of the type of ARs and the form of assistance they offer.

Speakers: Takanori Shibata (AIST), James Patton (RIC), Ayanna Howard (Georgia Tech), Charlie Kemp (Georgia Tech), Holly Yanco (UMass Lowell), Maja Matarić (USC), Brian Scassellati (Yale), Wendy Rogers (Georgia Tech), John-John Cabibihan (Qatar Univ.), Andrew Fagg (Univ. of Oklahoma), Michelle Johnson (UPenn), and Ayse Saygin (UCSD)

Full-Day Workshop: Assistance and Service Robotics in a Human Environment

Sunday Sept 14, 8:30-17:00, Salon 9

Organizers: Anne Spalanzani (Inria, France), David Daney (Inria, France), Yacine Amirat (LISSI-UPEC, France), Samer Mohammed (LISSI-UPEC, France), Ren Luo (National Taiwan University, Taiwan), Rachid Alami (LAAS Laboratory, France), Christian Laugier (Inria, France)

Website: http://www.lissi.fr/iros-ar2014/doku.php

Abstract: This workshop will focus on Robotics for people assistance and services, with a particular focus on frail people. The objective of the workshop is to provide a review and challenges of the relevant applications in Assistance and Service Robotics in a Human Environment. Topics related to mobility assistance, healthcare and wellbeing will be covered. Fundamental and technological research particularly related to autonomous indoors vehicles, sensor and actuators networks, wearable and ubiquitous technologies, and human-robot interaction, will be presented. This workshop will be the third edition of a series of workshops organized in this field at IROS 2012 and IROS 2013.

Speakers: Norihiro Hagita (ATR Intelligent Robotics and Communication Laboratories, Japan), Sami Haddadin (Institute of Automatic Control (IRT), University of Hanover, Germany), Ren Luo (National Taiwan University, Taiwan), Rachid Alami (LAAS Laboratory, France), Raja Chatila (ISIR Laboratory, France).

Full-Day Workshop: Robot Manipulation: What has been achieved and what remains to be done?

Sunday Sept 14, 8:30-17:00, Salon 10

Organizers: Erol Sahin (Middle East Technical University and Carnegie Mellon University), Siddhartha Srinivasa (Carnegie Mellon University)

Website: https://personalrobotics.ri.cmu.edu/workshops/manipulation-futures/

Abstract: Research on robotic manipulation has achieved important theoretical and technical advances in the last 50 years. Robot manipulators in factories have become a key element of industrial manufacturing, and are widely considered to be a success story. However, there remain challenges in extending this success beyond factory floors. The objective of the workshop is to discuss, understand and underline the key challenges inherent in manipulation that prevented its transition towards becoming a technology. The workshop will host invited lectures that will provide a historical evolution of ideas in robot manipulation, stating what has been achieved and what remains as challenges for future research.

Speakers: Rob Howe (Harvard University), Jean-Paul Laumond (LAAS-CNRS),Tomas Lozano-Perez (MIT), Matt Mason (Carnegie Mellon University), Stefan Schaal (University of Southern California)

Full-Day Workshop: Planning, Perception and Navigation for Intelligent Vehicles

Sunday Sept 14, 8:30-17:00, Salon 12

Organizers: Philippe Martinet (IRCCyN/Ecole Centrale of Nantes), Christian Laugier (Emotion/INRIA), Urbano Nunes (ISR/University of Coimbra), and Christoph Stiller (MRT/KIT)

Website: http://ppniv14.irccyn.ec-nantes.fr/

Abstract: The purpose of this workshop is to discuss topics related to the challenging problems of autonomous navigation and of driving assistance in open and dynamic environments. Technologies related to application fields such as unmanned outdoor vehicles or intelligent road vehicles will be considered from both the theoretical and technological point of views. Several research questions located on the cutting edge of the state of the art will be addressed. Among the many application areas that robotics is addressing, transportation of people and goods seem to be a domain that will dramatically benefit from intelligent automation. Fully automatic driving is emerging as the approach to dramatically improve efficiency while at the same time leading to the goal of zero fatalities.

Speakers: Fawzy Nashashibi (INRIA), Christoph Stiller (KIT), Alonzo Kelly (CMU), Danwei Wang (NTU), Javier Ibanez-Guzman (Renault), and Urbano Nunes (ISR)

Thursday Workshops

Half-Day Workshop: Visual Control of Mobile Robots – ViCoMoR

Thursday Sept 18, 8:30-12:00, State Ballroom

Organizers: Gonzalo Lopez-Nicolas (Universidad de Zaragoza, I3A), and Youcef Mezouar (IFMA, Clermont Université, Institut Pascal)

Website: http://vicomor.unizar.es

Abstract: Among the variety of sensors available today, vision systems stand out because they provide very rich information at low cost. One of the main reasons for integrating vision in the control loop was the interest for increased flexibility of robotic systems. However, versatility of vision systems comes at the cost of higher data processing complexity. Visual control has been one of the major research issues in robotics for more than four decades. Although control theory and computer vision are both mature areas of research, important advances that bring new challenges are happening nowadays such as the advent of RGB-D cameras, the use of omnidirectional vision, or the development of robust control techniques. Topics of interest include: Autonomous navigation and visual servoing techniques, visual perception for visual control, visual sensors, visual control with constraints, or new trends in visual control.

Speakers: Philippe Martinet (IRCCYN-CNRS, Ecole Centrale de Nantes), and Peter Corke (Queensland University of Technology)

Half-Day Workshop: Standardized Knowledge Representation and Ontologies for Robotics and Automation

Thursday Sept 18, 13:30-17:00, State Ballroom

Organizers: Paulo Gonçalves (IDMEC/LAETA, Portugal), Craig Schlenoff (NIST, USA), Edson Prestes (UFRGS, Brazil) and Tamás Haidegger (Obuda University, Hungary)

Website: http://www.est.ipcb.pt/laboratorios/robotica/iros-ora

Abstract: The primary goal of this workshop is to present and disseminate the current versions of standards and draft standards regarding robot interaction and knowledge sharing. The forum will provide a platform for the deeply affected community to exchange experiences. The robotics, automation, and ontology communities at large are encouraged to attend in order to discuss and improve the outcome of the IEEE-RAS Working Group entitled “Ontologies for Robotics and Automation” (IEEE WG ORA).

Speakers: Craig Schlenoff, (NIST, USA), Wonpil Yu (ETRI, Korea), Gurvinder Virk (ISO/IEC Convenor), Edson Prestes (UFRGS, Brazil), Stephen Balakirsky (Georgia Tech, USA), Paulo Gonçalves (IDMEC/LAETA, Universidade de Lisboa, Portugal), Tamás Haidegger (Óbuda University, Hungary)

Full-Day Workshop: Rehabilitation and Assistive Robotics: Bridging the Gap Between Clinicians and Roboticists

Thursday Sept 18, 8:30-17:00, Grand Ballroom

Organizers: Brenna Argall (Northwestern University, Rehabilitation Institute of Chicago), and Siddhartha Srinivasa (Carnegie Mellon University)

Website: http://www.eecs.northwestern.edu/~argall/14rar

Abstract: Rehabilitation and assistive technologies have the potential to change lives. Clinicians have successfully used therapy machines that physically assist a patient in performing rehabilitation exercises and activities of daily living. However, these machines can be more than just passive physical assistants. With tools from robotic perception, machine learning, and manipulation, these machines can be active, intelligent, and *autonomous* robots. This workshop aims to bring together clinicians and roboticists to identify the key challenges in rehabilitation and assistive robotics, collaborations for funding opportunities, and benchmarks and challenge problems for the field. We are particularly excited to leverage the close proximity of the Rehabilitation Institute of Chicago (RIC), the nation's top hospital for rehabilitation and assistance, to the conference venue and will be organizing an entire session at the RIC with lab tours.

Speakers: Yasin Dhaher (Northwestern University, RIC), Todd Kuiken (Northwestern University, RIC), Ben Kuipers (University of Michigan), and Jessica Pederson (RIC).

Full-Day Workshop: Towards Horizon 2020: Trends and challenges in micro/nanorobotics

Thursday Sept 18, 8:30-17:00, Salon 1

Organizers: Michaël Gauthier (FEMTO-ST, France), Fumihito ARAI (Nagoya University, Japan), Metin Sitti (CMU, USA), Brad Nelson (ETHZ, Switzerland).

Website: http://events.femto-st.fr/trendsnanorobots/

Abstract: The objective of this workshop is to define the future trend and issues in micro-nanorobotics. The workshop will be organised in two phases (two half days). First, short presentations on the future challenges of micro-nano-robotics (10 minutes) are going to be done by key-scientists in this field. The second step consists in two to four parallel workshops in front of a paper board to establish and to synthesise keypoints of four to eight major challenges.

Speakers: B. Nelson (ETHZ, Switzerland), N. Andreff (FEMTO-ST, France), F. Arai (Nagoya Univ., Japan), T. Arai (Osaka Univ., Japan), T. Fukuda (Nagoya, Univ. Japan), M. Sitti (CMU, USA), A. Ferreira (INSA, Bourges, France), S. Martel (Polytechnique Montréal, Canada), M. Gauthier (FEMTO-ST, France), Q. Zhou (AALTO, Finland), D. Popa (Univ. Texas, USA), D. Cappelleri (Purdue Univ., USA), P. Kalio (Tampere Univ., Finland), C. Diederichs (UNIOL, Germany), C. Huet (European Commission, Brussels, Belgium, EU).

Full-Day Workshop: Real-time Motion Generation & Control - Constraint-based Robot Programming

Thursday Sept 18, 8:30-17:00, Salon 2

Organizers: Gianni Borghesan (KU Leuven), Torsten Kroeger (Google), and Andrea Maria Zanchettin (Politecnico di Milano)

Website: http://cs.stanford.edu/people/tkr/iros2014

Abstract: The new generation of robots (redundant and/or mobile manipulators, humanoids, etc.) is challenging the robotics community to provide robust, reliable and fast motion planning and control algorithms allowing such robots to promptly react to unpredictable events, as we, humans, do. A new and lively research trend for such robotic systems relies on declarative and constraint-based task and motion specification. This workshop intends to encourage discussion between researchers working in constraint-based motion planning and control, covering various aspects of this problem.

Speakers: Oliver Brock (TU Berlin), Fabrizio Flacco (University of Rome), Kris Hauser (University of Indiana), Erwin Aertbelien (KU Leuven), Luis Sentis (University of Texas), and others.

Full-Day Workshop: Robots in Clutter: Perception and Interaction in Clutter

Thursday Sept 18, 8:30-17:00, Salon 3

Organizers: Michael Zillich (Vienna University of Technology), Dejan Pangercic (Robert Bosch LLC), Maren Bennewitz (University of Freiburg), Justus Piater (University of Innsbruck), Maria Fox (King's College London)

Website: http://workshops.acin.tuwien.ac.at/clutter2014

Abstract: Complex and cluttered environments continue to present challenging problems to many aspects of robotics research. Vision faces the problem of segmenting or recognising objects amidst clutter and occlusions. Unexpected scene changes pose challenges for maintaining valid and tractable scene representations for navigation, especially in highly dynamic scenes as encountered in self-driving cars. Manipulation cannot expect precise pose knowledge of all objects in a pile, let alone contact relations. All these problems will become increasingly manifest as robots move into unstructured domestic, industrial or outdoor settings. What is meant by “robust to clutter”', however, is difficult to define and adequate metrics and benchmarks are still missing. This workshop discusses experiences and ideas for handling various problems induced by clutter, and to advance theoretically founded and system-wide approaches of handling clutter.

Speakers: Oliver Brock (TU Berlin), Franceso Ferro (PAL Robotics), Tucker Hermans (to be confirmed) (Georgia Tech), Chris Mansley (Robert Bosch LLC)

Full-Day Workshop: Community Consensus Benchmarks and Systems for Clinical Translation of Medical Robots

Thursday Sept 18, 8:30-17:00, Salon 4

Organizers: Nabil Simaan (Vanderbilt University), Venkat Krovi (SUNY Buffalo), Peter Kazanzides (Johns Hopkins University), Simon DiMaio (Intuitive Surgical, Inc.)

Website: https://sites.google.com/site/ieeerasmedicalrobotics/

Abstract: The past decade has witnessed accelerated growth of medical robotics and computer-assisted medical technologies due to the significant practical utility, economic value, and diversity of applications benefiting patients, providers and healthcare systems. However, several challenges arise from the complexities engendered within the human body and the diverse sets of multi-disciplinary knowledge that need to be merged to create these system-level solutions and to successfully bring them to the market. We believe that there is a need for the robotics and medical device community to initiate a discussion on several issues that could benefit academia and industry in their shared pursuit of improved patient care. We therefore propose to initiate the first of a series of workshops at the 2014 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS) in Chicago.

Speakers: Peter Kazanzides (JHU), Nabil Simaan (Vanderbilt), Jaydev Desai (Maryland), Kevin Cleary (Sheikh Zayed Childrens Hospital), Simon DiMaio (Intuitive Surgical), Venkat Krovi (SUNY Buffalo), Blake Hannaford (U Washington), Dennis Fowler (Columbia U), Gregory Hager (JHU), Pankaj Singhal (SUNY Buffalo & Kaleida Health), Cameron Riviere (CMU), John Tomaszewski (SUNY Buffalo), Toshio Fukuda (Meijo U), Yo Kobayashi (Waseda U), Howie Choset (CMU), Russell Taylor (JHU), Tim Salcudean (U British Columbia), Guang-Zhong Yang (Imperial College London)

Full-Day Workshop: The role of human sensorimotor control in surgical robotics

Thursday Sept 18, 8:30-17:00, Salon 5

Organizers: Ilana Nisky (Ben-Gurion University), Anthony Jarc (Intuitive Surgical)

Website: http://www.stanford.edu/~inisky/Motor_Control_RAMIS_workshop.htm

Abstract: Surgery is a highly complex task requiring surgeons to precisely control instruments to operate on patients. A comprehensive understanding of surgeon sensorimotor control is fundamental to continuing improvements of teleoperated robot-assisted minimally invasive surgery platforms. Such platforms may also enable exciting findings in basic human sensorimotor control. To advance this new interdisciplinary research direction, we seek to foster a dialogue between the fields of: (1) human motor control and learning; (2) human-robot interaction, teleoperation, and surgical robotics; and (3) surgical training and skill assessment.

Speakers: Cenk Cavusoglu (Case Western Reserve University), Antonio Gangemi (University of Illinois at Chicago), Greg Hager (Johns Hopkins University), Katherine Kuchenbecker (University of Pennsylvania), Konrad Kording (Rehabilitation Institute of Chicago), Sandro Mussa-Ivaldi (Rehabilitation Institute of Chicago), Allison Okamura (Stanford University), Sam Vine (Exeter University), Guang-Zhong Yang (Imperial College of London)

Full-Day Workshop: Telerobotics for Real-Life Applications: Opportunities, Challenges, and New Developments

Thursday Sept 18, 8:30-17:00, Salon 6

Organizers: Dongjun Lee (Seoul National University), Jordi Artigas Esclusa (DLR), Seiichiro Katsura (Keio University), Shahin Sirouspour (McMaster University)

Website: http://inrol.snu.ac.kr/telewc2014

Abstract: Being one of the oldest subjects in robotics, telerobotics has enjoyed exciting theoretical advances and significant practical impacts in many applications. Even so, how to engineer a telerobotic system, which is complex enough to be truly useful in practice, yet, still easy to operate even with limited information-exchange and/or imperfect communication, has been a formidable challenge for the telerobotics community. The main aim of this 3rd Telerobotics Workshop is to provide a forum for exchange of ideas among the users and researchers, to discuss challenges and barriers to real-life applications of telerobotics systems and to explore innovative/promising solutions to these problems

Speakers: Simon DiMaio (Intuitive Surgical), Hyoung Il Son (Samsung Heavy Industries), Eric Martin (Canadian Space Agency), Jordi Artigas-Esclusa (DLR), Robin Murphy (Texas A&M Univ.), Philippe Garrec (CEA-LIST)

Full-Day Workshop: Compliant Manipulation: Challenges in Learning and Control

Thursday Sept 18, 8:30-17:00, Salon 7

Organizers: Klas Kronander (EPFL), Aude Billard (EPFL), Etienne Burdet (Imperial College London) and Jonas Buchli (ETHZ)

Website: http://lasa.epfl.ch/workshopIROS14/

Abstract: Robust and versatile compliant manipulation skills are a necessity for robots interacting with the real world. Despite significant progress in design of passively compliant mechanisms and active compliance control algorithms, today's best robots are still far behind humans in terms of manipulation performance and versatility. This workshop will identify current challenges in compliant manipulation problems and will address how recent advances in learning and control can be leveraged to advance the state of the art in this area of research.

Speakers: Neville Hogan (M.I.T), Jonas Buchli (ETHZ), Yoshihiko Nakamura (University of Tokyo), Sylvain Calinon (Idiap Research Institute), Etienne Burdet (Imperial College) and Matthew Howard (King's College)

Full-Day Workshop: Active Touch Sensing in Robots and Animals

Thursday Sept 18, 8:30-17:00, Salon 8

Organizers: Yon Visell (Drexel University), Vincent Hayward (Université Pierre et Marie Curie), Mitra Hartmann (Northwestern University), Nathan Lepora, (University of Bristol)

Website: http://re-touch-lab.com/iros2014/

Abstract: This workshop addresses the challenges posed by actively sensing and interacting with the world through the sense of touch, whether the latter is implemented through a technological or biological system. Active touch sensing is recovering information about the world by 'touching' rather than 'being touched' – by interpreting signals from sensors whose motion is deliberately controlled to facilitate information gain. The workshop is sponsored by the IEEE RAS Technical Committee on Haptics and will be associated with a special issue of IEEE Transactions on Haptics.

Speakers: Vincent Hayward (UPMC), James Tangorra (Drexel Univ.), Jeremy Fishel (Syntouch LLC), Mitra Hartmann (Northwestern Univ.), Melina Hale (Univ. Chicago), Katherine Kuchenbecker (Univ. Pennsylvania), Michael Wiertlewski (Northwestern Univ.), Yon Visell (Drexel Univ.), Others TBD

Full-Day Workshop: The future of multiple-robot research and its multiple identities

Thursday Sept 18, 8:30-17:00, Salon 10

Organizers: Nora Ayanian (USC, USA), Antonio Franchi (LAAS-CNRS, France), Lorenzo Sabattini (UNIMORE, Italy) and Dylan Shell (TAMU, USA)

Website: http://www.arscontrol.unimore.it/mrsiros14/

Abstract: The objective of this workshop is to assess the degree to which multi-robot systems is a distinct research sub-area within the robotics community rather than a topic that cuts-across each of the other sub-areas and topics. We wish to explore the degree to which core elements of multi-robot systems research (e.g., distributed algorithms, decentralized planning, etc.) span existing areas and to anticipate the degree to which these elements will in the future. This workshop aims at promoting a discussion to identify and define the overarching ideas that can tie together different research direction in multi-robot systems, and lead to the definition of common practices and standards.

Speakers: R. Alami (CNRS, France), C. Belta (BU, USA), N. Y. Chong (JAIST, Japan), M. Egerstedt (GATech, USA), R. Freeman (NWU, USA), V. Kumar (UPenn, USA), J. P. How (MIT, USA), A. Hsieh (Drexel, USA), V. Isler (UMN, USA), K. Lynch (NWU, USA), L. Parker (UTK, USA), D. Rus (MIT, USA), M. Schwager (BU, USA), K. Sekiyama (Nagoya Univ., Japan), G. Sukhatme (USC, USA)

Full-Day Workshop: Whole-Body Control for Robots in the Real World

Thursday Sept 18, 8:30-17:00, Salon 12

Organizers: Federico L. Moro (IIT), Michael Gienger (Honda RI), Oussama Khatib (Stanford), and Eiichi Yoshida (AIST)

Website: http://www.walk-man.eu/news/events/item/iros14-ws-ijhr-si-on-whole-body-control-for-robots-in-the-real-world.html

Abstract: Whole-Body Control aims to fill the gap between robots and humans performing multiple complex actions in compliant interaction with a dynamic environment. With the recent development of fully torque-controlled robots, theory can be put into practice. The main aim of this workshop is to bring together leading researchers in the field of WBC i) to paint a clear picture of the fast evolving state-of-the-art, ii) to encourage discussions on the current limitations, and on the future research directions, and iii) to develop new research collaborations to speed up the creation of reliable real world WBC Systems. Emphasis will be placed on the application of such systems on real robots performing tasks in the real world, and the speakers will be invited to share their hands-on experience.

Speakers: A. Del Prete (LAAS-CNRS), S. Feng (CMU), M. Morisawa (AIST), F.L. Moro (IIT), Y. Nakamura (Univ. of Tokyo), F. Nori (IIT), C. Ott (DLR), L. Righetti (MPI), L. Sentis (UT Austin), R. Tedrake (MIT), and P.M. Wensing and D.E. Orin (OSU)

Oral and Interactive Sessions

IROS 2014 has only three parallel oral tracks, and each paper is assigned a 3-minute oral presentation as well as an 80-minute interactive presentation. After giving the oral presentation in one session, the speaker moves to the Interactive Salons during the next session to talk in more detail with anyone who would like to learn more. Some oral sessions also feature talks by industrial sponsors.

Speaker Instructions

Your presentation has two components: a three-minute pitch and an 80-minute interactive presentation. This will afford you the opportunity to present your work to a large audience (there are only three parallel speaking sessions) and to interact more deeply with those who are interested to learn more.

The Pitch

Setup

For the speaking sessions, you will come to the front of the room at the beginning of the session. Speakers with odd-numbered talks (talks 1, 3, 5, etc.) speak from the left podium from the audience's viewpoint, while speakers with even-numbered talks (2, 4, 6, etc.) speak from the right podium.

While the speaker before you is speaking, you will have three minutes to set up your laptop. (VGA connection will be provided.) There will be a volunteer at the podium to help you if you need it. There will be a local monitor on the podium that shows what will project from your laptop to the screen, so you can be sure that the audience will see what you see on the monitor. There will be no audio hookup for your computer.

When the previous speaker finishes, their microphone will go dead, yours will become live, your monitor will be projected to the main screen, and the spotlight will shift to you. Your three minutes starts right then and you can begin your talk.

If you fail to connect during your three-minute setup time (which should be very rare), a secondary screen will always project the summary slide you submitted including the title of your paper and the authors' names with the speaker underlined. Again, your three minutes starts right then and you should complete your talk within the allotted time, only referring to this summary slide.

Speakers can test their laptops on a simulated setup in the Ashland Room (see the hotel map) to make sure everything is working properly.

Presenting

You will have only three minutes, but there will be no changeover time and no questions, so you should be able to get your message across so the audience will know if they want to learn more and visit your display during the interactive session. Use the time wisely! Questions and discussions will happen during the interactive sessions.

Rules

1. You must finish in three (3) minutes! Plan on 2:50 to be safe. After three minutes, your microphone will go dead and your laptop will no longer be projected, and you will get the figurative (maybe literal) hook!

2. Your talk will be video-recorded.

Suggestions

1. PRACTICE! This is a new format for many of us, and you will need to practice a number of times to get your message across effectively in only three minutes.
2. You will not be introduced. Give your name and the title of your paper.
3. Your presentation is an advertisement for your paper, so focus on insights rather than details.
4. Avoid spending too much time on related work.
5. Consider giving an application/motivation of your work, the main result, and one piece of technical “meat” (e.g., a theorem, a design principle, an equation, etc.) that will help the audience understand the methodology and the depth of the work, understanding that there will not be time for all the details.

The Interactive Session

After your speaking session, in the next session you will move to the Interactive Salons, where attendees can ask you questions and engage in discussion in an 80-minute interactive session. You will have a 42” LED 1920x1080 display to project your laptop (VGA connection provided). There will also be a fixed sign with the title and authors of your paper so attendees can find you easily.

Guidelines

1. If you have more than one author for your paper, we recommend you have two authors at your interactive station. This allows one author to walk around and talk to other authors of thematically-related papers while the second author presents the work.
2. If there are people waiting to talk to you, limit your discussion with any one attendee. Schedule a time later to get together to discuss in more detail.
3. You should have several slides prepared that get into the details, but do not plan to give full 15-minute one-way talks. The format of the interactive session should encourage lively discussions between paper authors and audience members. The format of the interactive session is not to repeat the same 15-min one-way talk over and over until the end of the session.

IROS 2014 Program At A Glance

	Track 1 Grand Ballroom	Track 2 State Ballroom	Track 3 Red Lacquer Room	Interactive Salons	Crystal Room	Exhibit Hall
Sunday September 14						
8:30-17:00	Workshops and Tutorials					Setup
18:00-19:30	**Welcome Reception**					
Monday September 15						
8:00-8:20	Conference Welcome					
8:20-9:10	Plenary I: The Quest for Robotic Vision Peter Corke, Queensland U of Technology					
9:20-10:40	MoA1 Manipulation and Grasping I Robust and Optimal Control	MoA2 Localization and Mapping I Motion and Path Planning I	MoA3 Bioinspired Robots I Multi-Robot Coordination			Exhibits
10:40-11:10	**Coffee Break**					
11:10-12:30	MoB1 Calibration and Identification Kinematics and Mechanism Design I	MoB2 Soft-Bodied Robotics Robot Learning I	MoB3 Navigation Visual Servoing	MoA Talks		
12:30-13:50	**Lunch; RSJ Power Lunch**					
13:50-15:10	MoC1 Micro-Nano Robots I Manipulation and Grasping II	MoC2 Humanoids and Bipeds I Computer Vision I	MoC3 Bioinspired Robots II Distributed Robotics	MoB Talks	Government Forum	
15:20-16:40	MoD1 Haptics Surgical Robotics I	MoD2 Human-Robot Interaction I Robot Learning II	MoD3 Formal Methods Software and Architecture	MoC Talks		
Evening	***Explore Chicago* Social Events**					
Tuesday September 16						
8:00-8:50	Plenary II: Development of Neural Interfaces for Robotic Prosthetic Limbs Todd Kuiken, Rehab Inst of Chicago and Northwestern Univ					
9:00-10:20	TuA1 Manipulation and Grasping III Parallel Robotics	TuA2 Motion and Path Planning II Localization and Mapping II	TuA3 Search, Rescue, and Audition Field Robotics	MoD Talks	Industry Foum: Perspectives on Entrepre-neurship in Robotics and Automation	Exhibits
10:20-10:50	**Coffee Break**					
10:50-12:10	TuB1 Medical Robots and Systems I Rehabilitation Robotics I	TuB2 Human-Robot Interaction II Robot Learning III	TuB3 Marine Robotics Space Robotics	TuA Talks		
12:10-13:30	**Lunch; IEEE RAS Women in Engineering Lunch**					
13:30-14:50	TuC1 Dynamics and Control Manipulation and Grasping IV	TuC2 Humanoids and Bipeds II Domestic and Interactive Robots	TuC3 Localization and Mapping III Visual Servoing and Tracking	TuB Talks		
15:00-16:20	TuD1 Actuators Kinematics and Mechanism Design II	TuD2 Reasoning and AI Planning Path and Task Planning	TuD3 Sensing I Sensing for Human Environments	TuC Talks		
16:20-16:50	**Coffee Break**					
16:50-17:55	TuE1 Constrained and Underactuated Robots Legged Robots I	TuE2 Human-Robot Interaction III Grasp Learning	TuE3 Unmanned Aerial Systems I Localization and Pose Estimation	TuD Talks		
18:30-21:30	**Banquet at the Art Institute of Chicago, 111 S Michigan Ave**					
Wednesday September 17						
8:00-8:50	Plenary III: From Visual SLAM to Generic Real-time 3D Scene Perception Andrew Davison, Imperial College London					
9:00-10:20	WeA1 Medical Robots and Systems II Rehabilitation Robotics II	WeA2 Motion and Path Planning III Planning, Failure Detection and Recovery	WeA3 Networked Robots Swarm Robotics	TuE Talks		Exhibits
10:20-10:50	**Coffee Break**					
10:50-12:10	WeB1 Mechanisms and Actuators Force and Tactile Sensing	WeB2 Humanoids and Bipeds III Human Detection and Tracking	WeB3 Collision Detection and Avoidance Sensing II	WeA Talks		
12:10-13:10	**Lunch; IEEE RAS Young Professional Lunch and IEEE RAS Student Lunch with Leaders**					
13:10-13:50	Awards Ceremony					
14:00-15:20	WeC1 Surgical Robotics II Teleoperation and Telerobotics	WeC2 Learning by Demonstration Industrial and Manufacturing Robots	WeC3 Localization and Mapping IV Locomotion, Navigation, and Mobility	WeB Talks		
15:20-15:50	**Coffee Break**					
15:50-17:10	WeD1 Micro-Nano Robots II Impedance, Compliance, and Force Control	WeD2 Unmanned Aerial Systems II Legged Robots II	WeD3 Computer Vision II Recognition	WeC Talks		
17:20-19:00	**Final Interactive Presentations (WeD Talks) and Farewell Party in the Interactive Salons**					
Thursday September 18						
8:30-17:00	Workshops and Tutorials					Navigation Contest

Monday Session A, 09:20 - 10:40

#	Time	Grand Ballroom	State Ballroom	Red Lacquer Room
		MoA1 **Manipulation and Grasping I &** **Robust and Optimal Control**	**MoA2** **Localization and Mapping I &** **Motion and Path Planning I**	**MoA3** **Bioinspired Robots I &** **Multi-Robot Coordination**
	Chair	Khatib, Oussama (Stanford University)	Oriolo, Giuseppe (Sapienza University of Rome)	Gini, Maria (University of Minnesota)
#	Time	**Session Keynote**	**Session Keynote**	**Session Keynote**
1	09:20-09:40	Keynote: What is Manipulation? *Mason, Matthew T.* Carnegie Mellon University	Keynote: Dense, Object-based 3D SLAM *Leonard, John* MIT	Keynote: Bio-inspired Multi-modal Flying Robots *Floreano, Dario* EPFL
		Manipulation and Grasping I	**Localization and Mapping I**	**Bioinspired Robots I**
2	09:40-09:43	Robotic Manipulation in Object Composition Space *Pajarinen, Joni; Kyrki, Ville*	Mining Visual Phrases for Long-Term Visual SLAM *Tanaka, Kanji; chokushi, yuuto; ando, masatoshi*	Modeling of Underwater Snake Robots Moving in a Vertical Plane in 3D *Kelasidi, Eleni; Pettersen, Kristin Y.; Gravdahl, Jan Tommy*
3	09:43-09:46	6D Proximity Servoing for Preshaping and Haptic Exploration Using Capacitive Tactile Proximity Sensors *Escaida Navarro, Stefan; Schonert, Martin; Hein, Björn; Woern, Heinz*	Towards Indoor Localization Using Visible Light Communication for Consumer Electronic Devices *Liu, Ming; Qiu, Kejie; Che, Fengyu; Li, Shaohua; Hussain, Babar; Wu, Liang; Yue, C. Patrick*	Actuation Strategy for Underactuated Anthropomorphic Hands *Tavakoli, Mahmoud; Enes, Baptiste; Marques, Lino; de Almeida, Anibal*
4	09:46-09:49	Multi-Joint Gripper with Differential Gear System *Tamamoto, Takumi; Sayama, Kazuhiro; Koganezawa, Koichi*	Network Localization from Relative Bearing Measurements *Kennedy, Ryan; Taylor, Camillo Jose*	New Rolling and Crawling Gaits for Snake-Like Robots *Primerano, Richard; Wolfe, Stephen*
5	09:49-09:52	Artificial Hand with Stiffness Adjuster *Koganezawa, Koichi; Ito, Akira*	2D-3D Camera Fusion for Visual Odometry in Outdoor Environments *Paudel, Danda Pani; Demonceaux, Cédric; Habed, Adlane; Vasseur, Pascal; Kweon, In So*	iSplash-MICRO: A 50mm Robotic Fish Generating the Maximum Velocity of Real Fish *Clapham, Richard James; Hu, Huosheng*
6	09:52-09:55	Design and Implementation of a Low-Cost and Lightweight Inflatable Robot Finger *QI, Ronghuai; Lam, Tin Lun; Xu, Yangsheng*	Position Control of a Robot End-Effector Based on Synthetic Aperture Wireless Localization *Vossiek, Martin; Konigorski, Ulrich; Marschall, Albert; Li, Gang; Voigt, Thorsten*	Mamba - A Waterproof Snake Robot with Tactile Sensing *Liljebäck, Pål; Stavdahl, Øyvind; Pettersen, Kristin Y.; Gravdahl, Jan Tommy*
7	09:55-09:58	Design of Hands for Aerial Manipulation: Actuator Number and Routing for Grasping and Perching *Backus, Spencer; Odhner, Lael; Dollar, Aaron*	Static forces weighted Jacobian motion models for improved Odometry *Hidalgo-Carrio, Javier; Babu, Ajish; Kirchner, Frank*	Multi-Arm Robotic Swimming with Octopus-Inspired Compliant Web *Sfakiotakis, Michael; Kazakidi, Asimina; Chatzidaki, Avgousta; Evdaimon, Theodoros; Tsakiris, Dimitris*
8	09:58-10:01	Robust Model Free Control of Robotic Manipulators with Prescribed Transient and Steady State Performance *Bechlioulis, Charalampos; Liarokapis, Minas; Kyriakopoulos, Kostas*	Visual Localization within LIDAR Maps for Automated Urban Driving *Wolcott, Ryan; Eustice, Ryan*	ReBiS - Reconfigurable Bipedal Snake Robot *Thakker, Rohan; Kamat, Ajinkya; Bharambe, Sachin; Chiddarwar, Shital; BHURCHANDI, KISHOR*
9	10:01-10:04	Dual Execution of Optimized Contact Interaction Trajectories *Toussaint, Marc; Ratliff, Nathan; Bohg, Jeannette; Righetti, Ludovic; Englert, Peter; Schaal, Stefan*	Decentralized Cooperative Trajectory Estimation for Autonomous Underwater Vehicles *Paull, Liam; Seto, Mae; Leonard, John*	Role of Compliant Leg in the Flea-Inspired Jumping Robot *Jung, Gwang-Pil; Kim, Ji-Suk; Koh, Je-Sung; Jung, Sunpill; Cho, Kyu-Jin*
10	10:04-10:07	Quasi-Static Manipulation of a Planar Elastic Rod Using Multiple Robotic Grippers *Mukadam, Mustafa; Borum, Andy; Bretl, Timothy*	Vision Based Robot Localization by Ground to Satellite Matching in GPS-Denied Situations *Viswanathan, Anirudh; Pires, Bernardo; Huber, Daniel*	Optimal Dynamic Force Mapping for Obstacle-Aided Locomotion in 2D Snake Robots *Holden, Christian; Stavdahl, Øyvind; Gravdahl, Jan Tommy*
11	10:07-10:10	Garment Perception and its Folding Using a Dual-arm Robot *Stria, Jan; Prusa, Daniel; Hlavac, Vaclav; Wagner, Libor; Petrík, Vladimír; Krsek, Pavel; Smutny, Vladimir*	Hybridization of Monte Carlo and Set-Membership Methods for the Global Localization of Underwater Robots *Neuland, Renata; Nicola, Jeremy; Maffei, Renan; Jaulin, Luc; Prestes, Edson; Kolberg, Mariana*	Empirical Investigation of Closed-Loop Control of Extensible Continuum Manipulators *Kapadia, Apoorva; Fry, Katelyn; Walker, Ian*

Monday Session A, 09:20 - 10:40 (Continued)

#	Time	Grand Ballroom MoA1 Robust and Optimal Control	State Ballroom MoA2 Motion and Path Planning I	Red Lacquer Room MoA3 Multi-Robot Coordination
12	10:10-10:13	Numerical Approximation for Visibility Based Pursuit Evasion Game *Bhattacharya, Sourabh; Basar, Tamer; Falcone, Maurizio*	A Novel RRT Extend Function for Efficient and Smooth Mobile Robot Motion Planning *Palmieri, Luigi; Arras, Kai Oliver*	Reactive Switching Protocols for Multi-Robot High-Level Tasks *Raman, Vasumathi*
13	10:13-10:16	Visibility-Based Motion Planning for Active Target Tracking and Localization *Wei, Hongchuan; Lu, Wenjie; Zhu, Pingping; Huang, Guoquan; Leonard, John; Ferrari, Silvia*	Guiding Sampling-Based Tree Search for Motion Planning with Dynamics Via Probabilistic Roadmap Abstractions *Le, Duong; Plaku, Erion*	Correlated Orienteering Problem and Its Application to Informative Path Planning for Persistent Monitoring Tasks *Yu, Jingjin; Schwager, Mac; Rus, Daniela*
14	10:16-10:19	Pursuit-Evasion Game for Normal Distributions *Jun, Chanyoung; Bhattacharya, Subhrajit; Ghrist, Robert*	Planning Agile Motions for Quadrotors in Constrained Environments *Boeuf, Alexandre; Cortes, Juan; Alami, Rachid; Simeon, Thierry*	Cooperative Control of a Heterogeneous Multi-Robot System based on Relative Localization *Cognetti, Marco; Oriolo, Giuseppe; Peliti, Pietro; Rosa, Lorenzo; Stegagno, Paolo*
15	10:19-10:22	Optimal control for robot-hand manipulation of an object using dynamic visual servoing *Jara, Carlos; Pomares, Jorge; Candelas Herías, Francisco Andrés; Torres, Fernando*	Optimal Navigation Functions for Nonlinear Stochastic Systems *Horowitz, Matanya; Burdick, Joel*	Three-Dimensional Multirobot Formation Control for Target Enclosing *Aranda, Miguel; Lopez-Nicolas, Gonzalo; Sagues, Carlos; Zavlanos, Michael M.*
16	10:22-10:25	Camera Control for Learning Nonlinear Target Dynamics Via Bayesian Nonparametric Dirichlet-Process Gaussian-Process (DP-GP) Models *Wei, Hongchuan; Lu, Wenjie; Zhu, Pingping; Ferrari, Silvia; Klein, Robert H; Omidshafiei, Shayegan; How, Jonathan Patrick*	A Lattice-Based Approach to Multi-Robot Motion Planning for Non-Holonomic Vehicles *Cirillo, Marcello; uras, tansel; Koenig, Sven*	Finding Optimal Routes for Multi-Robot Patrolling in Generic Graphs *Portugal, David; Pippin, Charles; Rocha, Rui P.; Christensen, Henrik Iskov*
17	10:25-10:28	Remote Operated Vehicle Tether Disturbances Analysis and Target Tracking Control *Huang, hai; sheng, ming-wei; Li, Yue-ming; Wan, Lei; Pang, Yongjie; di, wang*	Multi-Cost Robotic Motion Planning under Uncertainty *Simpson, Richard; Revell, James; Johansson, Anders; Richards, Arthur*	Fleet Size of Multi-Robot Systems for Exploration of Structured Environments *Cabrera-Mora, Flavio; Xiao, Jizhong*
18	10:28-10:31	Reactive Phase and Task Space Adaptation for Robust Motion Execution *Englert, Peter; Toussaint, Marc*	Constrained Path Optimization with Bezier Curve Primitives *Choi, Ji-wung; Huhtala, Kalevi*	Stable Formation of Groups of Robots Via Synchronization *Valbuena, Luis; Cruz, Patricio; Figueroa, Rafael; Sorrentino, Francesco; Fierro, Rafael*
19	10:31-10:34	Synchronization and Consensus of a Robot Network on an Underactuated Dynamic Platform *Nguyen, Kim Doang; Dankowicz, Harry*	Distance Metric Approximation for State-Space RRTs Using Supervised Learning *Bharatheesha, Mukunda; Caarls, Wouter; Wolfslag, Wouter; Wisse, Martijn*	The RoboCup 2013 Drop-In Player Challenges: Experiments in Ad Hoc Teamwork *MacAlpine, Patrick; Genter, Katie; Barrett, Samuel; Stone, Peter*
20	10:34-10:37	Robust Fixed Point Transformation Based Design for Model Reference Adaptive Control of a Modified TORA System *Tar, József Kázmér; Várkonyi, Teréz Anna; Kovács, Levente; Rudas, Imre J.; Haidegger, Tamas*	State Lattice with Controllers: Augmenting Lattice-Based Path Planning with Controller-Based Motion Primitives *Butzke, Jonathan; Sapkota, Krishna; Prasad, Kush; MacAllister, Brian; Likhachev, Maxim*	Aligning Coordinate Frames in Multi-Robot Systems with Relative Sensing Information *Nagavalli, Sasanka; Lybarger, Andrew; Luo, Lingzhi; Chakraborty, Nilanjan; Sycara, Katia*
21	10:37-10:40	Receding Horizon Optimization of Robot Motions Generated by Hierarchical Movement Primitives *Mühlig, Manuel; Hayashi, Akinobu; Gienger, Michael; Iba, Soshi; Yoshiike, Takahide*	Sponsor Talk: Motion Planning for Collaborative Robots *Barry, Jennifer* Rethink Robotics	A Mathematical Programming Approach to Collaborative Missions with Heterogeneous Teams *FEO, EDUARDO; Gambardella, Luca; Di Caro, Gianni A.*

Monday Session B, 11:10 - 12:30

#	Time	Grand Ballroom **MoB1** **Calibration and Identification &** **Kinematics and Mechanism Design I**	State Ballroom **MoB2** **Soft-Bodied Robotics &** **Robot Learning I**	Red Lacquer Room **MoB3** **Navigation &** **Visual Servoing**
	Chair	Maciejewski, Anthony A. (Colorado State University)	Paik, Jamie (EPFL)	Hutchinson, Seth (University of Illinois)
		Session Keynote	**Session Keynote**	**Session Keynote**
1	11:10-11:30	Keynote: Innovative Mechanical Systems to Address Current Robotics Challenges *Gosselin, Clement* Laval University	Keynote: Soft Robotics *Laschi, Cecilia* Scuola Superiore Sant'Anna di Pisa	Keynote: From Robotics to VR and Back *LaValle, Steven M* University of Illinois
		Calibration and Identification	**Soft-Bodied Robotics**	**Navigation**
2	11:30-11:33	Locally-Weighted Homographies for Calibration of Imaging Systems *Ranganathan, Pradeep; Olson, Edwin*	A New Coefficient-Adaptive Orthonormal Basis Function Model Structure for Identifying a Class of Pneumatic Soft Actuators *Wang, Xiaochen; Geng, Tao; Elsayed, Yahya; Ranzani, Tommaso; Saaj, Chakravarthini; Lekakou, Constantina*	Environment-Based Trajectory Clustering to Extract Principal Directions for Autonomous Vehicles *Tanzmeister, Georg; Wollherr, Dirk; Buss, Martin*
3	11:33-11:36	Towards Simultaneous Coordinate Calibrations for Cooperative Multiple Robots *Wang, Jiaole; Wu, Liao; Meng, Max Q.-H.; Ren, Hongliang*	Design of paper mechatronics: Towards a fully printed robot *Shigemune, Hiroki; Maeda, Shingo; Hara, Yusuke; Hashimoto, Shuji*	Wide-Field Optical Flow Aided Inertial Navigation for Unmanned Aerial Vehicles *Rhudy, Matthew; Chao, Haiyang; Gu, Yu*
4	11:36-11:39	Force Calibration of the the KUKA Lightweight Robot Including Embedded Joint Torque Sensors and Robot Structure *Gautier, Maxime; Jubien, Anthony*	Development of a Meal Assistive Exoskeleton Made of Soft Materials *Koo, Inwook; Yun, Chang-ho; Viana de Oliveira e Costa, Mateus; Scognamiglio, Joao; Yangali, Teodoro Andree; Park, Daegeun; Cho, Kyu-Jin*	Experimental Study of Odometry Estimation Methods Using RGB-D Cameras *fang, zheng; Scherer, Sebastian*
5	11:39-11:42	Calibrating a Pair of Inertial Sensors at Opposite Ends of an Imperfect Kinematic Chain *Birbach, Oliver; Bäuml, Berthold*	Spatial Parallel Soft Robotic Architectures *Rivera, Jordan; Kim, Charles*	Precise Vision-Aided Aerial Navigation *Chiu, Han-Pang; Das, Aveek; Miller, Philip; Samarasekera, Supun; Kumar, Rakesh*
6	11:42-11:45	Extrinsic calibration of a set of range cameras in 5 seconds without any pattern *Fernández-Moral, Eduardo; González-Jiménez, Javier; Rives, Patrick; Arevalo, Vicente*	Whole Arm Planning for a Soft and Highly Compliant 2D Robotic Manipulator *Marchese, Andrew; Katzschmann, Robert; Rus, Daniela*	Real-Time Autonomous 3D Navigation for Tracked Vehicles in Rescue Environments *Menna, Matteo; Gianni, Mario; Ferri, Federico; Pirri, Fiora*
7	11:45-11:48	Extrinsic Calibration of Non-Overlapping Camera-Laser System Using Structured Environment *Bok, Yunsu; Choi, Dong - Geol; Vasseur, Pascal; Kweon, In So*	An Untethered Jumping Soft Robot *Tolley, Michael Thomas; Shepherd, Robert; Karpelson, Michael; Bartlett, Nicholas; Galloway, Kevin; Wehner, Michael; Nunes, Rui; Whitesides, George; Wood, Robert*	Interactive Navigation of Humans from a Game Theoretic Perspective *Turnwald, Annemarie; Olszowy, Wiktor; Wollherr, Dirk; Buss, Martin*
8	11:48-11:51	Magnetometer Bias Calibration Based on Relative Angular Position: Theory and Experimental Comparative Evaluation *Troni, Giancarlo; Eustice, Ryan*	Motion Pattern Discrimination for Soft Robots with Morphologically Flexible Sensors *Culha, Utku; Wani, Umar; Nurzaman, Surya G.; Clemens, Frank; Iida, Fumiya*	Layered Costmaps for Context-Sensitive Navigation *Lu, David V.; Hershberger, Dave; Smart, William*
9	11:51-11:54	Automatic Calibration of RGBD and Thermal Cameras *Lussier, Jake; Thrun, Sebastian*	An Active Compliant Control Mode for Interaction with a Pneumatic Soft Robot *Queisser, Jeffrey; Neumann, Klaus; Rolf, Matthias; Reinhart, Rene Felix; Steil, Jochen J.*	Omnidirectional 3D Reconstruction in Augmented Manhattan Worlds *Schönbein, Miriam; Geiger, Andreas*
10	11:54-11:57	Spatio-Temporal Laser to Visual/Inertial Calibration with Applications to Hand-Held, Large Scale Scanning *Rehder, Joern; Furgale, Paul Timothy; Beardsley, Paul; Siegwart, Roland*	Conformable Actuation and Sensing with Robotic Fabric *Yuen, Michelle; Cherian, Arun; Case, Jennifer; Seipel, Justin; Kramer, Rebecca*	Semantic Mapping for Object Category and Structural Class *Zhao, Zhe; Chen, Xiaoping*
11	11:57-12:00	A Catadioptric Extension for RGB-D Cameras *Endres, Felix; Sprunk, Christoph; Kuemmerle, Rainer; Burgard, Wolfram*	Kinematics of a New Class of Smart Actuators for Soft Robots Based on Generalized Pneumatic Artificial Muscles *Krishnan, Girish*	Anytime Navigation with Progressive Hindsight Optimization *Godoy, Julio; Karamouzas, Ioannis; Guy, Stephen J.; Gini, Maria*

Monday Session B, 11:10 - 12:30 (Continued)

#	Time	Grand Ballroom MoB1 Kinematics and Mechanism Design I	State Ballroom MoB2 Robot Learning I	Red Lacquer Room MoB3 Visual Servoing
12	12:00-12:03	A Dual-Motor Robot Joint Mechanism with Epicyclic Gear Train *Babin, Vincent; Gosselin, Clement; Allan, Jean-Francois*	Unsupervised and Online Non-Stationary Obstacle Discovery and Modeling Using a Laser Range Finder *Duceux, Guillaume; Filliat, David*	6D Image-Based Visual Servoing for Robot Manipulators with uncalibrated Stereo Cameras *Cai, Caixia; Dean Leon, Emmanuel; Somani, Nikhil; Knoll, Alois*
13	12:03-12:06	Kinematic Design and Analysis for a Macaque Upper-Limb Exoskeleton with Shoulder Joint Alignment *Haninger, Kevin; Lu, Junkai; Chen, Wenjie; Tomizuka, Masayoshi*	Mutual Learning of an Object Concept and Language Model Based on MLDA and NPYLM *Nakamura, Tomoaki; Nagai, Takayuki; Funakoshi, Kotaro; Nagasaka, Shogo; Taniguchi, Tadahiro; Iwahashi, Naoto*	Weakly Calibrated Stereoscopic Visual Servoing for Laser Steering: Application to Microphonosurgery *TAMADAZTE, Brahim; Andreff, Nicolas*
14	12:06-12:09	An Alternative Approach to Robot Safety *Parmiggiani, Alberto; Randazzo, Marco; Natale, Lorenzo; Metta, Giorgio*	Object Manifold Learning with Action Features for Active Tactile Object Recognition *Tanaka, Daisuke; Matsubara, Takamitsu; Ichien, Kentaro; Sugimoto, Kenji*	Novel Two-Stage Control Scheme for Robust Constrained Visual Servoing *Assa, Akbar; Janabi-Sharifi, Farrokh*
15	12:09-12:12	On the Performance Evaluation and Analysis of General Robots with Mixed DoFs *SHAYYA, Samah; Krut, Sebastien; Company, Olivier; Baradat, Cédric; Pierrot, François*	Entropy Based Strategies for Physical Exploration of the Environment's Degrees of Freedom *Otte, Stefan; Kulick, Johannes; Toussaint, Marc; Brock, Oliver*	Lyapunov-Stable Eye-In-Hand Kinematic Visual Servoing with Unstructured Static Feature Points *Navarro-Alarcon, David; Liu, Yunhui*
16	12:12-12:15	Closed-Loop Inverse Kinematics under Inequality Constraints: Application to Concentric-Tube Manipulators *Azimian, Hamidreza; Looi, Thomas; Drake, James*	Knowledge Propagation and Relation Learning for Predicting Action Effects *Szedmak, Sandor; Ugur, Emre; Piater, Justus*	A Sequence of Micro-Assembly for Irregular Objects Based on a Multiple Manipulator Platform *Xing, Dengpeng; Xu, De; Li, Hai peng*
17	12:15-12:18	Novel Three-DOF Ankle Mechanisms for Lower-Limb Exoskeleton: Kinematic Analysis and Design of Passive-Type Ankle Module *Hong, Man Bok; Shin, Young June; Wang, Ji-Hyeun*	Learning to Reach into the Unknown: Selecting Initial Conditions When Reaching in Clutter *PARK, DAEHYUNG; Kapusta, Ariel; Kim, You Keun; Rehg, James; Kemp, Charlie*	Visual Servoing Based Trajectory Tracking of Underactuated Water Surface Robots without Direct Position Measurement *WANG, Kai; Liu, Yunhui; Li, Luyang*
18	12:18-12:21	Robust Solution of Prioritized Inverse Kinematics Based on Hestenes-Powell Multiplier Method *Sugihara, Tomomichi*	Learning Haptic Representation for Manipulating Deformable Food Objects *Gemici, Mevlana Celaleddin; Saxena, Ashutosh*	Image Jacobian Estimation Using Structure from Motion on a Centralized Point *Nevarez, Victor; Lumia, Ron*
19	12:21-12:24	Analytical Inverse Kinematic Solution for Modularized 7-DoF Redundant Manipulators with Offsets at Shoulder and Wrist *Luo, Ren; Lin, Tsung-Wei; Tsai, Yun-Hsuan*	A Neural Dynamics Architecture for Grasping That Integrates Perception and Movement Generation and Enables On-Line Updating *Knips, Guido; Zibner, Stephan Klaus Ulrich; Reimann, Hendrik; Popova, Irina; Schöner, Gregor*	Vision Guided Robotic Block Stacking *Macias, Nate; Wen, John*
20	12:24-12:27	A Flexible and Robust Robotic Arm Design and Skill Learning by Using Recurrent Neural Networks *Tan, Boon Hwa; Tang, Huajin; Yan, Rui; Tani, Jun*	Control in the Reliable Region of a Statistical Model with Gaussian Process Regression *Yun, Youngmok; Deshpande, Ashish*	A Two Phase RGB-D Visual Servoing Controller *Hojaij, Abdullah; Zelek, John S.; Asmar, Daniel*
21	12:27-12:30	Sponsor Talk: The da Vinci Xi Surgical System *DiMaio, Simon P.* Intuitive Surgical	Confidence-Based Roadmap Using Gaussian Process Regression for a Robot Control *Okadome, Yuya; Nakamura, Yutaka; URAI, Kenji; Nakata, Yoshihiro; Ishiguro, Hiroshi*	Pose Error Correction For Visual Features Prediction *Cazy, Nicolas; Dune, Claire; Wieber, Pierre-Brice; Robuffo Giordano, Paolo; Chaumette, Francois*

Monday Session C, 13:50 - 15:10

#	Time	Grand Ballroom MoC1 Micro-Nano Robots I & Manipulation and Grasping II	State Ballroom MoC2 Humanoids and Bipeds I & Computer Vision I	Red Lacquer Room MoC3 Bioinspired Robots II & Distributed Robotics
	Chair	Brock, Oliver (TU Berlin)	Dillmann, Rüdiger (Karlsruhe Institute of Technology)	Hsieh, M. Ani (Drexel University)
		Session Keynote	**Session Keynote**	**Session Keynote**
1	13:50-14:10	Keynote: Micro and Nano Robotics for Biomedical Innovations *Arai, Fumihito* Nagoya University	Keynote: What is a humanoid robot good for? *Yokoi, Kazuhito* AIST	Keynote: From Biology to Robot and Back *Choset, Howie* Carnegie Mellon University
		Micro-Nano Robots I	**Humanoids and Bipeds I**	**Bioinspired Robots II**
2	14:10-14:13	Three Dimensional Multi-Cell Spheroids Assembly Using Thermoresponsive Gel Probe *Takeuchi, Masaru; Nakajima, Masahiro; Fukuda, Toshio; Hasegawa, Yasuhisa*	Identification of HRP-2 Foot's Dynamics *Mikami, Yuya; Moulard, Thomas; Yoshida, Eiichi; Venture, Gentiane*	Compliance Computation for Continuum Types of Robots *Smoljkic, Gabrijel; Reynaerts, Dominiek; Vander Sloten, Jos; Vander Poorten, Emmanuel B*
3	14:13-14:16	Construction of Vascular-like Microtubes via Fluidic Axis-translation Self-assembly based on Multiple Hydrogels *Yue, Tao; Nakajima, Masahiro; Takeuchi, Masaru; Huang, Qiang; Fukuda, Toshio*	Integration of Non-Inclusive Contacts in Posture Generation *Brossette, Stanislas; Escande, Adrien; Vaillant, Joris; Keith, François; Moulard, Thomas; Kheddar, Abderrahmane*	Multiport Modeling of Force and Displacement in Elastic Transmissions for Underactuated Hands *Martell, Michael; Schultz, Joshua*
4	14:16-14:19	Magnetic Actuation of Ultra-Compliant Micro Robotic Mechanisms *Vogtmann, Dana; Bergbreiter, Sarah*	3D Dynamics of Bipedal Running: Effects of Step Width on an Amputee-Inspired Robot *Sullivan, Timothy; Seipel, Justin*	iSplash-II: Realizing Fast Carangiform Swimming to Outperform a Real Fish *Clapham, Richard James; Hu, Huosheng*
5	14:19-14:22	Selective and Rapid Cell Injection of Fluorescence Sensor Encapsulated in Liposome Using Optical Control of Zeta Potential and Local Vibration Stimulus by Optical Tweezers *Maruyama, Hisataka; Masuda, Taisuke; Ryu, heng jun; Arai, Fumihito*	Lyapunov Stability Margins for Humanoid Robot Balancing *Spyrakos-Papastavridis, Emmanouil; Perrin, Nicolas Yves; Tsagarakis, Nikolaos; Dai, Jian; Caldwell, Darwin G.*	Multi-Functional Bio-Inspired Leg for Underwater Robots *Kim, Hee Joong; Jun, Bong Huan; Lee, Jihong*
6	14:22-14:25	Real-Time LOC-based Morphological Cell Analysis System Using High-Speed Vision *Gu, Qingyi; Aoyama, Tadayoshi; Takaki, Takeshi; Ishii, Idaku; Takemoto, Ayumi; Sakamoto, Naoaki*	State Estimation for a Humanoid Robot *Rotella, Nicholas; Bloesch, Michael; Righetti, Ludovic; Schaal, Stefan*	Torque Control Strategies for Snake Robots *Rollinson, David; Alwala, Kalyan Vasudev; Zevallos, Nico; Choset, Howie*
7	14:25-14:28	Noncontact Fine Alignment for Multiple Microcontact Printing *Tanaka, Nobuyuki; Ota, Hiroki; Fukumori, Kazuhiro; Yamato, Masayuki; Okano, Teruo; Miyake, Jun*	Sideward Locomotion Control of Biped Robots Based on Dynamics Morphing *Atsuta, Hiroshi; Sugihara, Tomomichi*	A 3D Motion Planning Framework for Snake Robots *Liljebäck, Pål; Pettersen, Kristin Y.; Stavdahl, Øyvind; Gravdahl, Jan Tommy*
8	14:28-14:31	Study on Rotational and Unclogging Motions of Magnetic Chain-Like Microrobot *Belharet, Karim; Folio, David; Ferreira, Antoine*	Modular Low-Cost Humanoid Platform for Disaster Response *Yi, Seung-Joon; McGill, Stephen; Vadakedathu, Larry; He, Qin; Ha, Inyong; Rouleau, Michael; Hong, Dennis; Lee, Daniel D.*	Human Control of Robot Swarms with Dynamic Leaders *Walker, Phillip; Amirpour Amraii, Saman; Lewis, Michael; Chakraborty, Nilanjan; Sycara, Katia*
9	14:31-14:34	Development of Chemical Stimulation System for Local Environment Control by Using Combination of Spout and Suction from Dual Pipettes *Motoyoshi, Takahiro; Kojima, Masaru; Ohara, Kenichi; Horade, Mitsuhiro; Kamiyama, Kazuto; Mae, Yasushi; Arai, Tatsuo*	Perception and Control Strategies for Driving Utility Vehicles with a Humanoid Robot *Rasmussen, Christopher; Sohn, Kiwon; Wang, Qiaosong; Oh, Paul Y.*	Snakes on an Inclined Plane: Learning an Adaptive Sidewinding Motion for Changing Slopes *Gong, Chaohui; Tesch, Matthew; Rollinson, David; Choset, Howie*
10	14:34-14:37	A Stick-Slip Omnidirectional Powertrain for Low-Cost Swarm Robotics: Mechanism, Calibration, and Control *Klingner, John; Kanakia, Anshul; Farrow, Nicholas; Reishus, Dustin; Correll, Nikolaus*	Balancing experiments on a torque-controlled humanoid with hierarchical inverse dynamics *Herzog, Alexander; Righetti, Ludovic; Grimminger, Felix; Pastor, Peter; Schaal, Stefan*	Flapping Actuator Inspired by Lepidotrichia of Ray-Finned Fishes *Sekar, Karthik Srivatsa; Triantafyllou, Michael; Valdivia y Alvarado, Pablo*
11	14:37-14:40	Non-Vector Space Stochastic Control for Nano Robotic Manipulations *Zhao, Jianguo; Song, Bo; Xi, Ning*	Dynamic State Estimation Using Quadratic Programming *Xinjilefu, X; Feng, Siyuan; Atkeson, Christopher*	Design and Implementation of a Low Cost, Pump-Based, Depth Control of a Small Robotic Fish *Makrodimitris, Michail; Aliprantis, Ioannis; Papadopoulos, Evangelos*

Monday Session C, 13:50 - 15:10 (Continued)

#	Time	Grand Ballroom MoC1 Manipulation and Grasping II	State Ballroom MoC2 Computer Vision I	Red Lacquer Room MoC3 Distributed Robotics
12	14:40-14:43	Task Specific Robust Grasping for Multifingered Robot Hands *Boutselis, George; Bechlioulis, Charalampos; Liarokapis, Minas; Kyriakopoulos, Kostas*	"Look at This!" Learning to Guide Visual Saliency in Human-Robot Interaction *Schauerte, Boris; Stiefelhagen, Rainer*	Distributed Management and Representation of Data and Context in Robotic Applications *Dietrich, André; Zug, Sebastian; Mohammad, Siba; Kaiser, Jörg*
13	14:43-14:46	Achieving Elastic Stability of Concentric Tube Robots through Optimization of Tube Precurvature *Ha, Junhyoung; Park, Frank; Dupont, Pierre*	SuperFAST: Model-Based Adaptive Corner Detection for Scalable Robotic Vision *Florentz, Gaspard; Aldea, Emanuel*	Environment-independent Formation Flight for Micro Aerial Vehicles *Naegeli, Tobias; Conte, Christian; domahidi, alexander; Morari, Manfred; Hilliges, Otmar*
14	14:46-14:49	Cable Stiffened Flexible Link Manipulator *Dixit, Rahul; Kumar, R Prasanth*	Auto-Adjusting Camera Exposure for Outdoor Robotics Using Gradient Information *Shim, Inwook; Lee, Joon-Young; Kweon, In So*	Rapid Multirobot Deployment with Time Constraints *Carpin, Stefano; Pavone, Marco; Sadler, Brian*
15	14:49-14:52	Robotic Handwriting: Multi-Contact Manipulation Based on Reactional Internal Contact Hypothesis *Kim, Sung-Kyun; Jo, Joonhee; Oh, Yonghwan; Oh, Sang-Rok; Srinivasa, Siddhartha; Likhachev, Maxim*	SLAM with Object Discovery, Modeling and Mapping *Choudhary, Siddharth; Trevor, Alexander J B; Christensen, Henrik Iskov; Dellaert, Frank*	A Distributed Optimal Strategy for Rendezvous of Multi-Robots with Random Node Failures *Park, Hyongju; Hutchinson, Seth*
16	14:52-14:55	Cooperative Suspended Object Manipulation Using Reinforcement Learning and Energy-Based Control *Palunko, Ivana; Donner, Philine; Buss, Martin; Hirche, Sandra*	Real-Time Sequential Model-Based Non-Rigid SFM *Bronte, Sebastian; Paladini, Marco; Bergasa, Luis Miguel; Agapito, Lourdes; Arroyo, Roberto*	Distributed Cohesive Configuration Control for Swarm Robots with Boundary Information and Network Sensing *Lee, Seoung Kyou; McLurkin, James*
17	14:55-14:58	Robotic Dual Probe Setup for Reliable Pick and Place Processing on the Nanoscale Using Haptic Devices *Tiemerding, Tobias; Zimmermann, Soeren; Fatikow, Sergej*	Direct Superpixel Labeling for Mobile Robot Navigation Using Learned General Optical Flow Templates *Roberts, Richard; Dellaert, Frank*	Decentralized and Complete Multi-Robot Motion Planning in Confined Spaces *Wiktor, Adam; Scobee, Dexter; Messenger, Sean; Clark, Christopher M.*
18	14:58-15:01	Optimal Parameter Identification for Discrete Mechanical Systems with Application to Flexible Object Manipulation *Caldwell, Timothy; Coleman, David; Correll, Nikolaus*	A Directional Visual Descriptor for Large-Scale Coverage Problems *Tamassia, Marco; Farinelli, Alessandro; Murino, Vittorio; Del Bue, Alessio*	Mobile Robotic Wireless Sensor Networks for Efficient Spatial Prediction *Nguyen, Linh Van; Kodagoda, Sarath; Ranasinghe, Ravindra; Dissanayake, Gamini*
19	15:01-15:04	The Joint Coordination in Reach-To-Grap Movements *Li, Zhi; Gray, Kierstin; Roldan, Jay Ryan; Milutinovic, Dejan; Rosen, Jacob*	Real-Time Pose Estimation of Deformable Objects Using a Volumetric Approach *Li, Yinxiao; Wang, Yan; Case, Michael; Chang, Shih-Fu; Allen, Peter*	Improving Data Ferrying by Iteratively Learning the Radio Frequency Environment *Carfang, Anthony; Wagle, Neeti; Frew, Eric W.*
20	15:04-15:07	A Robot System Design for Low-Cost Multi-Robot Manipulation *McLurkin, James; McMullen, Adam; Robbins, Nicholas; Habibi, Golnaz; Becker, Aaron; Chou, Alvin; Li, Hao; John, Meagan; Okeke, Nnena; Rykowski, Joshua; Kim, Sunny; Xie, William; Taylor, Vaughn; Zhou, Yu; Shen, Hsin-Yu Jennifer; Chen, Nelson; Kaseman, Quillan; Langford, Lindsay; Hunt, Jeremy; Boone, Amanda; Koch, Kevin Koch*	PAS: Visual Odometry with Perspective Alignment Search *Richardson, Andrew; Olson, Edwin*	A Cooperative Formation Control Strategy Maintaining Connectivity of a Multi-Agent System *Dutta, Rajdeep; Sun, Liang; Kothari, Mangal; Sharma, Rajnikant; Pack, Daniel*
21	15:07-15:10	Declarative Specification of Task-Based Grasping with Constraint Validation *Schneider, Sven; Hochgeschwender, Nico; Kraetzschmar, Gerhard*	Planar Building Facade Segmentation and Mapping Using Appearance and Geometric Constraints *Lee, Joseph; Lu, Yan; Song, Dezhen*	Interactive Augmented Reality for Understanding and Analyzing Multi-Robot Systems *Ghiringhelli, Fabrizio; Guzzi, Jerome; Di Caro, Gianni A.; caglioti, vincenzo; Gambardella, Luca; Giusti, Alessandro*

Monday Session D, 15:20 - 16:40

		Grand Ballroom	State Ballroom	Red Lacquer Room
		MoD1 **Haptics &** **Surgical Robotics I**	**MoD2** **Human-Robot Interaction I &** **Robot Learning II**	**MoD3** **Formal Methods &** **Software and Architecture**
	Chair	Xiao, Jing (UNC-Charlotte)	De Luca, Alessandro (Sapienza University of Rome)	Tumova, Jana (Royal Institute of Technology)
#	Time	**Session Keynote**	**Session Keynote**	**Session Keynote**
1	15:20- 15:40	Keynote: Haptics in Robot-Assisted Surgery *Okamura, Allison M.* Stanford University	Keynote: Overview of Motor Interaction with Robots and Other Humans *Burdet, Etienne* Imperial College London	Keynote: Formal methods in robotics *Pappas, George J.* University of Pennsylvania
		Haptics	**Human-Robot Interaction I**	**Formal Methods**
2	15:40- 15:43	Steering of Flexible Needles Combining Kinesthetic and Vibratory Force Feedback *Pacchierotti, Claudio; Abayazid, Momen; Misra, Sarthak; Prattichizzo, Domenico*	A Peer Pressure Experiment: Recreation of the Asch Conformity Experiment with Robots *Brandstetter, Jürgen; Racz, Peter; Beckner, Clayton; Sandoval, Eduardo; Hay, Jennifer; Bartneck, Christoph*	A Compositional Approach to Stochastic Optimal Control with Co-safe Temporal Logic Specifications *Horowitz, Matanya; Wolff, Eric; Murray, Richard*
3	15:43- 15:46	Touch Attention Bayesian Models for Robotic Active Haptic Exploration of Heterogeneous Surfaces *Martins, Ricardo; Ferreira, João Filipe; Dias, Jorge*	Inverse Reinforcement Learning Algorithms and Features for Robot Navigation in Crowds: An Experimental Comparison *Vasquez, Dizan; Okal, Billy; Arras, Kai Oliver*	Formal Verification of Maneuver Automata for Parameterized Motion Primitives *Heß, Daniel; Althoff, Matthias; Sattel, Thomas*
4	15:46- 15:49	Design and Evaluation of a 1DoF ERF-Based Needle Insertion Haptic Platform *Graña Sanchez, Adrian; Sanchez Secades, Luis Alonso; Zemiti, Nabil; Poignet, Philippe*	Extraction of Person-Specific Motion Style Based on a Task Model and Imitation by Humanoid Robot *Okamoto, Takahiro; Shiratori, Takaaki; Glisson, Matthew; Yamane, Katsu; Kudoh, Shunsuke; Ikeuchi, Katsushi*	How Behavior Trees Modularize Robustness and Safety in Hybrid Systems *Colledanchise, Michele; Ogren, Petter*
5	15:49- 15:52	Haptic-Enabled Teleoperation of Base-Excited Hydraulic Manipulators Applied to Live-Line Maintenance *Banthia, Vikram; Maddahi, Yaser; Balakrishnan, Subramaniam; Sepehri, Nariman*	Determining Proper Grasp Configurations for Handovers through Observation of Object Movement Patterns and Inter-Object Interactions During Usage *Chan, Wesley Patrick; Kakiuchi, Yohei; Okada, Kei; Inaba, Masayuki*	Verification and Testing of Mobile Robot Navigation Algorithms: A Case Study in SPARK *Trojanek, Piotr; Eder, Kerstin*
6	15:52- 15:55	A Mixed-Initiative Control System for an Aerial Service Vehicle Supported by Force Feedback *Cacace, Jonathan; Finzi, Alberto; Lippiello, Vincenzo*	Using Spatial Language to Drive a Robot for an Indoor Environment Fetch Task *Huo, Zhiyu; Alexenko, Tatiana; Skubic, Marjorie*	Verifying and Validating Multirobot Missions *Lyons, Damian; Arkin, Ronald; Jiang, Shu; Harrington, Dagan; Liu, Tsung-Ming*
7	15:55- 15:58	Design of a Bladder Based Elastomeric Smart Shoe for Haptic Terrain Display *Wang, Yue; Minor, Mark*	Speech-Based Human-Robot Interaction Robust to Acoustic Reflections in Real Environment *Gomez, Randy; Inoue, Koji; Nakamura, Keisuke; Mizumoto, Takeshi; Nakadai, Kazuhiro*	Maximally Satisfying LTL Action Planning *Tumova, Jana; Marzinotto, Alejandro; Dimarogonas, Dimos V.; Kragic, Danica*
8	15:58- 16:01	Contact Force Decomposition Using Tactile Information for Haptic Augmented Reality *Kim, Hyoungkyun; Choi, Seungmoon; Chung, Wan Kyun*	Head-Eyes System and Gaze Analysis of the Humanoid Robot Romeo *Pateromichelakis, Nikolaos; Mazel, Alexandre; Hache, Marc-Antoine; KOUMPOGIANNIS, Thomas; Gelin, Rodolphe; MAISONNIER, Bruno; Berthoz, Alain*	Optimal and Dynamic Planning for Markov Decision Processes with Co-Safe LTL Specifications *Lacerda, Bruno; Parker, David; Hawes, Nick*
9	16:01- 16:04	RoboPuppet: Low-Cost, 3D Printed Miniatures for Teleoperating Full-Size Robots *Eilering, Anna; Franchi, Giulia; Hauser, Kris*	Development of a Rehabilitation Robot Suit with Velocity and Torque-Based Mechanical Safety Devices *Kai, Yoshihiro; KITAGUCHI, Satoshi; Kanno, Shotaro; Zhang, Wenlong; Tomizuka, Masayoshi*	SafeRobots: A Model-Driven Framework for Developing Robotic Systems *Ramaswamy, Arunkumar; Monsuez, Bruno; Tapus, Adriana*
10	16:04- 16:07	Haptic Exploration of Unknown Surfaces with Discontinuities *Jamisola, Jr., Rodrigo S.; Kormushev, Petar; Bicchi, Antonio; Caldwell, Darwin G.*	Modeling and Controller Design of Cooperative Robots in Workspace Sharing Human-Robot Assembly Teams *Liu, Changliu; Tomizuka, Masayoshi*	Automated Composition of Motion Primitives for Multi-Robot Systems from Safe LTL Specifications *Saha, Indranil; Ramaithitima, Rattanachai; Kumar, Vijay; Pappas, George J.; Seshia, Sanjit A.*
11	16:07- 16:10	The Patched Intrinsic Tactile Object: A Tool to Investigate Human Grasps *Serio, Alessandro; Riccomini, Emanuele; Tartaglia, Vincenzo; Sarakoglou, Ioannis; Gabiccini, Marco; Tsagarakis, Nikolaos; Bicchi, Antonio*	Adjutant: A Framework for Flexible Human-Machine Collaborative Systems *Guerin, Kelleher; Riedel, Sebastian Danilo; Bohren, Jonathan; Hager, Gregory*	A Stable Switched-System Approach to Obstacle Avoidance for Mobile Robots in SE(2) *Jin, JingFu; Green, Adrian; Gans, Nicholas (Nick)*

Monday Session D, 15:20 - 16:40 (Continued)

#	Time	Grand Ballroom MoD1 Surgical Robotics I	State Ballroom MoD2 Robot Learning II	Red Lacquer Room MoD3 Software and Architecture
12	16:10-16:13	Workspace Characterization for Concentric Tube Continuum Robots *Burgner-Kahrs, Jessica; Gilbert, Hunter B.; Granna, Josephine; Swaney, Philip J.; Webster III, Robert James*	Efficient Policy Search with a Parameterized Skill Memory *Reinhart, Rene Felix; Steil, Jochen J.*	Etasl/etc: A Constraint-Based Task Specification Language and Robot Controller Using Expression Graphs *Aertbelien, Erwin; De Schutter, Joris*
13	16:13-16:16	Preliminary Evaluation of a New Microsurgical Robotic System for Head and Neck Surgery *Olds, Kevin; Chalasani, Preetham; Pacheco-Lopez, Paulette; Iordachita, Iulian; Akst, Lee; Taylor, Russell H.*	Simultaneous On-Line Discovery and Improvement of Robotic Skill Options *Stulp, Freek; Herlant, Laura; Hoarau, Antoine; Raiola, Gennaro*	Robot Task Commander: A Framework and IDE for Robot Application Development *Hart, Stephen; Dinh, Paul; Yamokoski, John; Wightman, Brian; Radford, Nicolaus*
14	16:16-16:19	Surgical Structured Light for 3D Minimally Invasive Surgical Imaging *Reiter, Austin; Sigaras, Alexandros; Fowler, Dennis; Allen, Peter*	Dimensionality Reduction and Motion Coordination in Learning Trajectories with Dynamic Movement Primitives *Colomé, Adrià; Torras, Carme*	Enhancing Software Module Reusability Using Port Plug-Ins: An Experiment with the iCub Robot *Paikan, Ali; Tikhanoff, Vadim; Metta, Giorgio; Natale, Lorenzo*
15	16:19-16:22	Cooperative Teleoperation with Projection-Based Force Reflection for MIS *Takhmar, Amir; Polushin, Ilia G.; Talasaz, Ali; Patel, Rajnikant V.*	OrigamiBot-I: A Thread-Actuated Origami Robot for Manipulation and Locomotion *Vander Hoff, Evan; Jeong, Donghwa; Lee, Kiju*	Simple Concurrency for Robotics with the Roboscoop Framework *Rusakov, Andrey; Shin, Jiwon; Meyer, Bertrand*
16	16:22-16:25	Design of a Unified Active Locomotion Mechanism for a Wireless Laparoscopic Camera System *Liu, Xiaolong; Mancini, Gregory; Tan, Jindong*	Decoding Surface Electromyogram into Dynamic State to Extract Dynamic Motor Control Strategy of Human *Park, Seongsik; Chung, Wan Kyun*	A Lightweight, Cross-Platform, Multiuser Robot Visualization Using the Cloud *Hilton, William; Lofaro, Daniel; Kim, Youngmoo*
17	16:25-16:28	Toward Automated Intraocular Laser Surgery Using a Handheld Micromanipulator *Yang, Sungwook; MacLachlan, Robert A.; Riviere, Cameron N.*	Latent Space Policy Search for Robotics *Luck, Kevin Sebastian; Neumann, Gerhard; Berger, Erik; Peters, Jan; Ben Amor, Heni*	ReFrESH: A Self-Adaptation Framework to Support Fault Tolerance in Field Mobile Robots *Cui, Yanzhe; Voyles, Richard; Lane, Joshua; Mahoor, Mohammad*
18	16:28-16:31	Quasi-Static Modeling of the Da Vinci Instrument *Anooshahpour, Farshad; Polushin, Ilia G.; Patel, Rajnikant V.*	Learning of Closed-Loop Motion Control *Farshidian, Farbod; Neunert, Michael; Buchli, Jonas*	Speeding up Rao-Blackwellized Particle Filter SLAM with a Multithreaded Architecture *Gouveia, Bruno; Portugal, David; Marques, Lino*
19	16:31-16:34	Design and Evaluation of a Novel Flexible Robot for Transluminal and Endoluminal Surgery *Seneci, Carlo Alberto; Shang, Jianzhong; Leibrandt, Konrad; Vitiello, Valentina; Patel, Nisha; Darzi, Ara; Teare, Julian; Yang, Guang-Zhong*	Unsupervised Learning Approach to Attention-Path Planning for Large-Scale Environment Classification *LEE, Hosun; Jeong, Sungmoon; Chong, Nak Young*	Developing Virtual Testbeds for Intelligent Robot Manipulators - an Erobotics Approach *Guiffo Kaigom, Eric; Rossmann, Juergen*
20	16:34-16:37	Design of a Spine-Inspired Kinematic for the Guidance of Flexible Instruments in Minimally Invasive Surgery *Traeger, Mattias Felix; Roppenecker, Daniel B.; Leininger, Matthias R.; Schnoes, Florian; Lueth, Tim C.*	Automatic Channel Selection and Neural Signal Estimation across Channels of Neural Probes *Vysotska, Olga; Frank, Barbara; Istvan, Ulbert; Paul, Oliver; Ruther, Patrick; Stachniss, Cyrill; Burgard, Wolfram*	Crowdsourcing As a Methodology to Obtain Large and Varied Robotic Data Sets *de Croon, Guido; Gerke, Paul; Sprinkhuizen-Kuyper, Ida*
21	16:37-16:40	Hybrid Control of Master-Slave Velocity Control and Admittance Control for Safe Remote Surgery *Osa, Takayuki; Uchida, Satoshi; Sugita, Naohiko; Mitsuishi, Mamoru*	Fast Planning of Well Conditioned Trajectories for Model Learning *Wang, Cong; Zhao, Yu; Lin, Chung-Yen; Tomizuka, Masayoshi*	

Tuesday Session A, 09:00 - 10:20

		Grand Ballroom	State Ballroom	Red Lacquer Room
		TuA1 **Manipulation and Grasping III & Parallel Robotics**	**TuA2** **Motion and Path Planning II & Localization and Mapping II**	**TuA3** **Search, Rescue, and Audition & Field Robotics**
	Chair	Guglielmelli, Eugenio (Universita' Campus Bio-Medico)	LaValle, Steven M (University of Illinois)	Tadokoro, Satoshi (Tohoku University)
#	Time	**Session Keynote**	**Session Keynote**	**Session Keynote**
1	09:00-09:20	Keynote: Grasping and Manipulation by Humans and by Robots *Brock, Oliver* TU Berlin	Keynote: Sampling-Based Planning: Foundations & Applications *Amato, Nancy* Texas A&M	Keynote: Lessons Learned in Field Robotics from Disasters *Murphy, Robin* Texas A&M
		Manipulation and Grasping III	**Motion and Path Planning II**	**Search, Rescue, and Audition**
2	09:20-09:23	Characterization of the Precision Manipulation Capabilities of Robot Hands via the Continuous Group of Displacements *Rojas, Nicolas; Dollar, Aaron*	Proactive Kinodynamic Planning using the Extended Social Force Model and Human Motion Prediction in Urban Environments *Ferrer, Gonzalo; Sanfeliu, Alberto*	The Response Robotics Summer School 2013: Bringing Responders and Researchers Together to Advance Response Robotics *Sheh, Raymond Ka-Man; Collidge, Bill; Lazarescu, Mihai; Komsuoglu, Haldun; Jacoff, Adam*
3	09:23-09:26	Encoderless Robot Motion Control Using Vision Sensor and Back Electromotive Force *Kawamura, Akihiro; Tachibana, Miyako; Yamate, Soichiro; Kawamura, Sadao*	An Automatic Approach for the Generation of the Roadmap for Multi-AGV Systems in an Industrial Environment *Digani, Valerio; Sabattini, Lorenzo; Secchi, Cristian; Fantuzzi, Cesare*	Design of a Hybrid Exploration Robot for Air and Land Deployment (H.E.R.A.L.D) for Urban Search and Rescue Applications *Latscha, Stella; Kofron, Michael; Stroffolino, Anthony; Davis, Lauren; Merritt, Gabrielle; Piccoli, Matthew; Yim, Mark*
4	09:26-09:29	Humanoid Compliant Whole Arm Dexterous Manipulation: Control Design and Experiments *Wimboeck, Thomas; Florek - Jasinska, Monika; Ott, Christian*	Recursive Non-Uniform Coverage of Unknown Terrains for UAVs *Sadat, Abbas; Wawerla, Jens; Vaughan, Richard*	Approaches to Robotic Teleoperation in a Disaster Scenario: From Supervised Autonomy to Direct Control *Katyal, Kapil; Brown, Christopher; Hechtman, Steven A.; Para, Matthew; McGee, Timothy G.; Wolfe, Kevin; Murphy, Ryan Joseph; Kutzer, Michael Dennis Mays; Tunstel, Edward; Mcloughlin, Michael; Johannes, Matthew*
5	09:29-09:32	Analyzing Human Fingertip Usage in Dexterous Precision Manipulation: Implications for Robotic Finger Design *Bullock, Ian; Feix, Thomas; Dollar, Aaron*	Path Planning with Stability Uncertainty for Articulated Mobile Vehicles in Challenging Environments *Norouzi, Mohammad; Valls Miro, Jaime; Dissanayake, Gamini; Vidal-Calleja, Teresa A.*	Remote Vertical Exploration by Active Scope Camera into Collapsed Buildings *Junichi, Fukuda; Konyo, Masashi; Takeuchi, Eijiro; Tadokoro, Satoshi*
6	09:32-09:35	Adaptive Under-Actuated Anthropomorphic Hand: ISR-SoftHand *Tavakoli, Mahmoud; de Almeida, Anibal*	Closed-Loop Global Motion Planning for Reactive Execution of Learned Tasks *Bowen, Chris; Alterovitz, Ron*	Estimation of Ground Surface Radiation Sources from Dose Map Measured by Moving Dosimeter and 3D Map *Minamoto, Gaku; Takeuchi, Eijiro; Tadokoro, Satoshi*
7	09:35-09:38	Coordinated Motion Control of a Nonholonomic Mobile Manipulator for Accurate Motion Tracking *Jia, Yunyi; Xi, Ning; Cheng, Yu; Liang, Siyang*	An Empirical Study of Optimal Motion Planning *Luo, Jingru; Hauser, Kris*	Making a Robot Dance to Diverse Musical Genre in Noisy Environments *Oliveira, João Lobato; Nakamura, Keisuke; Langlois, Thibault; Gouyon, Fabien; Nakadai, Kazuhiro; Lim, Angelica; Reis, Luís Paulo; Okuno, Hiroshi G.*
8	09:38-09:41	Hierarchical Fingertip Space for Multi-Fingered Precision Grasping *Hang, Kaiyu; Stork, Johannes Andreas; Kragic, Danica*	The Lion and Man Game on Polyhedral Surfaces with Boundary *Noori, Narges; Isler, Volkan*	Improvement in Outdoor Sound Source Detection Using a Quadrotor-Embedded Microphone Array *Ohata, Takuma; Nakamura, Keisuke; Mizumoto, Takeshi; Tezuka, Taiki; Nakadai, Kazuhiro*
9	09:41-09:44	Modeling of Skid-Steer Mobile Manipulators Using Spatial Vector Algebra and Experimental Validation with a Compact Loader *Aguilera, Sergio; Torres-Torriti, Miguel; Auat Cheein, Fernando*	Motion Planning under Uncertainty for Medical Needle Steering Using Optimization in Belief Space *Sun, Wen; Alterovitz, Ron*	Visualization of auditory awareness based on sound source positions estimated by depth sensor and microphone array *Iyama, Takahiro; Sugiyama, Osamu; Otsuka, Takuma; Itoyama, Katsutoshi; Okuno, Hiroshi G.*
10	09:44-09:47	Physically-Consistent Sensor Fusion in Contact-Rich Behaviors *Lowrey, Kendall; Kolev, Svetoslav; Tassa, Yuval; Erez, Tom; Todorov, Emanuel*	A Sampling-Based Algorithm for Multi-Robot Visibility-Based Pursuit-Evasion *Stiffler, Nicholas; O'Kane, Jason*	Rapidly Learning Musical Beats in the Presence of Environmental and Robot Ego Noise *Grunberg, David; Kim, Youngmoo*
11	09:47-09:50	A Real-Time Distributed Architecture for Large-Scale Tactile Sensing *Baglini, Emanuele; Youssefi, Shahbaz; Mastrogiovanni, Fulvio; Cannata, Giorgio*	Online Learning of Task-Specific Dynamics for Periodic Tasks *Petric, Tadej; Gams, Andrej; Zlajpah, Leon; Ude, Ales*	Audio Ray Tracing for Position Estimation of Entities in Blind Regions *Even, Jani; Morales Saiki, Luis Yoichi; Kallakuri, Nagasrikanth; Ishi, Carlos Toshinori; Hagita, Norihiro*

Tuesday Session A, 09:00 - 10:20 (Continued)

#	Time	Grand Ballroom TuA1 Parallel Robotics	State Ballroom TuA2 Localization and Mapping II	Red Lacquer Room TuA3 Field Robotics
12	09:50-09:53	A New Extension of Desired Compensation Adaptive Control and Its Real-Time Application to Redundantly Actuated PKMs *Bennehar, Moussab; Chemori, Ahmed; Pierrot, François*	Towards Consistent Reconstructions of Indoor Spaces Based on 6D RGB-D Odometry and KinectFusion *Dong, Haiwei; Figueroa, Nadia; El Saddik, Abdulmotaleb*	An Adaptive Basic I/O Gain Tuning Method Based on Leveling Control Input Histogram for Human-Machine Systems *Kamezaki, Mitsuhiro; Iwata, Hiroyasu; Sugano, Shigeki*
13	09:53-09:56	Structural Synthesis of Dexterous Hands *Ozgur, Erol; Gogu, Grigore; Mezouar, Youcef*	Biologically Inspired SLAM Using Wi-Fi *Berkvens, Rafael; Jacobson, Adam; Milford, Michael J; peremans, herbert; Weyn, Maarten*	Development and Field Test of Teleoperated Mobile Robots for Active Volcano Observation *Nagatani, Keiji; Akiyama, Ken; Yamauchi, Genki; Yoshida, Kazuya; Hada, Yasushi; Yuta, Shinichi; Izu, Tomoyuki; Randy, Mackay*
14	09:56-09:59	Study of Reconfigurable Suspended Cable-Driven Parallel Robots for Airplane Maintenance *NGUYEN, Dinh Quan; Gouttefarde, Marc*	Point Cloud Registration Using Congruent Pyramids *Krishnan, Aravindhan; Saripalli, Srikanth*	Intelligent Slip-Optimization Control with Traction-Energy Trade-Off for Wheeled Robots on Rough Terrain *Kim, Jayoung; Lee, Jihong*
15	09:59-10:02	Workspace Analysis of Two Similar 3-DOF Axis-Symmetric Parallel Manipulators *Marlow, Kristan; Isaksson, Mats; Abdi, Hamid; Nahavandi, Saeid*	On the Formulation, Performance and Design Choices of Cost-Curve Occupancy Grids for Stereo-Vision Based 3D Reconstruction *Brandao, Martim; Ferreira, Ricardo; Hashimoto, Kenji; Santos-Victor, José; Takanishi, Atsuo*	Novel Robot Mechanism Capable of 3D Differential Driving Inside Pipelines *Yang, Seung Ung; Kim, Ho Moon; Suh, Jung Seok; Choi, Yun Seok; Mun, Hyeong Min; Park, Chan Min; Moon, Hyungpil; Choi, Hyouk Ryeol*
16	10:02-10:05	Improvement of the Direct Kinematic Model of a Haptic Device for Medical Application in Real Time Using an Extra Sensor *saafi, Houssem; laribi, med amine; Zeghloul, Said*	Handling Perceptual Clutter for Robot Vision with Partial Model-Based Interpretations *Tsai, Grace; Kuipers, Benjamin*	Autonomous Robotic System for Bridge Deck Data Collection and Analysis *La, Hung; Gucunski, Nenad; Kee, Seong-Hoon; Yi, Jingang; Senlet, Turgay; Nguyen, Luan*
17	10:05-10:08	Switching Strategy for Flexible Task Execution Using the Cooperative Dual Task-Space Framework *Figueredo, Luis Felipe da Cruz; Adorno, Bruno Vilhena; Ishihara, João Yoshiyuki; Borges, Geovany Araujo*	Modeling Motion Patterns of Dynamic Objects by IOHMM *Wang, Zhan; Ambrus, Rares; Jensfelt, Patric; Folkesson, John*	Road Surface Washing System for Decontaminating Radioactive Substances *Endo, Mitsuru; Endo, Mai; Kakizaki, Takao*
18	10:08-10:11	Vibration Control of 3P(S)4 Class Parallel Mechanisms for High Speed Applications Using Quantitative Feedback Design *Avci, Ebubekir; Kenmochi, Masanori; Kawanishi, Michihiro; Narikiyo, Tatsuo; Kawakami, Shinji; Saitoh, Yumi*	Fast Hybrid Relocation in Large Scale Metric-Topologic-Semantic Map *DROUILLY, Romain; Rives, Patrick; Morisset, Benoit*	A Framework for Predicting the Mission-Specific Performance of Autonomous Unmanned Systems *Durst, Phillip J; Gray, Wendell; Nikitenko, Agris; Caetano, Joao; King, Roger; Trentini, Michael*
19	10:11-10:14	Dimensional Synthesis of 4 DoFs (3T-1R) Actuatedly Redundant Parallel Manipulator Based on Dual Criteria: Dynamics and Precision *SHAYYA, Samah; Krut, Sebastien; Company, Olivier; Baradat, Cédric; Pierrot, François*	Stereo-Vision Based Obstacle Mapping for Indoor/Outdoor SLAM *Brand, Christoph; Schuster, Martin Johannes; Hirschmüller, Heiko; Suppa, Michael*	Experimental Analysis of Models for Trajectory Generation on Tracked Vehicles *Fink, Jonathan; Stump, Ethan*
20	10:14-10:17	Active Vibration Canceling of a Cable-Driven Parallel Robot Using Reaction Wheels *Weber, Xavier; Cuvillon, Loic; Gangloff, Jacques*	Meta-Rooms: Building and Maintaining Long Term Spatial Models in a Dynamic World *Ambrus, Rares; Bore, Nils; Folkesson, John; Jensfelt, Patric*	Sonar-Based Chain Following Using an Autonomous Underwater Vehicle *Hurtos, Natalia; Palomeras, Narcis; Carreras, Marc; Carrera, Arnau; Bechlioulis, Charalampos; Karras, George; Heshmati-alamdari, Shahab; Kyriakopoulos, Kostas*
21	10:17-10:20		Sponsor Talk: BRIN: Benchmark for Robotic Indoor Navigation *Parent, Gershon* Microsoft Robotics	Sponsor Talk: Vision-Based Navigation *Jones, Chris* iRobot Corporation

Tuesday Session B, 10:50 - 12:10

#	Time	Grand Ballroom **TuB1** **Medical Robots and Systems I &** **Rehabilitation Robotics I**	State Ballroom **TuB2** **Human-Robot Interaction II &** **Robot Learning III**	Red Lacquer Room **TuB3** **Marine Robotics &** **Space Robotics**
	Chair	Papanikolopoulos, Nikos (University of Minnesota)	Zhang, Jianwei (University of Hamburg)	Leonard, John (MIT)
		Session Keynote	**Session Keynote**	**Session Keynote**
1	10:50-11:10	Keynote: Medical Robotics - Melding Clinical Need with Engineering Research *Dupont, Pierre* Boston University	Keynote: Robots and Gaming - Therapy for Children with Disabilities *Howard, Ayanna* Georgia Tech	Keynote: Human-guided video data collection in marine environments *Dudek, Gregory* EPFL
		Medical Robots and Systems I	**Human-Robot Interaction II**	**Marine Robotics**
2	11:10-11:13	A Fast, Low-Cost, Computer Vision Approach for Tracking Surgical Tools *Dockter, Rodney; Sweet, Robert; Kowalewski, Timothy*	A Gesture Recognition System for Mobile Robots That Learns Online *Hamlet, Alan; Emami, Patrick*	Predicting the Speed of a Wave Glider Autonomous Surface Vehicle from Wave Model Data *Ngo, Phillip; Das, Jnaneshwar; Ogle, Jonathan; Thomas, Jesse; Anderson, Will; Smith, Ryan N.*
3	11:13-11:16	A Dynamically Consistent Hierarchical Control Architecture for Robotic-Assisted Tele-Echography *Santos, Luís; Cortesao, Rui*	Cartesian Impedance Control of Redundant Manipulators for Human-Robot Co-Manipulation *Ficuciello, Fanny; Romano, Amedeo; Villani, Luigi; Siciliano, Bruno*	3D Trajectory Synthesis and Control for a Legged Swimming Robot *Meger, David Paul; Shkurti, Florian; Cortés Poza, David; Giguere, Philippe; Dudek, Gregory*
4	11:16-11:19	Extended Kinematic Mapping of Tendon-Driven Continuum Robot for Neuroendoscopy *Kato, Takahisa; Okumura, Ichiro; Kose, Hidekazu; Takagi, Kiyoshi; Hata, Nobuhiko*	Estimation of Contact Forces Using a Virtual Force Sensor *Magrini, Emanuele; Flacco, Fabrizio; De Luca, Alessandro*	Control of a Compact, Tetherless ROV for In-Contact Inspection of Complex Underwater Structures *Bhattacharyya, Sampriti; Asada, Harry*
5	11:19-11:22	Dielectrophoresis-Based Automatic 3D Cell Manipulation and Patterning through a Micro-Electrode Integrated Multi-Layer Scaffold *Chu, Henry; Huan, Zhijie; Mills, James K.; Yang, Jie; Sun, Dong*	Multi-Muscle FES Control of the Human Arm for Interaction Tasks---Stabilizing with Muscle Co-Contraction and Postural Adjustment: A Simulation Study *Liao, Yu-Wei; Schearer, Eric; Perreault, Eric; Tresch, Matthew; Lynch, Kevin*	Three-Dimensional Reconstruction of Bridge Structures above the Waterline with an Unmanned Surface Vehicle *Han, Jungwook; Park, Jeonghong; Kim, JinWhan*
6	11:22-11:25	A Novel Redundant Motion Control Mechanism in Accordance with Medical Diagnostic and Therapeutic Task Functions for a NIUTS *Koizumi, Norihiro; Lee, Dongjun; Seo, Joonho; Tsukihara, Hiroyuki; Nomiya, Akira; Azuma, Takashi; Yoshinaka, Kiyoshi; Sugita, Naohiko; Homma, Yukio; Mitsuishi, Mamoru*	Pneumatic Tubular Body Fixture for Wearable Assistive Device - Analysis and Design of Active Cuff to Hold Upper Limb - *Hasegawa, Yasuhisa; Hasegawa, Takaaki; Eguchi, Kiyoshi*	I-AUV Docking and Intervention in a Subsea Panel *Palomeras, Narcis; Peñalver, Antonio; Massot-Campos, Miquel; Vallicrosa, Guillem; Negre Carrasco, Pep Lluis; Fernández, José Javier; Ridao, Pere; Sanz, Pedro J; Oliver, Gabriel A.; Palomer, Albert*
7	11:25-11:28	Simultaneously Powering and Controlling Many Actuators with a Clinical MRI Scanner *Becker, Aaron; Felfoul, Ouajdi; Dupont, Pierre*	Implementation and Experimental Validation of Dynamic Movement Primitives for Object Handover *Prada, Miguel; Remazeilles, Anthony; Koene, Ansgar Roald; Endo, Satoshi*	Active Range-Only Beacon Localization for AUV Homing *Vallicrosa, Guillem; Ridao, Pere; Ribas, David; Palomer, Albert*
8	11:28-11:31	Simultaneous Catheter and Environment Modeling for Trans-Catheter Aortic Valve Implantation *Shi, Chaoyang; Giannarou, Stamatia; Lee, Su-Lin; Yang, Guang-Zhong*	Support Vector Machine Classification of Muscle Cocontraction to Improve Physical Human-Robot Interaction *Moualeu, Antonio; Gallagher, William; Ueda, Jun*	Autonomous Vehicle Localization in a Vector Field: Underwater Vehicle Implementation *Song, Zhuoyuan; Mohseni, Kamran*
9	11:31-11:34	Structurally-Redesigned Concentric-Tube Manipulators with Improved Stability *Azimian, Hamidreza; Francis, Peter; Looi, Thomas; Drake, James*	Oscillation Reduction Scheme for Wearable Robots Employing Linear Actuators and Sensors *Park, Jong Hyeon; Choo, Junghoon; Jeong, Dong-Hyun; Jeong, Seungwoo; Chu, Gilwhoan*	Underway Path-Planning for an Unmanned Surface Vehicle Performing Cooperative Navigation for UUVs at Varying Depths *Hudson, Jonathan; Seto, Mae*
10	11:34-11:37	Online Identification of Abdominal Tissues in Vivo for Tissue-Aware and Injury-Avoiding Surgical Robots *Sie, Astrini; Winek, Michael; Kowalewski, Timothy*	Joint Configuration Strategy for Serial-Chain Safe Manipulators *HONG, SeongHun; Lee, Woosub; Cho, Changhyun; Kang, Sungchul; Lee, Hyeongcheol*	Experimental Validation of Robotic Manifold Tracking in Gyre-Like Flows *Michini, Matthew; Hsieh, M. Ani; Forgoston, Eric; Schwartz, Ira*
11	11:37-11:40	A Novel Micro Laser Ablation System Integrated with Image Sensor for Minimally Invasive Surgery *Su, Baiquan; Shi, Zhan; Liao, Hongen*	Single Muscle Site Semg Interface for Assistive Grasping *Weisz, Jonathan; Barszap, Alexander; Joshi, Sanjay; Allen, Peter*	Trajectory Planning with Adaptive Control Primitives for Autonomous Surface Vehicles Operating in Congested Civilian Traffic *Shah, Brual C.; Svec, Petr; Bertaska, Ivan R.; Klinger, Wilhelm; Sinisterra, Armando J.; Ellenrieder, Karl von; Dhanak, Manhar; Gupta, Satyandra K.*

Tuesday Session B, 10:50 - 12:10 (Continued)

#	Time	Grand Ballroom TuB1 Rehabilitation Robotics I	State Ballroom TuB2 Robot Learning III	Red Lacquer Room TuB3 Space Robotics
12	11:40-11:43	Preliminary Evaluation of a New Control Approach to Achieve Speed Adaptation in Robotic Transfemoral Prosthesis *Lenzi, Tommaso; Hargrove, Levi; Sensinger, Jonathon*	Using Haptics to Extract Object Shape from Rotational Manipulations *Strub, Claudius; Wörgötter, Florentin; Ritter, Helge Joachim; Sandamirskaya, Yulia*	Inchworm Style Gecko Adhesive Climbing Robot *kalouche, Simon; Wiltsie, Nicholas; Su, Hai-Jun; Parness, Aaron*
13	11:43-11:46	Development of an Elbow-Forearm Interlock Joint Mechanism Toward an Exoskeleton for Patients with Essential Tremor *Matsumoto, Yuya; Amemiya, Motoyuki; Kaneishi, Daisuke; Nakashima, Yasutaka; Seki, Masatoshi; Ando, Takeshi; Kobayashi, Yo; Iijima, Hiroshi; Nagaoka, Masanori; Fujie, Masakatsu G.*	Dynamic Attack Motion Prediction for Kendo Agent *Tanaka, Yasufumi; Kosuge, Kazuhiro*	Backup State Observer Based on Optic Flow Applied to Lunar Landing *Sabiron, Guillaume; Burlion, Laurent; Jonniaux, Grégory; Kervendal, Erwan; Bornschlegl, Eric; Raharijaona, Thibaut; Ruffier, Franck*
14	11:46-11:49	A Method for Predicting Personalized Pelvic Motion Based on Body Meta-Features for Gait Rehabilitation Robot *Shin, Sung Yul; Hong, Jisoo; Chun, Changmook; Kim, Seung-Jong; Kim, ChangHwan*	Integration of Various Concepts and Grounding of Word Meanings Using Multi-Layered Multimodal LDA for Sentence Generation *Attamimi, Muhammad; Fadlil, Muhammad; Abe, Kasumi; Nakamura, Tomoaki; Funakoshi, Kotaro; Nagai, Takayuki*	Experimental Evaluation of On-Board, Visual Mapping of an Object Spinning in Micro-Gravity Aboard the International Space Station *Tweddle, Brent Edward; Setterfield, Timothy Philip; Saenz-Otero, Alvar; Miller, David W.; Leonard, John*
15	11:49-11:52	Towards Local Reflexive Control of a Powered Transfemoral Prosthesis for Robust Amputee Push and Trip Recovery *Thatte, Nitish; Geyer, Hartmut*	A Machine Learning Approach for Real-Time Reachability Analysis *Allen, Ross; Clark, Ashley; Starek, Joseph; Pavone, Marco*	Small Body Surface Mobility with a Limbed Robot *Helmick, Daniel; Douillard, Bertrand; Bajracharya, Max*
16	11:52-11:55	Analysis of Inertial Motion in Swing Phase of Human Gait and Its Application to Motion Generation Method of Transfemoral Prosthesis *Wada, Takahiro; Sano, Hiroshi; Sekimoto, Masahiro*	Transfer of Sparse Coding Representations and Object Classifiers across Heterogeneous Robots *Kira, Zsolt*	On Controller Parametric Sensitivity of Passive Object Handling in Space by Robotic Servicers *Rekleitis, Georgios; Papadopoulos, Evangelos*
17	11:55-11:58	Investigation of Contralateral Leg Response to Unilateral Stiffness Perturbations Using a Novel Device *Skidmore, Jeffrey; Barkan, Andrew; Artemiadis, Panagiotis*	A Perceptual Memory System for Grounding Semantic Representations in Intelligent Service Robots *Oliveira, Miguel; Lim, Gi Hyun; Seabra Lopes, Luís; Mohades Kasaei, Seyed Hamidreza; Tomé, Ana Maria; Chauhan, Aneesh*	Design of a Hopping Mechanism using Permanent Magnets for Small-scale Exploration Rovers *Kurisu, Masamitsu*
18	11:58-12:01	Mobile Robotic Gait Rehabilitation System CORBYS: Overview and First Results on Orthosis Actuation *Slavnic, Sinisa; Ristic-Durrant, Danijela; Tschakarow, Roko; Brendel, Thomas; Tüttemann, Markus; Leu, Adrian; Gräser, Axel*	Actor-Critic Design Using Echo State Networks in a Simulated Quadruped Robot *Schmidt, Nico M.; Baumgartner, Matthias; Pfeifer, Rolf*	Soft Landing of Capsule by Casting Manipulator System *Arisumi, Hitoshi; Otsuki, Masatsugu; Nishida, Shin-Ichiro*
19	12:01-12:04	Design and Control of an Exoskeleton System for Gait Rehabilitation Capable of Natural Pelvic Movement *Jung, Chan-Yul; Choi, Junho; Park, Shinsuk; Lee, Jong Min; Kim, ChangHwan; Kim, Seung-Jong*	Expensive Multiobjective Optimization for Robotics with Consideration of Heteroscedastic Noise *Ariizumi, Ryo; Tesch, Matthew; Choset, Howie; Matsuno, Fumitoshi*	Particle Filter Based 3D Position Tracking for Terrain Rovers Using Laser Point Clouds *Jayasekara, Peshala Gehan; Ishigami, Genya; Kubota, Takashi*
20	12:04-12:07	Integrated Control Method for Power-Assisted Rehabilitation: Ellipsoid Regression and Impedance Control *Lee, Jaemin; Kim, MinKyu; Oh, Sang-Rok; Kim, Keehoon*	Flop and Roll: Learning Robust Goal-Directed Locomotion for a Tensegrity Robot *Iscen, Atil; Agogino, Adrian; SunSpiral, Vytas; Tumer, Kagan*	A Real-Time Recognition Based Drilling Strategy for Lunar Exploration *Quan, Qiquan; Tang, Junyue*
21	12:07-12:10	reachMAN2: A Compact Rehabilitation Robot to Train Reaching and Manipulation *TONG, LIU ZHU; Klein, Julius; Anne Dual, Seraina; Teo, Chee Leong; burdet, etienne*	Efficient Bayesian Local Model Learning for Control *Meier, Franziska; Hennig, Philipp; Schaal, Stefan*	

Tuesday Session C, 13:30 - 14:50

#	Time	Grand Ballroom	State Ballroom	Red Lacquer Room
		TuC1 Dynamics and Control & Manipulation and Grasping IV	**TuC2 Humanoids and Bipeds II & Domestic and Interactive Robots**	**TuC3 Localization and Mapping III & Visual Servoing and Tracking**
	Chair	Buchli, Jonas (ETH Zurich)	Lee, C. S. George (Purdue University)	Neira, José (Universidad de Zaragoza)
#	Time	**Session Keynote**	**Session Keynote**	**Session Keynote**
1	13:30-13:50	Keynote: Highly dynamic, energy-aware, biomimetic robots *Stramigioli, Stefano* University of Twente	Keynote: Human-Robot Interaction Socially Assistive Robotics *Scassellati, Brian* Yale University	Keynote: The SLAM Problem - A Fifteen Year Journey ..... *Dissanayake, Gamini* University of Technology, Sydney
		Dynamics and Control	**Humanoids and Bipeds II**	**Localization and Mapping III**
2	13:50-13:53	Robust Control of Flexible Joint Robots Based on Motor-Side Dynamics Reshaping Using Disturbance Observer (DOB) *Kim, Min Jun; Chung, Wan Kyun*	Perturbation Recovery of Biped Walking by Updating the Footstep *Fu, Chenglong*	Direction-Driven Navigation Using Cognitive Map for Mobile Robots *Shim, Vui Ann; Tian, Bo; Yuan, Miaolong; Tang, Huajin; Li, Haizhou*
3	13:53-13:56	A Novel RISE-Based Adaptive Feedforward Controller for Redundantly Actuated Parallel Manipulators *Bennehar, Moussab; Chemori, Ahmed; Pierrot, François*	Swing-Leg Retraction Efficiency in Bipedal Walking *Hasaneini, Seyed Javad; Macnab, Chris; Bertram, John; Leung, Henry*	ISPCG: Incremental Subgraph-Preconditioned Conjugate Gradient Method for Online SLAM with Many Loop-Closures *Jian, Yong-Dian; Dellaert, Frank*
4	13:56-13:59	Constrained Directions As a Path Planning Algorithm for Mobile Robots under Slip and Actuator Limitations *Soltani-Zarrin, Rana; Jayasuriya, Suhada*	Falling Prevention of Humanoid Robots by Switching Standing Balance and Hopping Motion Based on MOA Set *Yamamoto, Ko*	Real-Time RGB-D Registration and Mapping in Texture-Less Environments Using Ranked Order Statistics *Yousif, Khalid; Bab-hadiashar, Alireza; Hoseinnezhad, Reza*
5	13:59-14:02	Partially Analytical Extra-Insensitive Shaper for a Lightly Damped Flexible Arm *Kang, Chul-Goo; Ha, Manh-Tuan*	Preliminary Walking Experiments with Underactuated 3D Bipedal Robot MARLO *Buss, Brian G.; Ramezani, Alireza; Akbari Hamed, Kaveh; Griffin, Brent Austin; Galloway, Kevin; Grizzle, J.W*	Online Global Loop Closure Detection for Large-Scale Multi-Session Graph-Based SLAM *Labbé, Mathieu; Michaud, Francois*
6	14:02-14:05	Terminal Sliding-Mode Based Force Tracking Control of Piezoelectric Actuators for Variable Physical Damping System *Lee, Jinoh; Jin, Maolin; Tsagarakis, Nikolaos; Caldwell, Darwin G.*	Running into a Trap: Numerical Design of Task-Optimal Preflex Behaviors for Delayed Disturbance Responses *Van Why, Johnathan; Hubicki, Christian; Jones, Mikhail; Daley, Monica; Hurst, Jonathan*	Selecting Good Measurements Via L1 Relaxation: A Convex Approach for Robust Estimation Over Graphs *Carlone, Luca; Censi, Andrea; Dellaert, Frank*
7	14:05-14:08	Development of a Single Controller for the Compensation of Several Types of Disturbances During Task Execution of a Wheeled Inverted Pendulum Assistant Robot *Canete, Luis; Takahashi, Takayuki*	SLIP with Swing Leg Augmentation As a Model for Running *Mohammadi Nejad Rashty, Aida; Ahmad Sharbafi, Maziar; Seyfarth, Andre*	Hybrid Inference Optimization for Robust Pose Graph Estimation *Segal, Aleksandr V.; Reid, Ian*
8	14:08-14:11	A Reverse Priority Approach to Multi-Task Control of Redundant Robots *Flacco, Fabrizio; De Luca, Alessandro*	Quantifying the Trade-Offs between Stability versus Energy Use for Underactuated Biped Walking *Saglam, Cenk Oguz; Byl, Katie*	Robust Graph SLAM Back-Ends: A Comparative Analysis *Latif, Yasir; Cadena Lerma, Cesar Dario; Neira, José*
9	14:11-14:14	Dynamic Modeling of Constant Curvature Continuum Robots Using the Euler-Lagrange Formalism *Falkenhahn, Valentin; Mahl, Tobias; Hildebrandt, Alexander; Neumann, Ruediger; Sawodny, Oliver*	Highly Robust Running of Articulated Bipeds in Unobserved Terrain *Wu, Albert; Geyer, Hartmut*	Graph SLAM with Signed Distance Function Maps on a Humanoid Robot *Wagner, René; Frese, Udo; Bäuml, Berthold*
10	14:14-14:17	Fast and Reasonable Contact Force Computation in Forward Dynamics Based on Momentum-Level Penetration Compensation *Wakisaka, Naoki; Sugihara, Tomomichi*	From Template to Anchor: A Novel Control Strategy for Spring-Mass Running of Bipedal Robots *Dadashzadeh, Behnam; Vejdani, Hamid Reza; Hurst, Jonathan*	Credibilist Simultaneous Localization and Mapping with a LIDAR *Trehard, Guillaume; Alsayed, Zayed; Pollard, Evangeline; BRADAI, Benazouz; Nashashibi, Fawzi*
11	14:17-14:20	Recursive Dynamics and Feedback Linearizing Control of Serial-Chain Manipulators *Travers, Matthew; Choset, Howie*	An Estimation Model for Footstep Modifications of Biped Robots *Wittmann, Robert; Hildebrandt, Arne-Christoph; Ewald, Alexander; Buschmann, Thomas*	Novel Insights into the Impact of Graph Structure on SLAM *Khosoussi, Kasra; Huang, Shoudong; Dissanayake, Gamini*

Tuesday Session C, 13:30 - 14:50 (Continued)

#	Time	Grand Ballroom TuC1 Manipulation and Grasping IV	State Ballroom TuC2 Domestic and Interactive Robots	Red Lacquer Room TuC3 Visual Servoing and Tracking
12	14:20-14:23	Grasp Planning for Constricted Parts of Objects Approximated with Quadric Surfaces *Tsuji, Tokuo; Uto, Soichiro; Harada, Kensuke; Kurazume, Ryo; Hasegawa, Tsutomu; Morooka, Ken'ichi*	Finding and Navigating to Household Objects with UHF RFID Tags by Optimizing RF Signal Strength *Deyle, Travis; Reynolds, Matthew; Kemp, Charlie*	Robust Model Predictive Control for Visual Servoing *Assa, Akbar; Janabi-Sharifi, Farrokh*
13	14:23-14:26	Fast Grasping of Unknown Objects Using Force Balance Optimization *LEI, QUJIANG; Wisse, Martijn*	RGB-D Sensor Setup for Multiple Tasks of Home Robots and Experimental Results *de la Puente, Paloma; Bajones, Markus; Einramhof, Peter; Wolf, Daniel; Fischinger, David; Vincze, Markus*	Prescribed Performance Image Based Visual Servoing under Field of View Constraints *Heshmati-alamdari, Shahab; Bechlioulis, Charalampos; Liarokapis, Minas; Kyriakopoulos, Kostas*
14	14:26-14:29	Robotic Nonprehensile Catching: Initial Experiments *Yashima, Masahito; Yamawaki, Tasuku*	Enhanced Robotic Cleaning with a Low-Cost Tool Attachment *Xu, Zhe; Cakmak, Maya*	Monocular Template-Based Vehicle Tracking for Autonomous Convoy Driving *Fries, Carsten; Wuensche, Hans J*
15	14:29-14:32	Changing Pre-Grasp Strategies with Increasing Object Location Uncertainty *Illing, Boris; Asfour, Tamim; Pollard, Nancy S*	CHARM: A Platform for Algorithmic Robotics Education & Research *Singh, Surya; Kurniawati, Hanna; Soltani Naveh, Kianoosh; Song, Joshua; Zastrow, Tyson*	Real-Time Object Pose Recognition and Tracking with an Imprecisely Calibrated Moving RGB-D Camera *Pauwels, Karl; Ivan, Vladimir; Ros, Eduardo; Vijayakumar, Sethu*
16	14:32-14:35	Shrinkable, Stiffness-Controllable Soft Manipulator Based on a Bio-Inspired Antagonistic Actuation Principle *Stilli, Agostino; Wurdemann, Helge Arne; Althoefer, Kaspar*	Development of a Comic Mark Based Expressive Robotic Head Adapted to Japanese Cultural Background *KISHI, Tatsuhiro; Futaki, Hajime; Trovato, Gabriele; Endo, Nobutsuna; Destephe, Matthieu; Cosentino, Sarah; Hashimoto, Kenji; Takanishi, Atsuo*	Robust Ground Surface Map Generation Using Vehicle-Mounted Stereo Camera *Motooka, Kouma; Sugimoto, Shigeki; Okutomi, Masatoshi; Shima, Takeshi*
17	14:35-14:38	Guided Locomotion in 3D for Snake Robots Based on Contact Force Optimization *Ponte, Hugo; Travers, Matthew; Choset, Howie*	Effects of Bodily Mood Expression of a Robotic Teacher on Students *Xu, Junchao; broekens, joost; Hindriks, Koen; Neerincx, Mark*	RGB-D Fusion: Real-Time Robust Tracking and Dense Mapping with RGB-D Data Fusion *Lee, Seong-Oh; Lim, Hwasup; Kim, Hyoung-Gon; Ahn, Sang Chul*
18	14:38-14:41	Push Resistance in In-Hand Manipulation *He, Junhu; Zhang, Jianwei*	Real-Time Recognition of Pointing Gestures for Robot to Robot Interaction *Kondaxakis, Polychronis; Pajarinen, Joni; Kyrki, Ville*	Bearings-Only Path Following with a Vision-Based Potential Field *Sabatta, Deon; Siegwart, Roland*
19	14:41-14:44	Online Interactive Perception of Articulated Objects with Multi-Level Recursive Estimation Based on Task-Specific Priors *Martín Martín, Roberto; Brock, Oliver*	Adaptive Spacing in Human-Robot Interactions *Papadakis, Panagiotis; Rives, Patrick; Spalanzani, Anne*	Event-Based, 6-DOF Pose Tracking for High-Speed Maneuvers *Mueggler, Elias; Huber, Basil; Scaramuzza, Davide*
20	14:44-14:47	Using Environment Objects As Tools: Unconventional Door Opening *Levihn, Martin; Stilman, Mike*	Determining the Affective Body Language of Older Adults during Socially Assistive HRI *McColl, Derek; Nejat, Goldie*	Learning Visual Feature Descriptors for Dynamic Lighting Conditions *Carlevaris-Bianco, Nicholas; Eustice, Ryan*
21	14:47-14:50	Sponsor Talk: Components for Mobile Manipulation: Light-Weight Arms and Robotic Hands *Parlitz, Christopher* SCHUNK	Sponsor Talk: The Eyes: A History of Baxter's Personification *Maroney, Kyle* Rethink Robotics	Detection of Small Moving Objects Using a Moving Camera *Shakeri, Moein; Zhang, Hong*

Tuesday Session D, 15:00 - 16:20

#	Time	Grand Ballroom **TuD1** **Actuators &** **Kinematics and Mechanism Design II**	State Ballroom **TuD2** **Reasoning and AI Planning &** **Path and Task Planning**	Red Lacquer Room **TuD3** **Sensing I &** **Sensing for Human Environments**
	Chair	Krovi, Venkat (University at Buffalo (SUNY Buffalo))	Jacobs, Sam Ade (ABB Inc)	Song, Dezhen (Texas A&M University)
#	Time	**Session Keynote**	**Session Keynote**	**Session Keynote**
1	15:00-15:20	Keynote: Robots for Interaction with Humans and Unknown Environments *Albu-Schäffer, Alin* DLR	Keynote: Symbiotic Mobile Robot Autonomy in Human Environments *Veloso, Manuela* Carnegie Mellon University	Keynote: Life In a World of Ubiquitous Sensing *Hager, Gregory* Johns Hopkins University
		Actuators	**Reasoning and AI Planning**	**Sensing I**
2	15:20-15:23	Soft Pneumatic Actuator Skin with Embedded Sensors *Suh, Chansu; Condal Margarit, Jordi; Song, Yun Seong; Paik, Jamie*	Prior-Assisted Propagation of Spatial Information for Object Search *Lorbach, Malte; Höfer, Sebastian; Brock, Oliver*	Augmenting Bayes Filters with the Relevance Vector Machine for Time-Varying Context-Dependent Observation Distribution *Ravet, Alexandre; Lacroix, Simon; Hattenberger, Gautier*
3	15:23-15:26	Towards Variable Stiffness Control of Antagonistic Twisted String Actuators *Popov, Dmitry; Gaponov, Igor; Ryu, Jee-Hwan*	Combining Top-Down Spatial Reasoning and Bottom-Up Object Class Recognition for Scene Understanding *Kunze, Lars; Burbridge, Christopher; Alberti, Marina; Thippur, Akshaya; Folkesson, John; Jensfelt, Patric; Hawes, Nick*	Audio-Visual Classification and Detection of Human Manipulation Actions *Pieropan, Alessandro; Salvi, Giampiero; Pauwels, Karl; Kjellstrom, Hedvig*
4	15:26-15:29	A Multiplex Pneumatic Actuator Drive Method Based on Acoustic Communication in Air Supply Line *Suzumori, Koichi; Osaki, Naoto; Misumi, Jumpei; Yamamoto, Akina; Kanda, Takefumi*	Learning Relational Affordance Models for Two-Arm Robots *Moldovan, Bogdan; De Raedt, Luc*	Object Shape Categorization in RGBD Images using Hierarchical Graph Constellation Models based on Unsupervisedly Learned Shape Parts described by a Set of Shape Specificity Levels *Mueller, Christian Atanas; Pathak, Kaustubh; Birk, Andreas*
5	15:29-15:32	A Low-Friction Passive Fluid Transmission and Fluid-Tendon Soft Actuator *Whitney, John; Glisson, Matthew; Brockmeyer, Eric; Hodgins, Jessica*	Cognitive Factories with Multiple Teams of Heterogeneous Robots: Hybrid Reasoning for Optimal Feasible Global Plans *Saribatur, Zeynep G.; Erdem, Esra; Patoglu, Volkan*	sEMG-Based Decoding of Human Intentions Robust to the Changes of Electrode Positions *Park, Myoung Soo*
6	15:32-15:35	Design of a Novel Intermittent Self-Closing Mechanism for a MACCEPA-Based Series-Parallel Elastic Actuator (SPEA) *Mathijssen, Glenn; Furnémont, Raphaël; Brackx, Branko; Van Ham, Ronald; Lefeber, Dirk; Vanderborght, Bram*	Incorporating Kinodynamic Constraints in Automated Design of Simple Machines *Erdogan, Can; Stilman, Mike*	Multi-Target Visual Tracking with Aerial Robots *Tokekar, Pratap; Isler, Volkan; Franchi, Antonio*
7	15:35-15:38	A Resonant Parallel Elastic Actuator for Biorobotic Applications *Sudano, Angelo; Tagliamonte, Nevio Luigi; Accoto, Dino; Guglielmelli, Eugenio*	Unifying Multi-Goal Path Planning for Autonomous Data Collection *Faigl, Jan; Hollinger, Geoffrey*	Opportunistic Sampling-Based Planning for Active Visual SLAM *Chaves, Stephen; Kim, Ayoung; Eustice, Ryan*
8	15:38-15:41	Smart Braid: Air Muscles That Measure Force and Displacement *Felt, Wyatt; Remy, C. David*	Stochastic Collection and Replenishment (SCAR) Optimisation for Persistent Autonomy *Palmer, Andrew William; Hill, Andrew John; Scheding, Steven*	Ear-Based Exploration on Hybrid Metric/Topological Maps *Zhang, Qiwen; Whitney, David; Shkurti, Florian; Rekleitis, Ioannis*
9	15:41-15:44	Variable Stiffness Fabrics with Embedded Shape Memory Materials for Wearable Applications *Chenal, Thomas; Case, Jennifer; Paik, Jamie; Kramer, Rebecca*	Coverage Planning with Finite Resources *Strimel, Grant; Veloso, Manuela*	Fast and Effective Visual Place Recognition using Binary Codes and Disparity Information *Arroyo, Roberto; Fernández Alcantarilla, Pablo; Bergasa, Luis Miguel; Yebes, José Javier; Bronte, Sebastian*
10	15:44-15:47	A Flexible Passive Joint for Robotic Fish Pectoral Fins: Design, Dynamic Modeling, and Experimental Results *Bazaz Behbahani, Sanaz; Tan, Xiaobo*	Coordination in Human-Robot Teams Using Mental Modeling and Plan Recognition *Talamadupula, Kartik; Briggs, Gordon; Chakraborti, Tathagata; Scheutz, Matthias; Kambhampati, Subbarao*	A Linear Approach to Visuo-Inertial Fusion for Homography-Based Filtering and Estimation *Eudes, Alexandre; Morin, Pascal*
11	15:47-15:50	Formulation and Optimization of Pulley-Gear-Type SMA Heat Engine Toward Microfluidic MEMS Motor *Aono, Hiroyuki; Imamura, Ryota; Fuchiwaki, Ohmi; Yamanashi, Yuki; Böhringer, Karl F.*	A Framework for Formal Specification of Robotic Constraint-Based Tasks and their Concurrent Execution with Online QoS Monitoring *Scioni, Enea; Borghesan, Gianni; Bruyninckx, Herman; Bonfe, Marcello*	Fusion of Optical Flow and Inertial Measurements for Robust Egomotion Estimation *Bloesch, Michael; Omari, Sammy; Fankhauser, Péter; Sommer, Hannes; Gehring, Christian; Hwangbo, Jemin; Hoepflinger, Mark; Hutter, Marco; Siegwart, Roland*

Tuesday Session D, 15:00 - 16:20 (Continued)

#	Time	Grand Ballroom TuD1 Kinematics and Mechanism Design II	State Ballroom TuD2 Path and Task Planning	Red Lacquer Room TuD3 Sensing for Human Environments
12	15:50- 15:53	Design, Principles, and Testing of a Latching Modular Robot Connector *Eckenstein, Nick; Yim, Mark*	Synthesizing Manipulation Sequences for Under-Specified Tasks Using Unrolled Markov Random Fields *Sung, Jaeyong; Selman, Bart; Saxena, Ashutosh*	Cameraman Robot: Dynamic Trajectory Tracking with Final Time Constraint Using State-Time Space Stochastic Approach *Ardiyanto, Igi; Miura, Jun*
13	15:53- 15:56	Design, Modeling and Performance Evaluation of a Long and Slim Continuum Robotic Cable *Tonapi, Manas; Godage, Isuru S.; Walker, Ian*	A Probability-Based Path Planning Method Using Fuzzy Logic *Lee, Jaeyeon; Park, Wooram*	Automatic Detection and Verification of Pipeline Construction Features with Multi-Modal Data *Vidal-Calleja, Teresa A.; Valls Miro, Jaime; Martin, Fernando; Lingnau, Daniel C.; Russell, David E.*
14	15:56- 15:59	Kinetostatic Optimization for an Adjustable Four-Bar Based Articulated Leg-Wheel Subsystem *Alamdari, Aliakbar; Sovizi, Javad; Jun, Seung-kook; Krovi, Venkat*	Multi-Goal Path Planning Based on the Generalized Traveling Salesman Problem with Neighborhoods *Vicencio, Kevin; Davis, Brian; Gentilini, Iacopo*	Grasping Point Selection on an Item of Crumpled Clothing Based on Relational Shape Description *Yamazaki, Kimitoshi*
15	15:59- 16:02	A Single DOF Arm for Transition of Climbing Robots between Perpendicular Planes *Viegas, Carlos; Tavakoli, Mahmoud*	A Multi-Tree Extension of the Transition-Based RRT: Application to Ordering-And-Pathfinding Problems in Continuous Cost Spaces *Devaurs, Didier; Simeon, Thierry; Cortes, Juan*	A Solution to Pose Ambiguity of Visual Markers Using Moire Patterns *Tanaka, Hideyuki; Sumi, Yasushi; Matsumoto, Yoshio*
16	16:02- 16:05	Design of Variable Release Torque-Based Compliant Spring-Clutch and Torque Estimation *Seok, Jushin; Kang, Sungchul; Lee, Woosub*	Informed RRT*: Optimal Sampling-based Path Planning Focused via Direct Sampling of an Admissible Ellipsoidal Heuristic *Gammell, Jonathan David; Srinivasa, Siddhartha; Barfoot, Timothy*	On Leader Following and Classification *Stein, Procópio; Spalanzani, Anne; Santos, Vitor; Laugier, Christian*
17	16:05- 16:08	Principles of Microscale Flexure Hinge Design for Enhanced Endurance *Malka, Ronit; Lussier Desbiens, Alexis; Chen, YuFeng; Wood, Robert*	Integrating Multiple Soft Constraints for Planning Practical Paths *Yang, Jing; dymond, patrick; Jenkin, Michael*	Complexity-Based Motion Features and Their Applications to Action Recognition by Hierarchical Spatio-Temporal Naive Bayes Classifier *Kwon, Woo Young; Suh, Il Hong*
18	16:08- 16:11	Strengthening of 3D Printed Robotic Parts Via Fill Compositing *Belter, Joseph; Dollar, Aaron*	Sampling-Based Trajectory Imitation in Constrained Environments Using Laplacian-RRT* *Nierhoff, Thomas; Hirche, Sandra; Nakamura, Yoshihiko*	Enhancement of Layered Hidden Markov Model by Brain-Inspired Feedback Mechanism *Lee, Sang Hyoung; Kim, Min Gu; Suh, Il Hong*
19	16:11- 16:14	Cogeneration of Mechanical, Electrical, and Software Designs for Printable Robots from Structural Specifications *Mehta, Ankur; DelPreto, Joseph; Shaya, Benjamin; Rus, Daniela*	The Anatomy of a Distributed Motion Planning Roadmap *Jacobs, Sam Ade; Amato, Nancy*	Guiding Computational Perception through a Shared Auditory Space *Martinson, Eric; Yalla, Ganesh*
20	16:14- 16:17	Design of a Robotic Finger Using Series Gear Chain Mechanisms *Mishima, Yuuki; Ozawa, Ryuta*	Safest Path Adversarial Coverage *Yehoshua, Roi; Agmon, Noa; Kaminka, Gal A*	Classification and Identification of Robot Sensing Data Based on Nested Infinite GMM *Sasaki, Yoko; Hatao, Naotaka; Kagami, Satoshi*
21	16:17- 16:20	Sponsor Talk: The Next Research Revolution with KUKA's Robotic Reference Platforms *Ryan, Corey* KUKA Robotics Corp	Planning with the STAR(s) *Karydis, Konstantinos; Zarrouk, David; Poulakakis, Ioannis; Fearing, Ronald; Tanner, Herbert G.*	Localization of Multiple Sources from a Binaural Head in a Known Noisy Environment *Portello, Alban; Bustamante, Gabriel; Danès, Patrick; Mifsud, Alexis*

Tuesday Session E, 16:50 - 17:55

#	Time	Grand Ballroom **TuE1** **Constrained and Underactuated Robots & Legged Robots I**	State Ballroom **TuE2** **Human-Robot Interaction III & Grasp Learning**	Red Lacquer Room **TuE3** **Unmanned Aerial Systems I & Localization and Pose Estimation**
	Chair	Buehler, Martin (Vecna Technologies)	Wettels, Nicholas (NASA-JPL)	Clark, Christopher M. (Harvey Mudd College)
		Session Keynote	**Session Keynote**	**Session Keynote**
1	16:50-17:10	Keynote: Robot Motion Optimization *Park, Frank* Seoul National University	Keynote: Perception-Action-Learning and Associative Skill Memories *Schaal, Stefan* University of Southern California	Keynote: Aerial Robot Swarms *Kumar, Vijay* University of Pennsylvania
		Constrained and Underactuated Robots	**Human-Robot Interaction III**	**Unmanned Aerial Systems I**
2	17:10-17:13	A Novel Continuum-Style Robot with Multilayer Compliant Modules *Qi, Peng; Qiu, Chen; Liu, Hongbin; Dai, Jian; Seneviratne, lakmal; Althoefer, Kaspar*	Remote Control System for Multiple Mobile Robots Using Touch Panel Interface and Autonomous Mobility *Ochiai, Yuya; Takemura, Kentaro; Ikeda, Atsutoshi; Takamatsu, Jun; Ogasawara, Tsukasa*	Frequency-Domain Flight Dynamics Model Identification of MAVs - Miniature Quad-Rotor Aerial Vehicles *Guowei, Cai; Al Mehairi, Hind; Al-Hosani, Hanan; Dias, Jorge; Seneviratne, lakmal*
3	17:13-17:16	A Fish-Like Locomotion Model in an Ideal Fluid with Lateral-Line-Inspired Background Flow Estimation *Xu, Yiming; Mohseni, Kamran*	Ridesharing with Passenger Transfers *Coltin, Brian; Veloso, Manuela*	Simulating Quadrotor UAVs in Outdoor Scenarios *Symington, Andrew Colquhoun; De Nardi, Renzo; Julier, Simon Justin; Hailes, Stephen*
4	17:16-17:19	MR Compatible Continuum Robot Based on Closed Elastica with Bending and Twisting *Yamada, Atsushi; Naka, Shigeyuki; Morikawa, Shigehiro; Tani, Tohru*	Modeling of Human Velocity Habituation for a Robotic Wheelchair *Morales Saiki, Luis Yoichi; Abdur-Rahim, Jamilah; Even, Jani; Kondo, Tadahisa; Hagita, Norihiro; Ogawa, Takeshi; Ishii, Shin; Watanabe, Atsushi*	Health Aware Stochastic Planning for Persistent Package Delivery Missions Using Quadrotors *Agha-mohammadi, Ali-akbar; Ure, Nazim Kemal; How, Jonathan; Vian, John*
5	17:19-17:22	Trajectory Optimization of Flapping Wings Modeled as a Three Degree-Of-Freedoms Oscillation System *Qin, Yi; Cheng, Bo; Deng, Xinyan*	Physical Embodied Communication between Robots and Children: An Approach for Relationship Building by Holding Hands *Hieida, Chie; Abe, Kasumi; Attamimi, Muhammad; Shimotomai, Takayuki; Nagai, Takayuki; Omori, Takashi*	High-Throughput Study of Flapping Wing Aerodynamics for Biological and Robotic Applications *Gravish, Nicholas; Chen, YuFeng; Combes, Stacey; Wood, Robert*
6	17:22-17:25	The Use of Unicycle Robot Control Strategies for Skid-Steer Robots through the ICR Kinematic Mapping *Pentzer, Jesse; Brennan, Sean; Reichard, Karl*	Using Social Cues to Estimate Possible Destinations When Driving a Robotic Wheelchair *ESCOBEDO-CABELLO, Jesus-Arturo; Spalanzani, Anne; Laugier, Christian*	Computational Morphology for a Soft Micro Air Vehicle in Hovering Flight *Chevallereau, Christine; Porez, Mathieu; Boyer, Frédéric*
7	17:25-17:28	Open-Source, Affordable, Modular, Light-Weight, Underactuated Robot Hands *Zisimatos, Agisilaos; Liarokapis, Minas; Mavrogiannis, Christoforos; Kyriakopoulos, Kostas*	A Novel User-Guided Interface for Robot Search *Kosti, Shahar; Sarne, David; Kaminka, Gal A*	Towards Valve Turning Using a Dual-Arm Aerial Manipulator *Korpela, Christopher M.; Orsag, Matko; Oh, Paul Y.*
8	17:28-17:31	Modeling of Wheeled Mobile Robots As Differential-Algebraic Systems *Kelly, Alonzo; Seegmiller, Neal Andrew*	Contextual Task-Aware Shared Autonomy for Assistive Mobile Robot Teleoperation *Gao, Ming; Oberländer, Jan; Schamm, Thomas; Zöllner, Johann Marius*	Control of a Multirotor Outdoor Aerial Manipulator *Heredia, Guillermo; Jimenez-Cano, Antonio; Sanchez, M. Ivan; Llorente, Domingo; Vega, Victor; Braga, Juan; Acosta, Jose Angel; Ollero, Anibal*
9	17:31-17:34	Practical Identification and Flatness Based Control of a Terrestrial Quadrotor *thorel, sylvain; d'Andréa-Novel, Brigitte*	Personalizing Vision-Based Gestural Interfaces for HRI with UAVs: A Transfer Learning Approach *Costante, Gabriele; Bellocchio, Enrico; Valigi, Paolo; Ricci, Elisa*	Reinforcement Learning for Autonomous Dynamic Soaring in Shear Winds *Montella, Corey; Spletzer, John*
10	17:34-17:37	Partial Force Control of Constrained Floating-Base Robots *Del Prete, Andrea; Mansard, Nicolas; Nori, Francesco; Metta, Giorgio; Natale, Lorenzo*	Multimodal Real-Time Contingency Detection for HRI *Chu, Vivian; Bullard, Kalesha; Thomaz, Andrea Lockerd*	Vision-Based Absolute Localization for Unmanned Aerial Vehicles *YOL, Aurélien; Delabarre, Bertrand; Dame, Amaury; DARTOIS, Jean-Emile; Marchand, Eric*
11	17:37-17:40	Balancing Control Algorithm for a 3D Under-Actuated Robot *Azad, Morteza; Featherstone, Roy*	Pose Estimation in Physical Human-Machine Interactions with Application to Bicycle Riding *Zhang, Yizhai; Chen, Kuo; Yi, Jingang; Liu, Liu*	Variable Impedance Control for Aerial Interaction *Mersha, Abeje Y.; Stramigioli, Stefano; Carloni, Raffaella*

Tuesday Session E, 16:50 - 17:55 (Continued)

#	Time	Grand Ballroom TuE1 Legged Robots I	State Ballroom TuE2 Grasp Learning	Red Lacquer Room TuE3 Localization and Pose Estimation
12	17:40- 17:43	On the Convergence of Fixed-point Iteration in Solving Complementarity Problems Arising in Robot Locomotion and Manipulation *Lu, Ying; Trinkle, Jeff*	Learning of Grasp Adaptation through Experience and Tactile Sensing *Li, Miao; Bekiroglu, Yasemin; Kragic, Danica; Billard, Aude*	Improving Object Tracking through Distributed Exploration of an Information Map *Neveln, Izaak; Miller, Lauren; MacIver, Malcolm A.; Murphey, Todd*
13	17:43- 17:46	Quadruped Bounding Control with Variable Duty Cycle Via Vertical Impulse Scaling *Park, Hae-Won; Chuah, Meng Yee (Michael); Kim, Sangbae*	Construction of an Object Manipulation Database from Grasp Demonstrations *Kent, David; Chernova, Sonia*	Topometric Localization on a Road Network *Xu, Danfei; Badino, Hernan; Huber, Daniel*
14	17:46- 17:49	Posture and Balance Control for Humanoid Robots in Multi-Contact Scenarios Based on Model Predictive Control *Henze, Bernd; Ott, Christian; Roa, Maximo A.*	Evaluating the Efficacy of Grasp Metrics for Utilization in a Gaussian Process-Based Grasp Predictor *Goins, Alex; Carpenter, Ryan; Wong, Weng-Keen; Balasubramanian, Ravi*	Pose Estimation of Servo-Brake-Controlled Caster Units Arbitrarily Located on a Mobile Base *Saida, Masao; Hirata, Yasuhisa; Kosuge, Kazuhiro*
15	17:49- 17:52	Optimal Gaits and Motions for Legged Robots *Xi, Weitao; Remy, C. David*	Predicting Object Interactions from Contact Distributions *Kroemer, Oliver; Peters, Jan*	Rail-Guided Robotic End-Effector Position Error Due to Rail Compliance and Ship Motion *Borgerink, Dian J.; Stegenga, Jan; Brouwer, Dannis M.; Wörtche, Heinrich; Stramigioli, Stefano*
16	17:52- 17:55	Quadratic Programming-Based Inverse Dynamics Control for Legged Robots with Sticking and Slipping Frictional Contacts *Zapolsky, Samuel; Drumwright, Evan*	Learning Robot Tactile Sensing for Object Manipulation *Chebotar, Yevgen; Kroemer, Oliver; Peters, Jan*	A Multi-AUV State Estimator for Determining the 3D Position of Tagged Fish *Lin, Yukun; Kastein, Hannah; Peterson, Taylor; White, Connor; Lowe, Christopher G.; Clark, Christopher M.*

Wednesday Session A, 09:00 - 10:20

		Grand Ballroom	State Ballroom	Red Lacquer Room
		WeA1 **Medical Robots and Systems II & Rehabilitation Robotics II**	**WeA2** **Motion and Path Planning III & Planning, Failure Detection and Recovery**	**WeA3** **Networked Robots & Swarm Robotics**
	Chair	Taylor, Russell H. (Johns Hopkins University)	Kroeger, Torsten (Google, Inc.)	Vaughan, Richard (Simon Fraser University)
#	Time	**Session Keynote**	**Session Keynote**	**Session Keynote**
1	09:00-09:20	Keynote: Towards Intelligent Robotic Surgical Assistants *Cavusoglu, M. Cenk* Case Western Reserve University	Keynote: Planning for Complex High-Level Missions *Kavraki, Lydia* Rice University	Keynote: Networked Robots *Rus, Daniela* MIT
		Medical Robots and Systems II	**Motion and Path Planning III**	**Networked Robots**
2	09:20-09:23	Task-Space Motion Planning of MRI-Actuated Catheters for Catheter Ablation of Atrial Fibrillation *Greigarn, Tipakorn; Cavusoglu, M. Cenk*	Nonlinear Dimensionality Reduction for Kinematic Cartography with an Application Toward Robotic Locomotion *Dear, Tony; Hatton, Ross; Choset, Howie*	Autonomous Wireless Backbone Deployment with Bounded Number of Networked Robots *Santos, Elerson Rubens da Silva; Vieira, Marcos*
3	09:23-09:26	Using Lie Algebra for Shape Estimation of Medical Snake Robots *Rangaprasad, Arun Srivatsan; Travers, Matthew; Choset, Howie*	Orienting in Mid-Air through Configuration Changes to Achieve a Rolling Landing for Reducing Impact after a Fall *Bingham, Jeffrey; Lee, Jeongseok; Haksar, Ravi; Ueda, Jun; Liu, Karen*	Point Cloud Culling for Robot Vision Tasks under Communication Constraints *Beksi, William; Papanikolopoulos, Nikos*
4	09:26-09:29	Modeling and Control of Robotic Surgical Platform for Single-Port Access Surgery *Lee, Jusuk; Kim, Jiyoung; Lee, Kwang-Kyu; Hyung, SeungYong; Kim, Yong-Jae; Kwon, Woong; Roh, Kyungshik; Choi, Jung-Yun*	Motion Planning for Non-Holonomic Mobile Robots Using the I-PID Controller and Potential Field *Ma, Yingchong; Zheng, Gang; perruquetti, Wilfrid; QIU, Zhaopeng*	Robust Routing and Multi-Confirmation Transmission Protocol for Connectivity Management of Mobile Robotic Teams *Stephan, James; Fink, Jonathan; Charrow, Benjamin; Kumar, Vijay; Ribeiro, Alejandro*
5	09:29-09:32	Semi-Autonomous Navigation for Robot Assisted Tele-Echography Using Generalized Shape Models and Co-Registered RGB-D Cameras *Zhang, Lin; Lee, Su-Lin; Yang, Guang-Zhong; Mylonas, George*	Spherical Parabolic Blends for Robot Workspace Trajectories *Dantam, Neil; Stilman, Mike*	A Centralized-Equivalent Decentralized Implementation of Extended Kalman Filters for Cooperative Localization *Kia, Solmaz; Rounds, Stephen; Martinez, Sonia*
6	09:32-09:35	State Recognition of Bone Drilling with Audio Signal in Robotic Orthopedics Surgery System *Sun, Yu; Jin, Haiyang; HU, Ying; Zhang, Peng; Zhang, Jianwei*	Trajectory Planning for Car-Like Robots in Unknown, Unstructured Environments *Fassbender, Dennis; Mueller, Andre; Wuensche, Hans J*	From Autonomy to Cooperative Traded Control of Humanoid Manipulation Tasks with Unreliable Communication: System Design and Lessons Learned *Mainprice, Jim; Phillips-Grafflin, Calder; Suay, Halit Bener; Alunni, Nicholas; Lofaro, Daniel; Berenson, Dmitry; Chernova, Sonia; Lindeman, Robert; Oh, Paul Y.*
7	09:35-09:38	Estimating Contact Force for Steerable Ablation Catheters Based on Shape Analysis *Khoshnam Tehrani, Mahta; Patel, Rajnikant V.*	Fast, Dynamic Trajectory Planning for a Dynamically Stable Mobile Robot *Shomin, Michael; Hollis, Ralph*	Route Swarm: Wireless Network Optimization through Mobility *Williams, Ryan; Gasparri, Andrea; Krishnamachari, Bhaskar*
8	09:38-09:41	Predicting Kinematic Configuration from String Length for a Snake-Like Manipulator Not Exhibiting Constant Curvature Bending *Murphy, Ryan Joseph; Otake, Yoshito; Taylor, Russell H.; Armand, Mehran*	Risk-Aware Trajectory Generation with Application to Safe Quadrotor Landing *Mueller, Joerg; Sukhatme, Gaurav*	Cooperative Dynamic Behaviors in Networked Systems with Decentralized State Estimation *Sabattini, Lorenzo; Secchi, Cristian; Fantuzzi, Cesare*
9	09:41-09:44	Comparison of Methods for Estimating the Position of Actuated Instruments in Flexible Endoscopic Surgery *Cabras, Paolo; Goyard, David; Nageotte, Florent; zanne, Philippe; Doignon, Christophe*	Hierarchical Robustness Approach for Nonprehensile Catching of Rigid Objects *Pekarovskiy, Alexander; Stockmann, Ferdinand; Okada, Masafumi; Buss, Martin*	Adding Transmission Diversity to Unmanned Systems through Radio Switching and Directivity *Lowrance, Christopher John; Lauf, Adrian P.*
10	09:44-09:47	Robust Forceps Tracking Using Online Calibration of Hand-Eye Coordination for Microsurgical Robotic System *Tanaka, Shinichi; Baek, Young Min; Harada, Kanako; Sugita, Naohiko; Morita, Akio; Sora, Shigeo; Nakatomi, Hirofumi; Saito, Nobuhito; Mitsuishi, Mamoru*	Parameterized Controller Generation for Multiple Mode Behavior *Gong, Chaohui; Travers, Matthew; Kao, Hsien-Tang; Choset, Howie*	Effective Compression of Range Data Streams for Remote Robot Operations using H.264 *Nenci, Fabrizio; Spinello, Luciano; Stachniss, Cyrill*
11	09:47-09:50	MRI-Powered Closed-Loop Control for Multiple Magnetic Capsules *Eqtami, Alina; Felfoul, Ouajdi; Dupont, Pierre*	Extending Equilibria to Periodic Orbits for Walkers Using Continuation Methods *Rosa, Nelson; Lynch, Kevin*	Network Lifetime Maximization in Mobile Visual Sensor Networks *Yu, Shengwei; Lee, C. S. George*

Wednesday Session A, 09:00 - 10:20 (Continued)

#	Time	Grand Ballroom WeA1 Rehabilitation Robotics II	State Ballroom WeA2 Planning, Failure Detection and Recovery	Red Lacquer Room WeA3 Swarm Robotics
12	09:50-09:53	Development and Evaluation of an Operation Interface for Physical Therapy Devices Based on Rehabilitation Database *Tsuji, Toshiaki; Momiki, Chinami; Sakaino, Sho*	Global Registration of Mid-Range 3D Observations and Short Range Next Best Views *Aleotti, Jacopo; Lodi Rizzini, Dario; Monica, Riccardo; Caselli, Stefano*	Task Assignment and Trajectory Optimization for Displaying Stick Figure Animations with Multiple Mobile Robots *Yamane, Katsu; Goerner, Jared*
13	09:53-09:56	EMG-Based Continuous Control Method for Electric Wheelchair *Jang, Giho; Choi, Youngjin*	Model-Free Robot Anomaly Detection *Hornung, Rachel Hannah; Urbanek, Holger; Klodmann, Julian; Osendorfer, Christian; van der Smagt, Patrick*	Worst-Case Optimal Average Consensus Estimators for Robot Swarms *Elwin, Matthew; Freeman, Randy; Lynch, Kevin*
14	09:56-09:59	NTUH-II Robot Arm with Dynamic Torque Gain Adjustment Method for Frozen Shoulder Rehabilitation *Lin, Chia-Hsun; Lien, Wei-Ming; Wang, Wei-Wen; Chen, Sung-Hua; Lo, Chan-Hsiang; Lin, Sheng-Yen; Fu, Li-Chen; Lai, Jin-Shin*	A Constraint-Based Method for Solving Sequential Manipulation Planning Problems *Lozano-Perez, Tomas; Kaelbling, Leslie*	Robust Sensor Cloud Localization from Range Measurements *Dubbelman, Gijs; Duisterwinkel, Erik; Demi, Libertario; Talnishnikh, Elena; Wörtche, Heinrich; Bergmans, Jan W. M.*
15	09:59-10:02	Involuntary Movement During Haptics-Enabled Robotic Rehabilitation: Analysis and Control Design *Atashzar, Seyed Farokh; Saxena, Abhijit; Shahbazi, Mahya; Patel, Rajnikant V.*	Attack Resilient State Estimation for Autonomous Robotic Systems *Bezzo, Nicola; Weimer, James; Pajic, Miroslav; Sokolsky, Oleg; Pappas, George J.; Lee, Insup*	Application of Grazing-Inspired Guidance Laws to Autonomous Information Gathering *Apker, Thomas; Liu, Shih-Yuan; Sofge, Donald; Hedrick, Karl*
16	10:02-10:05	A Framework for Supervised Robotics-Assisted Mirror Rehabilitation Therapy *Shahbazi, Mahya; Atashzar, Seyed Farokh; Patel, Rajnikant V.*	A Metric for Self-Rightability and Understanding Its Relationship to Simple Morphologies *Kessens, Chad C.; Lennon, Craig; Collins, Jason*	Human-Swarm Interaction Using Spatial Gestures *Nagi, Jawad; Giusti, Alessandro; Gambardella, Luca; Di Caro, Gianni A.*
17	10:05-10:08	Development of an Upper Limb Exoskeleton Powered Via Pneumatic Electric Hybrid Actuators with Bowden Cable *Noda, Tomoyuki; Teramae, Tatsuya; Ugurlu, Barkan; Morimoto, Jun*	Sampling Based Motion Planning with Reachable Volumes: Application to Manipulators and Closed Chain Systems *McMahon, Troy; Thomas, Shawna; Amato, Nancy*	Mapping of Unknown Environments Using Minimal Sensing from a Stochastic Swarm *Dirafzoon, Alireza; Betthauser, Joseph; Schornick, Jeff; Benavides, Daniel; Lobaton, Edgar*
18	10:08-10:11	A Novel Customized Cable-Driven Robot for 3-DOF Wrist and Forearm Motion Training *Cui, Xiang; Chen, Weihai; Agrawal, Sunil; Wang, Jianhua*	Probabilistically Complete Kinodynamic Planning for Robot Manipulators with Acceleration Limits *Kunz, Tobias; Stilman, Mike*	Probabilistic Guidance of Distributed Systems Using Sequential Convex Programming *Morgan, Daniel; Subramanian, Giri Prashanth; Bandyopadhyay, Saptarshi; Chung, Soon-Jo; Hadaegh, Fred*
19	10:11-10:14	Identifying Inverse Human Arm Dynamics Using a Robotic Testbed *Schearer, Eric; Liao, Yu-Wei; Perreault, Eric; Tresch, Matthew; Memberg, William; Kirsch, Robert; Lynch, Kevin*	Run-Time Detection of Faults in Autonomous Mobile Robots Based on the Comparison of Simulated and Real Robot Behaviour *Millard, Alan Gregory; Timmis, Jon; Winfield, Alan*	Geodesic Topological Voronoi Tessellations in Triangulated Environments with Multi-Robot Systems *Lee, Seoung Kyou; Fekete, Sándor; McLurkin, James*
20	10:14-10:17	A Risk Assessment Infrastructure for Powered Wheelchair Motion Commands without Full Sensor Coverage *TalebiFard, Pouria; Sattar, Junaed; Mitchell, Ian*	Sampling-Based Tree Search with Discrete Abstractions for Motion Planning with Dynamics and Temporal Logic *McMahon, James; Plaku, Erion*	Outdoor Flocking and Formation Flight with Autonomous Aerial Robots *Vásárhelyi, Gábor; Virágh, Csaba; Somorjai, Gergo; Tarcai, Norbert; Szörényi, Tamás; Nepusz, Tamás; Vicsek, Tamas*
21	10:17-10:20	LINarm: a Low-cost Variable Stiffness Device for Upper-limb Rehabilitation *Malosio, Matteo; Caimmi, Marco; Legnani, Giovanni; Molinari, Lorenzo*	Distributed Fault Detection and Recovery for Networked Robots *Arrichiello, Filippo; Marino, Alessandro; Pierri, Francesco*	Sponsor Talk: Autonomous Robot Fleets for Automated Warehouses *Sweet, Larry* Symbotic LLC

Wednesday Session B, 10:50 - 12:10

		Grand Ballroom	State Ballroom	Red Lacquer Room
		WeB1 **Mechanisms and Actuators & Force and Tactile Sensing**	**WeB2** **Humanoids and Bipeds III & Human Detection and Tracking**	**WeB3** **Collision Detection and Avoidance & Sensing II**
	Chair	Okamura, Allison M. (Stanford University)	Bertrand, Sylvain (IHMC)	MacDonald, Bruce (University of Auckland)

#	Time	Session Keynote	Session Keynote	Session Keynote
1	10:50-11:10	Keynote: Natural Machine Motion and Embodied Intelligence *Bicchi, Antonio* University of Pisa	Keynote on Humanoids and Bipeds *Hong, Dennis* UCLA	Keynote: Bayesian Perception & Decision From Theory to Real World Applications *Laugier, Christian* INRIA

#	Time	Mechanisms and Actuators	Humanoids and Bipeds III	Collision Detection and Avoidance
2	11:10-11:13	Dynamic Trajectory Planning of Planar 2-Dof Redundantly Actuated Cable-Suspended Parallel Robots *Tang, Lewei; Gosselin, Clement; Tang, Xiaoqiang; Jiang, Xiaoling*	3D-SLIP Steering for High-Speed Humanoid Turns *Wensing, Patrick; Orin, David*	Real-Time Collision Avoidance in Human-Robot Interaction Based on Kinetostatic Safety Field *Parigi Polverini, Matteo; Zanchettin, Andrea Maria; Rocco, Paolo*
3	11:13-11:16	Workspace Augmentation of Spatial 3-DOF Cable Parallel Robots Using Differential Actuation *Khakpour, Hamed; Birglen, Lionel*	Emergence of Humanoid Walking Behaviors from Mixed-Integer Model Predictive Control *Ibanez, Aurélien; Bidaud, Philippe; Padois, Vincent*	Determining States of Inevitable Collision Using Reachability Analysis *Lawitzky, Andreas; Nicklas, Anselm; Wollherr, Dirk; Buss, Martin*
4	11:16-11:19	Tendon Routing Resolving Inverse Kinematics for Variable Stiffness Joint *Shirafuji, Shouhei; Ikemoto, Shuhei; Hosoda, Koh*	Trajectory Generation for Continuous Leg Forces During Double Support and Heel-To-Toe Shift Based on Divergent Component of Motion *Englsberger, Johannes; Koolen, Twan; Bertrand, Sylvain; Pratt, Jerry; Ott, Christian; Albu-Schäffer, Alin*	Collision Prediction among Polygons with Arbitrary Shape and Unknown Motion *Lu, Yanyan; Xi, Zhonghua; Lien, Jyh-Ming*
5	11:19-11:22	Drum Stroke Variation Using Variable Stiffness Actuators *Kim, Yongtae; Garabini, Manolo; Park, Jaeheung; Bicchi, Antonio*	Model Preview Control in Multi-Contact Motion - Application to a Humanoid Robot *Audren, Hervé; Vaillant, Joris; Kheddar, Abderrahmane; Escande, Adrien; Kaneko, Kenji; Yoshida, Eiichi*	Unified GPU Voxel Collision Detection for Mobile Manipulation Planning *Hermann, Andreas; Drews, Florian; Bauer, Jörg; Klemm, Sebastian; Roennau, Arne; Dillmann, Rüdiger*
6	11:22-11:25	Compliant Robotic Systems on Graphs *Groothuis, Stefan S.; Stramigioli, Stefano; Carloni, Raffaella*	Predictive Control for Dynamic Locomotion of Real Humanoid Robots *Piperakis, Stylianos; Orfanoudakis, Emmanouil; Lagoudakis, Michail*	A Practical Reachability-Based Collision Avoidance Algorithm for Sampled-Data Systems: Application to Ground Robots *Dabadie, Charles; Kaynama, Shahab; Tomlin, Claire*
7	11:25-11:28	Reaching desired states time-optimally from equilibrium and vice versa for visco-elastic joint robots with limited elastic deflection *Mansfeld, Nico; Haddadin, Sami*	A Robot-Machine Interface for Full-Functionality Automation Using a Humanoid *Jeong, Heejin; Shim, David Hyunchul; Cho, Sungwook*	Time Scaled Collision Cone Based Trajectory Optimization Approach for Reactive Planning in Dynamic Environments *Singh, Arun Kumar; GOPALAKRISHNAN, BHARATH; Krishna, Madhava*
8	11:28-11:31	Force-Guiding Particle Chains for Shape-Shifting Displays *Lasagni, Matteo; Roemer, Kay*	Planar Sliding Analysis of a Biped Robot in Centroid Acceleration Space *Senoo, Taku; Ishikawa, Masatoshi*	A Representation Method Based on the Probability of Collision for Safe Robot Navigation in Domestic Environments *Coenen, Sebastiaan Antonius Maria; Lunenburg, Janno Johan Maria; van de Molengraft, Marinus Jacobus Gerardus; Steinbuch, Maarten*
9	11:31-11:34	A Class of Microstructures for Scalable Collective Actuation of Programmable Matter *Holobut, Pawel; Kursa, Michał; Lengiewicz, Jakub*	Energy Based Control of Compass Gait Soft Limbed Bipeds *Godage, Isuru S.; Wang, Yue; Walker, Ian*	Real-Time 3D Collision Avoidance for Biped Robots *Hildebrandt, Arne-Christoph; Wittmann, Robert; Wahrmann, Daniel; Ewald, Alexander; Buschmann, Thomas*
10	11:34-11:37	HiGen: A High-Speed Genderless Mechanical Connection Mechanism with Single-Sided Disconnect for Self-Reconfigurable Modular Robots *Parrott, Christopher; Dodd, T J; Gross, Roderich*	Analytical Control Parameters of the Swing Leg Retraction Method using an Instantaneous SLIP Model *Shemer, Natan; Degani, Amir*	Ensuring Safety in Human-Robot Coexistence Environment *Tsai, Chi-Shen; Hu, Jwu-Sheng; Tomizuka, Masayoshi*
11	11:37-11:40	Stretchable Electroadhesion for Soft Robots *Germann, Juerg Markus; Schubert, Bryan; Floreano, Dario*	Task-Oriented Whole-Body Planning for Humanoids Based on Hybrid Motion Generation *Cognetti, Marco; Mohammadi, Pouya; Oriolo, Giuseppe; Vendittelli, Marilena*	A Unified Framework for External Wrench Estimation, Interaction Control and Collision Reflexes for Flying Robots *Tomic, Teodor; Haddadin, Sami*

Wednesday Session B, 10:50 - 12:10 (Continued)

#	Time	Grand Ballroom WeB1 Force and Tactile Sensing	State Ballroom WeB2 Human Detection and Tracking	Red Lacquer Room WeB3 Sensing II
12	11:40- 11:43	Miniature Capacitive Three-Axis Force Sensor *Bekhti, Rachid; Duchaine, Vincent; Cardou, Philippe*	Real-Time People Detection and Tracking for Indoor Surveillance Using Multiple Top-View Depth Cameras *Tseng, Ting-En; Liu, An-Sheng; Hsiao, Po-Hao; Huang, Cheng-Ming; Fu, Li-Chen*	Deterioration of Depth Measurements Due to Interference of Multiple RGB-D Sensors *Martín Martín, Roberto; Lorbach, Malte; Brock, Oliver*
13	11:43- 11:46	A Framework for Dynamic Sensory Substitution *Mkhitaryan, Artashes; Burschka, Darius*	Robot-Assisted Human Indoor Localization Using the Kinect Sensor and Smartphones *Jiang, Chao; Fahad, Muhammad; Guo, Yi; Yang, Jie; Chen, Yingying*	IMU/LIDAR Based Positioning of a Gangway for Maintenance Operations on Wind Farms *merriaux, Pierre; Boutteau, Rémi; Vasseur, Pascal; Savatier, Xavier*
14	11:46- 11:49	High-Throughput Analysis of the Morphology and Mechanics of Tip Growing Cells Using a Microrobotic Platform *Felekis, Dimitrios; Vogler, Hannes; Mecja, Geraldo; Muntwyler, Simon; Sakar, Mahmut Selman; Grossniklaus, Ueli; Nelson, Bradley J.*	Gesture-Based Attention Direction for a Telepresence Robot: Design and Experimental Study *Tee, Keng Peng; Yan, Rui; Chua, Yuanwei; Huang, Zhiyong; Liemhetcharat, Somchaya*	A Quantitative Evaluation of Surface Normal Estimation in Point Clouds *Jordan, Krzysztof; Mordohai, Philippos*
15	11:49- 11:52	What's in the Container? Classifying Object Contents from Vision and Touch *Güler, Püren; Bekiroglu, Yasemin; Kragic, Danica; Gratal Martínez, Xavi; Pauwels, Karl*	Kinect-Based People Detection and Tracking from Small-Footprint Ground Robots *Pesenti Gritti, Armando; Tarabini, Oscar; Guzzi, Jerome; Di Caro, Gianni A.; caglioti, vincenzo; Gambardella, Luca; Giusti, Alessandro*	View Planning for 3D Object Reconstruction with a Mobile Manipulator Robot *Vasquez-Gomez, J. Irving; Sucar, Luis Enrique; Murrieta-Cid, Rafael*
16	11:52- 11:55	3D Spatial Self-Organization of a Modular Artificial Skin *Mittendorfer, Philipp; Dean-Leon, Emmanuel; Cheng, Gordon*	Robust Articulated Upper Body Pose Tracking under Severe Occlusions *Sigalas, Markos; Pateraki, Maria; Trahanias, Panos*	Planar Pose Estimation for General Cameras Using Known 3D Lines *Miraldo, Pedro; Araujo, Helder*
17	11:55- 11:58	Detection of Membrane Puncture with Haptic Feedback Using a Tip-Force Sensing Needle *Elayaperumal, Santhi; Bae, Jung Hwa; Daniel, Bruce; Cutkosky, Mark*	Pedestrian Detection Combining RGB and Dense LIDAR Data *Premebida, Cristiano; Carreira, Joao Luis da Silva; Batista, Jorge; Nunes, Urbano*	GPS-Based Preliminary Map Estimation for Autonomous Vehicle Mission Preparation *Dupuis, Yohan; merriaux, Pierre; Subirats, Peggy; Boutteau, Rémi; Savatier, Xavier; Vasseur, Pascal*
18	11:58- 12:01	Active Gathering of Frictional Properties from Objects *Rosales, Carlos; Ajoudani, Arash; Gabiccini, Marco; Bicchi, Antonio*	Confidence-Based Pedestrian Tracking in Unstructured Environments Using 3D Laser Distance Measurements *Häselich, Marcel; Jöbgen, Benedikt; Wojke, Nicolai; Hedrich, Jens; Paulus, Dietrich*	Dynamic Objects Tracking with a Mobile Robot Using Passive UHF RFID Tags *Liu, Ran; Huskić, Goran; Zell, Andreas*
19	12:01- 12:04	Localization and Manipulation of Small Parts Using GelSight Tactile Sensing *Li, Rui; Platt, Robert; Yuan, Wenzhen; ten Pas, Andreas; Roscup, Nathan; Srinivasan, Mandayam; Adelson, Edward*	Whole-Body Pose Estimation in Physical Rider-Bicycle Interactions with a Monocular Camera and a Set of Wearable Gyroscopes *Lu, Xiang; Yu, Kaiyan; Zhang, Yizhai; Yi, Jingang; Liu, Jingtai*	Spatio-Temporal Motion Features for Laser-Based Moving Objects Detection and Tracking *Shen, Xiaotong; Kim, Seong-Woo; Ang Jr, Marcelo H*
20	12:04- 12:07	Exploiting Global Force Torque Measurements for Local Compliance Estimation in Tactile Arrays *Ciliberto, Carlo; Fiorio, Luca; Maggiali, Marco; Natale, Lorenzo; Rosasco, Lorenzo; Metta, Giorgio; SANDINI, GIULIO; Nori, Francesco*	Pedalvatar: An IMU-Based Real-Time Body Motion Capture System Using Foot Rooted Kinematic Model *Zheng, Yang; Chan, Ka Chun; Wang, Charlie C.L.*	The Role of Target Modeling in Designing Search Strategies *Renzaglia, Alessandro; Noori, Narges; Isler, Volkan*
21	12:07- 12:10	Toward a Modular Soft Sensor-Embedded Glove for Human Hand Motion and Tactile Pressure Measurement *Hammond III, Frank L.; Menguc, Yigit; Wood, Robert*	Sponsor Talk: TOYOTA - Partner Robot *Djugash, Joseph* Toyota Motor Eng. & Manuf. North America	Advances in Fibrillar On-Off Polymer Adhesive: Sensing and Engagement Speed *Wettels, Nicholas; Parness, Aaron*

Wednesday Session C, 14:00 - 15:20

#	Time	Grand Ballroom **WeC1** **Surgical Robotics II & Teleoperation and Telerobotics**	State Ballroom **WeC2** **Learning by Demonstration & Industrial and Manufacturing Robotics**	Red Lacquer Room **WeC3** **Localization and Mapping IV & Locomotion, Navigation, and Mobility**
	Chair	Hamel, William R. (University of Tennessee)	Parker, Lynne (University of Tennessee)	Antonelli, Gianluca (Univ. of Cassino and S. Lazio)
		Session Keynote	**Session Keynote**	**Session Keynote**
1	14:00-14:20	Keynote: Surgical Robotics: Transition to Automation *Hannaford, Blake* University of Washington	Keynote: Machine Learning of Motor Skills for Robotics *Peters, Jan* TU Darmstadt	Keynote: Toward Persistent SLAM in Challenging Environments *Eustice, Ryan* University of Michigan
		Surgical Robotics II	**Learning by Demonstration**	**Localization and Mapping IV**
2	14:20-14:23	Bimanual Telerobotic Surgery with Asymmetric Haptic Force Feedback: A Davinci Surgical System Implementation *Mohareri, Omid; Schneider, Caitlin; Salcudean, Septimiu E.*	A Robust Autoregressive Gaussian Process Motion Model Using L1-Norm Based Low-Rank Kernel Approximation *Kim, Eunwoo; Choi, Sungjoon; Oh, Songhwai*	Simultaneous Localization and Planning on Multiple Map Hypotheses *Morris, Timothy; Dayoub, Feras; Corke, Peter; Upcroft, Ben*
3	14:23-14:26	First 3D Printed Medical Robot for ENT Surgery - Application Specific Manufacturing of Laser Sintered Disposable Manipulators *Entsfellner, Konrad; Kuru, Ismail; Maier, Thomas; Gumprecht, Jan David Jerome; Lueth, Tim C.*	Unifying Scene Registration and Trajectory Optimization for Learning from Demonstrations with Application to Manipulation of Deformable Objects *Lee, Alex Xavier; Huang, Sandy; Hadfield-Menell, Dylan; Tzeng, Eric; Abbeel, Pieter*	Long--Term Topological Localisation for Service Robots in Dynamic Environments Using Spectral Maps *Krajník, Tomás; Pulido Fentanes, Jaime; Martinez Mozos, Oscar; Duckett, Tom; Ekekrantz, Johan; Hanheide, Marc*
4	14:26-14:29	Mass and Inertia Optimization for Natural Motion in Hands-On Robotic Surgery *Petersen, Joshua; Rodriguez y Baena, Ferdinando*	Robot Learns Chinese Calligraphy from Demonstrations *Sun, Yuandong; QIAN, Huihuan; Xu, Yangsheng*	SAIL-MAP: Loop-Closure Detection Using Saliency-Based Features *BIREM, Merwan; QUINTON, Jean-Charles; berry, francois; Mezouar, Youcef*
5	14:29-14:32	Interleaved Continuum-Rigid Manipulation Approach: Development and Functional Evaluation of a Clinical Scale Manipulator *Conrad, Benjamin; Zinn, Michael*	Learning to Sequence Movement Primitives from Demonstrations *Manschitz, Simon; Kober, Jens; Gienger, Michael; Peters, Jan*	Visual Place Recognition using HMM Sequence Matching *Hansen, Peter; Browning, Brett*
6	14:32-14:35	Using Monocular Images to Estimate Interaction Forces During Minimally Invasive Surgery *Noohi, Ehsan; Parastegari, Sina; Zefran, Milos*	Kinematically Optimised Predictions of Object Motion *Belter, Dominik; Wyatt, Jeremy; Kopicki, Marek; Zurek, Sebastian*	Linear-Time Estimation with Tree Assumed Density Filtering and Low-Rank Approximation *Ta, Duy-Nguyen; Dellaert, Frank*
7	14:35-14:38	Recursive Estimation of Needle Pose for Control of 3D-Ultrasound-Guided Robotic Needle Steering *Adebar, Troy K.; Okamura, Allison M.*	Program Synthesis by Examples for Object Repositioning Tasks *Feniello, Ashley; Dang, Hao; Birchfield, Stan*	Large-Scale Image Mosaicking Using Multimodal Hyperedge Constraints from Multiple Registration Methods within the Generalized Graph SLAM Framework *Pfingsthorn, Max; Birk, Andreas; Ferreira, Fausto; Veruggio, Gianmarco; Caccia, Massimo; Bruzzone, Gabriele*
8	14:38-14:41	Development of Multi-Axial Force Sensing System for Haptic Feedback Enabled Minimally Invasive Robotic Surgery *Lee, Dong-Hyuk; Kim, Uikyum; Choi, Hyouk Ryeol*	LAT: A Simple Learning from Demonstration Method *Reiner, Benjamin; Ertel, Wolfgang; Posenauer, Heiko; Schneider, Markus*	Localization Algorithm Based on Zigbee Wireless Sensor Network with Application to an Active Shopping Cart *Gai, Shengnan; Jung, Eui-jung; Yi, Byung-Ju*
9	14:41-14:44	Estimation of Needle Tissue Interaction Based on Non-Linear Elastic Modulus and Friction Force Patterns *Elgezua Fernandez, Inko; Kobayashi, Yo; Fujie, Masakatsu G.*	Discovering Task Constraints through Observation and Active Learning *Hayes, Bradley; Scassellati, Brian*	RF Odometry for Localization in Pipes Based on Periodic Signal Fadings *Rizzo, Carlos; Kumar, Vijay; Lera, Francisco; Villarroel, José Luis*
10	14:44-14:47	Design and Realization of Grasper-Integrated Force Sensor for Minimally Invasive Robotic Surgery *Kim, Uikyum; Lee, Dong-Hyuk; Choi, Hyouk Ryeol; Moon, Hyungpil; Koo, Ja Choon*	Unsupervised Object Individuation from RGB-D Image Sequences *Koo, Seongyong; Lee, Dongheui; Kwon, Dong-Soo*	Multi-Vehicle Localisation with Additive Compressed Factor Graphs *Toohey, Lachlan; Pizarro, Oscar; Williams, Stefan Bernard*
11	14:47-14:50	A Biomechanical Model Describing Tangential Tissue Deformations During Contact Micro-Probe Scanning *Rosa, Benoît; Morel, Guillaume; Szewczyk, Jérôme*	Grasp Planning Based on Strategy Extracted from Demonstration *Lin, Yun; Sun, Yu*	Building Local Terrain Maps Using Spatio-Temporal Classification for Semantic Robot Localization *Laible, Stefan; Zell, Andreas*

Wednesday Session C, 14:00 - 15:20 (Continued)

#	Time	Grand Ballroom WeC1 Teleoperation and Telerobotics	State Ballroom WeC2 Industrial and Manufacturing Robotics	Red Lacquer Room WeC3 Locomotion, Navigation, and Mobility
12	14:50-14:53	Industrial Robotic Assembly Process Modeling Using Support Vector Regression *Li, Binbin; Chen, Heping; Jin, Tongdan*	Stiffness Modeling of Industrial Robots for Deformation Compensation in Machining *Schneider, Ulrich; Momeni, Mahdi; Ansaloni, Matteo; Verl, Alexander*	HexaMorph: A Reconfigurable and Foldable Hexapod Robot Inspired by Origami *Gao, Wei; Huo, Ke; Seehra, Jasjeet Singh; Ramani, Karthik; Cipra, Raymond*
13	14:53-14:56	Teleoperation System Using past Image Records for Mobile Manipulator *Murata, Ryosuke; Songtong, Sira; Mizumoto, Hisashi; Kon, Kazuyuki; Matsuno, Fumitoshi*	A Study on Data-Driven In-Hand Twisting Process Using a Novel Dexterous Robotic Gripper for Assembly Automation *Chen, Fei; Cannella, Ferdinando; Canali, Carlo; Hauptman, Traveler; Sofia, Giuseppe; Caldwell, Darwin G.*	On the Optimal Selection of Motors and Transmissions for Electromechanical and Robotic Systems *Rezazadeh, Siavash; Hurst, Jonathan*
14	14:56-14:59	Experimental Evaluation of Guidance and Forbidden Region Virtual Fixtures for Object Telemanipulation *King, H. Hawkeye; Hannaford, Blake*	Velocity Coordination and Corner Matching in a Multi-Robot Sewing Cell *Schrimpf, Johannes; Bjerkeng, Magnus; Mathisen, Geir*	Active Behavior of Musculoskeletal Robot Arms Driven by Pneumatic Artificial Muscles for Receiving Human's Direct Teaching Effectively *Ikemoto, Shuhei; Kayano, Yuji; Hosoda, Koh*
15	14:59-15:02	Investigating Human Perceptions of Robot Capabilities in Remote Human-Robot Team Tasks Based on First-Person Robot Video Feeds *Canning, Cody; Donahue, Thomas; Scheutz, Matthias*	On the Location of the Center of Mass for Parts with Shape Variation *Panahi, Fatemeh; van der Stappen, Frank*	Received Signal Strength Based Bearing-Only Robot Navigation in a Sensor Network Field *Deshpande, Nikhil; Grant, Edward; Draelos, Mark; Henderson, Thomas C.*
16	15:02-15:05	Know Thy User: Designing Human-Robot Interaction Paradigms for Multi-Robot Manipulation *Lewis, Bennie; Sukthankar, Gita*	Design and Motion Planning of Body-In-White Assembly Cells *Pellegrinelli, Stefania; Pedrocchi, Nicola; Molinari Tosatti, Lorenzo; Fischer, Anath; Tolio, Tullio A. M.*	GeckoGripper: A Soft, Inflatable Robotic Gripper Using Gecko-Inspired Elastomer Micro-Fiber Adhesives *Song, Sukho; Majidi, Carmel; Sitti, Metin*
17	15:05-15:08	Modeling Visuo-Motor Control and Guidance Functions in Remote-Control Operation *Andersh, Jonathan; Li, Bin; Mettler, Berenice*	Cartesian Sensor-Less Force Control for Industrial Robots *Cho, Hyunchul; Kim, Min Jeong; Lim, Hyunkyu; Kim, Donghyeok*	Design and Architecture of a Series Elastic Snake Robot *Rollinson, David; Bilgen, Yigit; Brown, H. Ben; Enner, Florian; Ford, Steven; Layton, Curtis; Rembisz, Justine; Schwerin, Michael; Willig, Andrew; Velagapudi, Prasanna; Choset, Howie*
18	15:08-15:11	Transparency Compensation for Bilateral Teleoperators with Time-Varying Communication Delays *Rodriguez-Seda, Erick J.*	Improving the Sequence of Robotic Tasks with Freedom of Execution *Alatartsev, Sergey; Ortmeier, Frank*	Hybrid Unmanned Aerial Underwater Vehicle: Modeling and Simulation *Drews Jr, Paulo; Alves Neto, Armando; Campos, Mario Montenegro*
19	15:11-15:14	Model-Free Path Planning for Redundant Robots Using Sparse Data from Kinesthetic Teaching *Seidel, Daniel; Emmerich, Christian; Steil, Jochen J.*	Parallel Active/Passive Force Control of Industrial Robots with Joint Compliance *Dayal, Udai, Arun; Hayat, Abdullah Aamir; Saha, Subir Kumar*	Circumnavigation by a Mobile Robot Using Bearing Measurements *Zheng, Ronghao; Sun, Dong*
20	15:14-15:17	Learning Task Outcome Prediction for Robot Control from Interactive Environments *Haidu, Andrei; Daniel, Kohlsdorf; Beetz, Michael*	Automated Guidance of Peg-In-Hole Assembly Tasks for Complex-Shaped Parts *Song, Hee-Chan; Kim, Young-Loul; Song, Jae-Bok*	
21	15:17-15:20		Intuitive Skill-Level Programming of Industrial Handling Tasks on a Mobile Manipulator *Pedersen, Mikkel Rath; Herzog, Dennis Levin; Krueger, Volker*	

Wednesday Session D, 15:50 - 17:10

#	Time	Grand Ballroom **WeD1** **Micro-Nano Robots II & Impedance, Compliance, and Force Control**	State Ballroom **WeD2** **Unmanned Aerial Systems II & Legged Robots II**	Red Lacquer Room **WeD3** **Computer Vision II & Recognition**
	Chair	Sun, Dong (City University of Hong Kong)	Carloni, Raffaella (University of Twente)	Martinet, Philippe (Ecole Centrale de Nantes)
		Session Keynote	**Session Keynote**	**Session Keynote**
1	15:50-16:10	Keynote: Soft, printable, and small: an overview of manufacturing methods for novel robots at Harvard *Wood, Robert* Harvard University	Keynote: Material-Handling - Paradigms for Humanoids and UAVs *Oh, Paul Y.* University of Nevada, Las Vegas (UNLV)	Keynote: Semantic Parsing in Indoors and Outdoors Environments *Kosecka, Jana* George Mason University
		Micro-Nano Robots II	**Unmanned Aerial Systems II**	**Computer Vision II**
2	16:10-16:13	Modeling and experiments of high speed magnetic micromanipulation at the air/liquid interface *Dkhil, Mohamed; Bolopion, Aude; Gauthier, Michael; Régnier, Stéphane*	Robust Attitude Controller for Uncertain Hexarotor Micro Aerial Vehicles (MAVs) *Derawi, Dafizal; Salim, Nurul Dayana; Zamzuri, Hairi; Liu, Hao; Abdul Rahman, Mohd Azizi; Mazlan, Saiful Amri*	A Model-Free Approach for the Segmentation of Unknown Objects *ASIF, UMAR; Bennamoun, Mohammed; Sohel, Ferdous*
3	16:13-16:16	Assembly and Mechanical Characterizations of Polymer Microhelical Devices *Alvo, Sébastien; Decanini, Dominique; Couraud, Laurent; Haghiri-Gosnet, Anne-Marie; Hwang, Gilgueng*	Emergency Landing for a Quadrotor in Case of a Propeller Failure: A Backstepping Approach *Lippiello, Vincenzo; Ruggiero, Fabio; Serra, Diana*	Automatic Detection of Pole-Like Structures in 3D Urban Environments *Tombari, Federico; Fioraio, Nicola; Cavallari, Tommaso; Salti, Samuele; Petrelli, Alioscia; Di Stefano, Luigi*
4	16:16-16:19	Controllable Roll-To-Swim Motion Transition of Helical Nanoswimmers *Barbot, Antoine; Decanini, Dominique; Hwang, Gilgueng*	Guaranteed Road Network Search with Small Unmanned Aircraft *Dille, Michael; Grocholsky, Ben; Singh, Sanjiv*	Real-Time and Low Latency Embedded Computer Vision Hardware Based on a Combination of FPGA and Mobile CPU *Honegger, Dominik; Oleynikova, Helen; Pollefeys, Marc*
5	16:19-16:22	Three Dimensional Rotation of Bovine Oocyte by using Magnetically Driven On-chip Robot *Feng, Lin; U, Ningga; Turan, Bilal; Arai, Fumihito*	A Ground-Based Optical System for Autonomous Landing of a Fixed Wing UAV *Kong, Weiwei; Zhou, Dianle; Zhang, Yu; Zhang, Daibing; Wang, Xun; Zhao, Boxin; Yan, Chengping; Shen, Lincheng; Zhang, Jianwei*	Multi-View Terrain Classification Using Panoramic Imagery and LIDAR *Taghavi Namin, Sarah; Najafi, Mohammad; Petersson, Lars*
6	16:22-16:25	Robust Nanomanipulation Control Based on Laser Beam Feedback *Amari, Nabil; Folio, David; Ferreira, Antoine*	On Crop Height Estimation with UAVs *Anthony, David; Elbaum, Sebastian; Lorenz, Aaron; Detweiler, Carrick*	Efficient Real-Time Loop Closure Detection Using GMM and Tree Structure *BOULEKCHOUR, MOHAMMED; Aouf, Nabil*
7	16:25-16:28	Microrobotic Platform for Mechanical Stimulation of Swimming Microorganism on a Chip *Ahmad, Belal; Kawahara, Tomohiro; Yasuda, Takashi; Arai, Fumihito*	Model-Aided State Estimation for Quadrotor Micro Air Vehicles Amidst Wind Disturbances *Abeywardena, Dinuka; Wang, Zhan; Dissanayake, Gamini; Waslander, Steven Lake; Kodagoda, Sarath*	Place Categorization using Sparse and Redundant Representations *Carrillo, Henry; Latif, Yasir; Neira, José; Castellanos, Jose A.*
8	16:28-16:31	Magnetic-Based Motion Control of Sperm-Shaped Microrobots Using Weak Oscillating Magnetic Fields *Khalil, Islam S.M.; Youakim, Kareem; Sanchez Secades, Luis Alonso; Misra, Sarthak*	Inspection of Pole-Like Structures Using Vision-Controlled VTOL UAV and Shared Autonomy *Sa, Inkyu; Hrabar, Stefan; Corke, Peter*	Real-Time Global Localization of Intelligent Road Vehicles in Lane-Level Via Lane Marking Detection and Shape Registration *Cui, Dixiao; Xue, Jianru; Du, Shaoyi; Zheng, Nanning*
9	16:31-16:34	On-Chip Flexible Scaffold for Construction of Multishaped Tissues *Chumtong, Puwanan; Kojima, Masaru; Horade, Mitsuhiro; Ohara, Kenichi; Kamiyama, Kazuto; Mae, Yasushi; Akiyama, Yoshikatsu; Yamato, Masayuki; Arai, Tatsuo*	Image-Based Control for Dynamically Cross-Coupled Aerial Manipulation *Mebarki, Rafik; Lippiello, Vincenzo; Siciliano, Bruno*	On-Road Vehicle Detection through Part Model Learning and Probabilistic Inference *Wang, Chao; Zhao, Huijing; Guo, Chunzhao; Mita, Seiichi; Zha, Hongbin*
10	16:34-16:37	Cell Isolation System for Rare Circulating Tumor Cell *Masuda, Taisuke; Sun, Yiling; Song, Woneui; Niimi, Miyako; Yusa, Akiko; Hayao, Nakanishi; Arai, Fumihito*	The Quadroller: Modeling of a UAV/UGV Hybrid Quadrotor *Page, Jared; Pounds, Paul*	Real-time Depth Enhanced Monocular Odometry *Zhang, Ji; Kaess, Michael; Singh, Sanjiv*
11	16:37-16:40	Incorporating In-Situ Force Sensing Capabilities in a Magnetic Microrobot *Jing, Wuming; Cappelleri, David*	Persistent monitoring with a team of autonomous gliders using static soaring *Acevedo, José Joaquín; Lawrance, Nicholas Robert Jonathon; Arrue, Begoña C.; Sukkarieh, Salah; Ollero, Anibal*	MEVO: Multi-Environment Stereo Visual Odometry *Koletschka, Thomas; Puig, Luis; Daniilidis, Kostas*

Wednesday Session D, 15:50 - 17:10 (Continued)

#	Time	Grand Ballroom WeD1 Impedance, Compliance, and Force Control	State Ballroom WeD2 Legged Robots II	Red Lacquer Room WeD3 Recognition
12	16:40-16:43	Joint Space Torque Controller Based on Time-Delay Control with Collision Detection *Hur, Sung-moon; Oh, Sang-Rok; Oh, Yonghwan*	Compliant Terrain Legged Locomotion Using a Viscoplastic Approach *Vasilopoulos, Vasileios; Paraskevas, Iosif S.; Papadopoulos, Evangelos*	Place Recognition and Self-Localization in Interior Hallways by Indoor Mobile Robots: A Signature-Based Cascaded Filtering Framework *Ahmad Yousef, Khalil; Park, Johnny; Kak, Avinash*
13	16:43-16:46	Force/vision Control for Robotic Cutting of Soft Materials *Long, Philip; Khalil, Wisama; Martinet, Philippe*	Passive Dynamic Walking of Compass-Like Biped Robot with Dynamic Absorbers *Akutsu, Yukihiro; Asano, Fumihiko; Tokuda, Isao*	Automated Perception of Safe Docking Locations with Alignment Information for Assistive Wheelchairs *Jain, Siddarth; Argall, Brenna*
14	16:46-16:49	Hierarchical Inequality Task Specification for Indirect Force Controlled Robots Using Quadratic Programming *Lutscher, Ewald; Cheng, Gordon*	More Solutions Means More Problems: Resolving Kinematic Redundancy in Robot Locomotion on Complex Terrain *Satzinger, Brian; Reid, Jason; Bajracharya, Max; Hebert, Paul; Byl, Katie*	Terrain Classification Using Laser Range Finder *Walas, Krzysztof, Tadeusz; Nowicki, Michal*
15	16:49-16:52	Fast Dual-Arm Manipulation Using Variable Admittance Control: Implementation and Experimental Results *Bjerkeng, Magnus; Schrimpf, Johannes; Myhre, Torstein; Pettersen, Kristin Y.*	Hopping Control for the Musculoskeletal Bipedal Robot BioBiped *Ahmad Sharbafi, Maziar; Radkhah, Katayon; von Stryk, Oskar; Seyfarth, Andre*	A Novel Feature for Polyp Detection in Wireless Capsule Endoscopy Images *Yuan, Yixuan; Meng, Max Q.-H.*
16	16:52-16:55	External Torque Sensing Algorithm for Flexible-Joint Robot Based on Disturbance Observer Structure *Park, Young Jin; Chung, Wan Kyun*	A Passive Dynamic Quadruped That Moves in a Large Variety of Gaits *Gan, Zhenyu; Remy, C. David*	Automation of "Ground Truth" Annotation for Multi-View RGB-D Object Instance Recognition Datasets *Aldoma, Aitor; Fäulhammer, Thomas; Vincze, Markus*
17	16:55-16:58	Implicit Force Control for an Industrial Robot with Flexible Joints and Flexible Links *Rossi, Roberto; Bascetta, Luca; Rocco, Paolo*	Velocity Disturbance Rejection for Planar Bipeds Walking with HZD-Based Control *Post, David; Schmiedeler, James*	Recognition of Inside Pipeline Geometry by Using PSD Sensors for Autonomous Navigation *Choi, Yun Seok; Kim, Ho Moon; Suh, Jung Seok; Mun, Hyeong Min; Yang, Seung Ung; Park, Chan Min; Choi, Hyouk Ryeol*
18	16:58-17:01	Cartesian Space Synchronous Impedance Control of Two 7-DOF Robot Arm Manipulators *Jin, Minghe; Zhang, Zijian; Ni, Fenglei; Liu, Hong*	Reactive Posture Behaviors for Stable Legged Locomotion Over Steep Inclines and Large Obstacles *Roennau, Arne; Heppner, Georg; Nowicki, Michal; Zöllner, Johann Marius; Dillmann, Rüdiger*	Large Scale Place Recognition in 2D LIDAR Scans Using Geometrical Landmark Relations *Himstedt, Marian; Hartmann, Jan; Hellbach, Sven; Boehme, Hans-Joachim; Maehle, Erik*
19	17:01-17:04	Fully Omnidirectional Compliance in Mobile Robots Via Drive-Torque Sensor Feedback *Kim, Kwan Suk; Kwok, Alan; Thomas, Gray; Sentis, Luis*	The Effect of Leg Impedance on Stability and Efficiency in Quadrupedal Trotting *Bosworth, William; Kim, Sangbae; Hogan, Neville*	Evaluation of Feature Selection and Model Training Strategies for Object Category Recognition *Ali, Haider; Marton, Zoltan-Csaba*
20	17:04-17:07	Augmenting Impedance Control with Structural Compliance for Improved Contact Transition Performance *Kim, Dongwon; Gillespie, Brent; Johnson, Brandon*	On the Energetics of Quadrupedal Bounding with and without Torso Compliance *Cao, Qu; Poulakakis, Ioannis*	Automatic Segmentation and Recognition of Human Activities from Observation Based on Semantic Reasoning *Ramirez-Amaro, Karinne; Beetz, Michael; Cheng, Gordon*
21	17:07-17:10	Fuzzy Learning Variable Admittance Control for Human-Robot Cooperation *Dimeas, Fotios; Aspragathos, Nikos A.*	On the Dynamics of a Quadruped Robot Model with Impedance Control: Self-Stabilizing High Speed Trot-Running and Period-Doubling Bifurcations *Lee, Jongwoo; Hyun, Dong Jin; Ahn, Jooeun; Kim, Sangbae; Hogan, Neville*	Detection of Liquids in Cups Based on the Refraction of Light with a Depth Camera Using Triangulation *Hara, Yoshitaka; Honda, Fuhito; Tsubouchi, Takashi; Ohya, Akihisa*

Monday September 15

Manipulation and Grasping I / Robust and Optimal Control

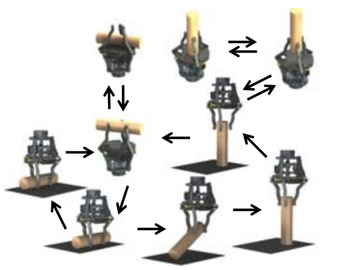
Chair *Oussama Khatib, Stanford University*
Co-Chair

09:20–09:40	MoA1.1

Keynote: What is Manipulation?

Matthew Mason
Carnegie Mellon University

- Fun with definitions
- Examples
  - Robo
  - Bio
- Types
- Manipulation graphs

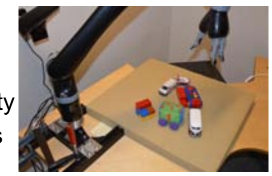


09:40–09:43	MoA1.2

Robotic manipulation in object composition space

Joni Pajarinen[1], Ville Kyrki[1],
[1]Aalto University

- RGB-D image: uncertainty about object composition
- Instead of "best" composition, plan actions using a probability distribution over compositions
- For task planning use a POMDP model that takes uncertainty in object compositions, observations, and actions, into account



09:43–09:46	MoA1.3

6D Proximity Servoing for Preshaping and Haptic Exploration using CTPS

Stefan Escaida Navarro, Martin Schonert,
Björn Hein and Heinz Wörn
Karlsruhe Institute of Technology

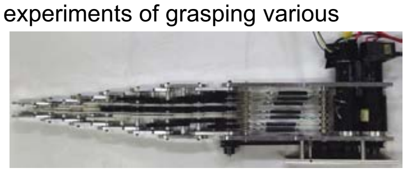
- Gripper equipped with 2x2 arrangement of capacitive tactile proximity sensors (CTPS) in its fingers
- Implementation of *proximity servoing* which allows for applications such as *preshaping* and *haptic exploration*

09:46–09:49	MoA1.4

Multi-Joint Gripper with Differential Gear System

Takumi Tamamoto, Kazuhiro Sayama,
and Koichi Koganezawa
Tokai University, Japan

- Multi-joint gripper with differential gear system using no-wire transmission.
- It has a variable stiffness mechanism.
- The paper shows experiments of grasping various shape objects as well as simulation study.

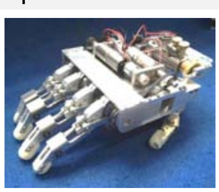


09:49–09:52	MoA1.5

Artificial Hand with Stiffness Adjuster

Koichi Koganezawa and Akira Ito
Department of Mechanical Engineering.,
Tokai University, Japan

- Underactuated with Back-drivability using the Planetary gear system.
- Synergic grasping motion by the compound four-bar linkage.
- Stiffness adjusting of joints.
- All-in-one design with five actuators in the palm with no wire transmission.
- Simple and intrinsically safe control.
- It achieves six typical motions as a hand.

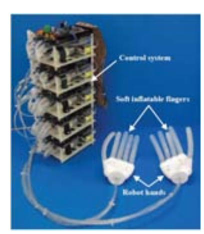


09:52–09:55	MoA1.6

Design and Implementation of a Low-Cost and Lightweight Inflatable Robot Finger

Ronghuai Qi[1], Tin Lun Lam[1], and Yangsheng Xu[2]
[1]Smart China Research, Smart China Holdings Limited, Hong Kong
[2]Dept. of Mechanical and Automation Engineering, The Chinese University of Hong Kong, Hong Kong

- A new structure of soft inflatable robot finger is proposed
- It only weighs 0.8 grams
- The cost of fabricating is pretty low
- It can be easily and massively manufactured
- It has many potential applications (e.g. human-safe interactions, etc.)



Manipulation and Grasping I / Robust and Optimal Control

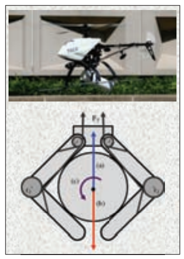
Chair *Oussama Khatib, Stanford University*
Co-Chair

09:55–09:58 MoA1.7

Design of Hands for Aerial Manipulation: Actuator Number and Routing for Grasping and Perching

Spencer B. Backus[1], Lael U. Odhner[1] and Aaron M. Dollar[1]
[1]Yale University

- Grasping objects from UAV's while in flight is challenging
- We present a grasp simulation and use it to analyze the impacts of hand design parameters under conditions a grasping UAV might encounter.

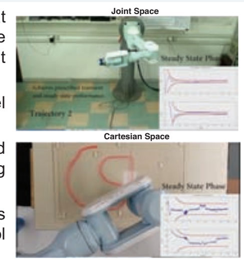


09:58–10:01 MoA1.8

Robust Model Free Control of Robotic Manipulators with Prescribed Transient and Steady State Performance

Charalampos P. Bechlioulis, Minas V. Liarokapis and Kostas J. Kyriakopoulos
National Technical University of Athens

- A novel model-free control scheme that imposes prescribed transient and steady state response for robotic manipulators in both joint and Cartesian workspace.
- No information regarding the dynamic model is employed.
- The control gains selection is simple and decoupled from the achieved tracking performance.
- Very low computational complexity makes implementation on fast embedded control platforms straightforward.



10:01–10:04 MoA1.9

Dual Execution of Optimized Contact Interaction Trajectories

M. Toussaint[1], N. Ratliff[12], J. Bohg[2], L. Righetti[2], P. Englert[1], S. Schaal[2]
[1]Univ. of Stuttgart, [2]Max-Plank-Inst. Tübingen

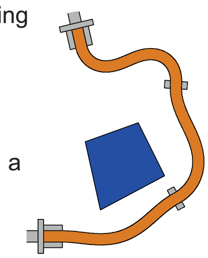
- Efficient manipulation needs contact interaction to reduce uncertainty
- We optimize trajectories, rewarding uncertainty reduction through constraint interaction
- Force controllers reproduce the constraint interaction profile encoded in the **dual solution**

10:04–10:07 MoA1.10

Quasi-static manipulation of a planar elastic rod using multiple robotic grippers

M. Mukadam, A. Borum, and T. Bretl
University of Illinois at Urbana-Champaign, USA

- We develop a manipulation planning algorithm for a planar elastic rod held by multiple robotic grippers
- Upper and lower bounds are established for the number of grippers needed to hold the rod in a collision-free configuration in an environment with obstacles

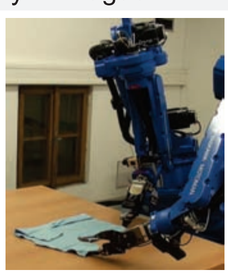


10:07–10:10 MoA1.11

Garment Perception and its Folding using a Dual-arm Robot

Jan Stria, Daniel Průša, Václav Hlaváč, L. Wagner, V. Petrík, P. Krsek, V. Smutný
Czech Technical University in Prague

- Complete pipeline for **fully automated folding** of various garments (shirts, pants, towels)
- Based on fitting garment contour (extracted from a single image) to **polygonal model of clothing** (partially learned from data)
- Achieved **state of the art** results

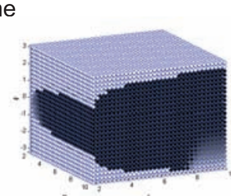


10:10–10:13 MoA1.12

Numerical Approximation for Visibility Based Pursuit Evasion Game

Sourabh Bhattacharya[1], Tamer Basar[2], and Maurizio Falcone[3] [1]Iowa State University
[2]University of Illinois [3]LaSapienza, Rome

- Vision-based pursuit-evasion game in the presence of obstacles.
- Existence of a value function.
- Numerical computation of saddle-point strategies.
- Convergence of the numerical schemes.



Manipulation and Grasping I / Robust and Optimal Control

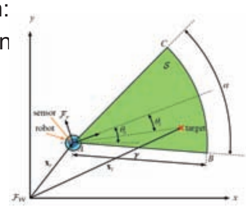
Chair *Oussama Khatib, Stanford University*
Co-Chair

10:13–10:16 MoA1.13

Optimized Visibility Motion Planning for Target Tracking and Localization

Hongchuan Wei[1], Wenjie Lu[1], Pingping Zhu[1]
Guoquan Huang[2], John Leonard[3], Silvia Ferrari[1]
[1]Duke University [2]Delaware University [3]MIT

- Target tracking-robot localization: Maximize probability of detection
- Control law for sector shaped sensor under EKF framework
- Low target loss rate



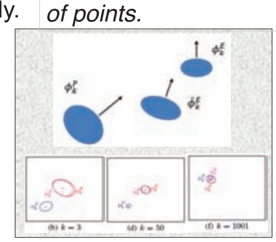
10:16–10:19 MoA1.14

Pursuit-Evasion Game for Normal Distributions

Chanyoung Jun, Subhrajit Bhattacharya, Robert Ghrist
University of Pennsylvania

- Design control input for pursuer with knowledge of pursuer's distribution, ϕ^P, and evader's estimated distribution, $\hat{\phi}^E$, only.
- Show bound of the distance $\lim_{k\to\infty} \mathcal{D}(\phi_k^E, \hat{\phi}_k^E)$
- Show bound of "distance" $\lim_{k\to\infty} \mathcal{F}(\phi_k^P, \hat{\phi}_k^E)$
- Hence show that distance $\lim_{k\to\infty} \mathcal{F}(\phi_k^P, \phi_k^E)$ i.e., pursuer "catches up" with the evader.

Agents represented by normal probability distributions instead of points.

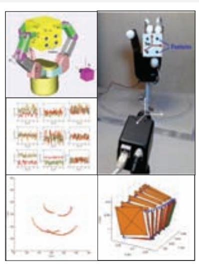


10:19–10:22 MoA1.15

Optimal control for robot-hand manipulation using dynamic visual servoing

Carlos A. Jara, Jorge Pomares,
Francisco A. Candelas and Fernando Torres
University of Alicante

- Framework to define direct visual servoing control laws for robot hands: $\tau = W^{-1/2}\cdot\left(J_T^{+}M^{-1}W^{-1/2}\right)^{+}\cdot\left(\ddot{s}_d + K_D\cdot\dot{e}_s + K_P\cdot e_s - \dot{J}_T^{+}\cdot\dot{q} - J_T^{+}M^{-1}F_{cg}\right)$
- Robot-hand guidance using visual servoing and maintenance of interaction forces (control law with torques optimization).

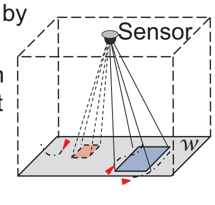


10:22–10:25 MoA1.16

Camera Control For Learning Nonlinear Target Dynamics via Bayesian Nonparametric Dirichlet-Process

H. Wei[1], W. Lu[1], P. Zhu[1], S. Ferrari[1],
R. H. Klein[2], S. Omidshafiei[2], J. P. How[2]
[1]Duke [2]MIT

- Described complex target behavior by DP-GP mixture model
- Expected information value function to calculate gain by a measurement
- Particle filter representing target position distribution to reduce computational complexity

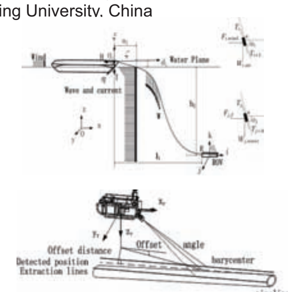


10:25–10:28 MoA1.17

Remote Operated Vehicle Tether Disturbances Analysis and Target Tracking Control

Huang Hai, Sheng Ming-wei, Li Yue-ming, Wan Lei, Pang Yong-jie
National Key Laboratory of Science and Technology of Underwater Vehicle, Harbin Engineering University, China

- The tether effects have been analyzed through a partial differential equation with waves and current disturbances
- A backstepping sliding mode controller has been established.
- Realize a spiral line and pipeline tracking

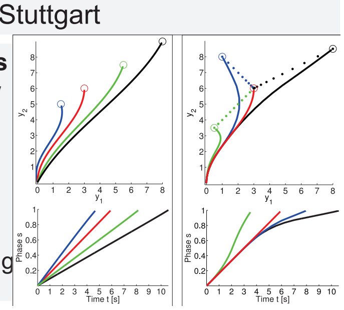


10:28–10:31 MoA1.18

Reactive Phase and Task Space Adaptation for Robust Motion Execution

Peter Englert
Marc Toussaint
U Stuttgart

- **Adapting motion plans** during execution to new situations
- Parameterization with **phase variable** instead of fixed timing
- **Goal:** Bridge gap between motion planning and motion execution



Manipulation and Grasping I / Robust and Optimal Control

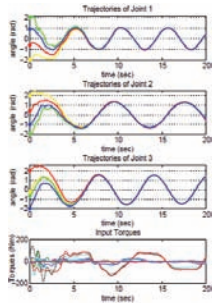
Chair *Oussama Khatib, Stanford University*
Co-Chair

10:31–10:34 MoA1.19

Synchronization and Consensus of a Robot Network on a Dynamic Platform

Kim-Doang Nguyen, Harry Dankowicz,
University of Illinois at Urbana-Champaign

- A fast adaptation scheme for cooperative control, which does not require the system model.
- The behavior of the controlled network matches closely that of a nonadaptive reference system.
- The cooperation control objectives are achieved despite the platform's unmodelled dynamics.

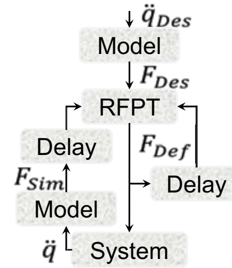


10:34–10:37 MoA1.20

Robust Fixed Point Traf. Based Design for MRAC of a Modified TORA System

J.K. Tar, T.A. Várkonyi,
L. Kovács, I.J. Rudas, T. Haidegger
ABC for iRobotics, Óbuda University, Hungary

- Iterative control strategy
- Simple design methodology through rough model estimation
- Limited to 3 free parameters
- Avoiding complex calculation
- Control is trustworthy, despite local stability is only guaranteed
- Error is halved, if employed

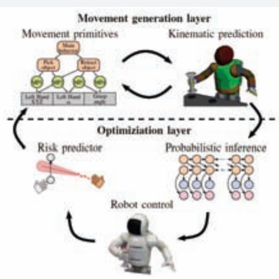


10:37–10:40 MoA1.21

Receding Horizon Optimization of Robot Motions generated by Hierarchical Movement Primitives

Manuel Mühlig[1], Akinobu Hayashi[1],
Michael Gienger[1], Soshi Iba[2] and Takahide Yoshiike[2]
[1]Honda Research Institute Europe [2]Honda R&D Co.

- Motion generation framework that combines MPs with receding horizon optimization
- Continuous optimization of robot motion, with rapid reaction to disturbances
- Real robot experiment with human interaction



Localization and Mapping I / Motion and Path Planning I

Chair *Giuseppe Oriolo, Sapienza University of Rome*
Co-Chair

09:20–09:40	MoA2.1

Keynote: Dense, Object-based 3D SLAM

John Leonard
Massachusetts Institute of Technology

- This talk will review recent progress in dense 3D SLAM algorithm development
- Key tool: Kintinuous (Whelan et al., ICRA 2013/IROS 2014)
- Extension to detect objects from changes in the environment
- Future: Object-oriented and Semantic 3D SLAM

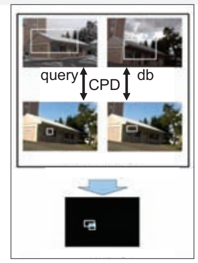
Deformation-based loop closure (Whelan)

09:40–09:43	MoA2.2

Mining Visual Phrases for Long-Term Visual SLAM

Kanji Tanaka[1], Yuuto Chokushi[1], Masatoshi Ando[1]
[1]University of Fukui

- Single-view place recognition for long-term visual SLAM
- Visual phrases explain an input query/DB scene image
- Mining visual experience to find effective visual phrases
- A compact discriminative bounding box –based scene descriptor

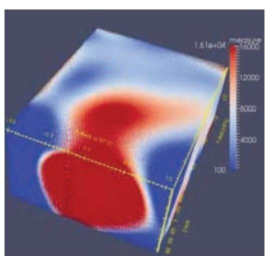


09:43–09:46	MoA2.3

Towards Indoor Localization using Visible Light Communication for Consumer Electronic Devices

Ming Liu, Kejie Qiu, Fengyu Che, Shaohua Li, Babar Hussain, Liang Wu, C. Patrick Yue
The Hong Kong University of Science and Technology
{eelium, kqiuaa, fyche, slias, bhussain, eewuliang, eepatrick}@ust.hk

- A dedicated driver for LED beacons with VLC capability, which at the same time could also support indoor illumination.
- use standard microphone to decode the analog signal captured by the photonic sensor
- a novel algorithm to decode the light pattern using rolling-shutter cameras
- model the luminance distribution for a VLC bulb in 3D space using Gaussian Process



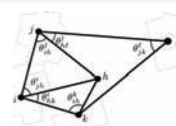
09:46–09:49	MoA2.4

Network localization from relative bearing measurements

Ryan Kennedy and Camillo J. Taylor
University of Pennsylvania

Setup: A network where each node can only measure relative angles

Problem: What is the layout of the entire network?



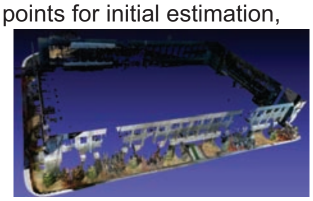
We present a novel optimization problem and two algorithms for solving it. We also show how the method can be extended to 3D, and discuss its relation to the "structure-from-motion" problem in computer vision.

09:49–09:52	MoA2.5

2D-3D Camera Fusion for Visual Odometry in Outdoor Environments

Danda Pani Paudel[1], Cédric Demonceaux[1], Adlane Habed[2], Pascal Vasseur[3], In So Kweon[4]
[1]Bourgogne U [2]Strasbourg U [3]Rouen U [4]KAIST

- We propose an optimization framework for robot localization using both 2D and 3D information.
- It uses minimal number of points for initial estimation, constrained optimization based motion refinement.
- Weights derived from scale-histogram take care of the scene occlusions.



09:52–09:55	MoA2.6

Position Control of a Robot End-Effector Based on SAR Wireless Localization

Albert Marschall[1], Thorsten Voigt[2], Gang Li[1], Ulrich Konigorski[2] and Martin Vossiek[1]
[1]FAU Erlangen-Nürnberg [2]TU Darmstadt

- Innovative position control concept of a lightweight non-rigid robot with wireless positioning approach
- Robust and ultra-precise synthetic aperture radar (SAR) locating algorithm for severe multipath environments
- Accurate system error compensation

3-axis linear unit with light-weight arm and transponder

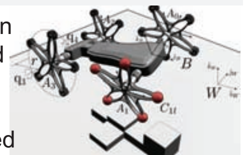
Localization and Mapping I / Motion and Path Planning I

Chair *Giuseppe Oriolo, Sapienza University of Rome*
Co-Chair

09:55–09:58	MoA2.7

Static forces weighted Jacobian motion models for improved Odometry

J. Hidalgo-Carrio[1], A. Babu[1], F. Kirchner[1,2]
[1]DFKI - Robotics Innovation Center [2]University of Bremen



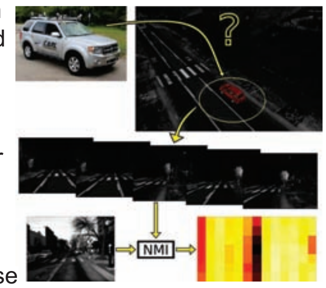
The prediction step of a localization framework is commonly performed using odometry techniques. A Jacobian motion model-based approach for real-time inertial-aided odometry is presented. The algorithm relates normal forces with the probability of a contact-point to slip. Field testing and in-depth error analysis are discussed, resulting in a more accurate localization.

09:58–10:01	MoA2.8

Visual Localization within LIDAR Maps for Automated Urban Driving

Ryan W. Wolcott and Ryan M. Eustice
University of Michigan

- Full image registration in 3D prior map augmented with surface reflectivities
- Benchmarked against state-of-the-art LIDAR methods, yielding similar error rates
- Leveraged OpenGL and CUDA for 10 Hz pose updates and real-time use

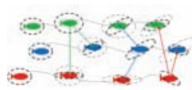


10:01–10:04	MoA2.9

Decentralized Cooperative Trajectory Estimation for AUVs

Liam Paull[1], Mae Seto[2] and John J. Leonard[1]
[1]MIT [2]Defence R&D Canada

- Full multi-AUV cooperative trajectory estimation
- Feasible data packet sizes for acoustic communications
- Estimates are consistent and exact



Acoustic coms with 3 AUVs in TDMA scheme

10:04–10:07	MoA2.10

Vision Based Robot Localization by Ground to Satellite Matching in GPS-denied Situations

Anirudh Viswanathan, Bernardo Pires, Daniel Huber
Robotics Institute, Carnegie Mellon University

- Matching ground level images to satellite or aerial vehicle images.
- Challenging due to the change in perspective between the ground and aerial imagery.
- Explore image-feature space for the matching problem.

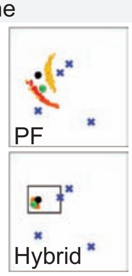
Air-Ground Localization

10:07–10:10	MoA2.11

Hybridization of Monte Carlo and Set-membership Methods for the Global Localization of Underwater Robot

Renata Neuland[1], Jeremy Nicola[2], Renan Maffei[1], Luc Jaulin[2], Edson Prestes[1] and Mariana Kolberg[1]
[1]UFRGS [2]ENSTA Bretagne

- A new approach that combines probabilistic and interval strategies to solve the global localization problem.
- Contractors reduce the uncertainty about the robot localization.
- Particle filter refines the localization using the interval results.

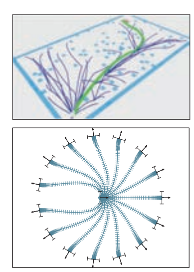


10:10–10:13	MoA2.12

A Novel RRT Extend Function for Efficient and Smooth Mobile Robot Motion Planning

Luigi Palmieri, Kai O. Arras,
Social Robotics Lab, University of Freiburg

- A **novel extender** for sampling-based motion planners that solves the 2-point BVP
- We modify a discontinous control law for wheeled robots and prove all relevant **stability properties**
- Experiments show that the approach outperfoms motion primitives and a spline-based extender:
  - For RRT, it finds **smoother paths** in **less time** with **smaller trees**. For RRT*, it finds **shorter paths** with **smaller trees** while being on par in planning time and smoothness.
  - When given more planning time for RRT*, our approach finds the **lowest cost solution**



Localization and Mapping I / Motion and Path Planning I

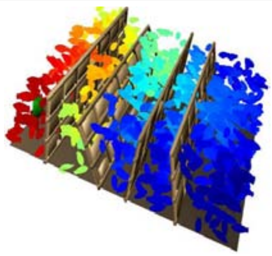
Chair *Giuseppe Oriolo, Sapienza University of Rome*
Co-Chair

10:13–10:16 MoA2.13

Guiding Sampling-Based Tree Search for Motion Planning with Dynamics via Probabilistic Roadmap Abstractions

Duong Le[1] and Erion Plaku[1]
[1]Catholic University of America

- Roadmap constructed over low-dimensional configuration space
- Guides expansion of motion tree in the full state space
- Simulation experiments with nonlinear dynamics and physics-based simulations

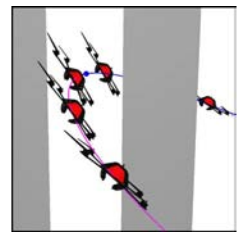


10:16–10:19 MoA2.14

Planning agile motions for quadrotors in constrained environments

Alexandre Boeuf[1], Juan Cortés[1], Rachid Alami[1] and Thierry Siméon[1]
[1]LAAS-CNRS and Univ de Toulouse, France

- Computationally efficient local trajectory planner for quadrotors used in two global motion planning approaches:
  1. As part of an optimization method within a decoupled approach.
  2. As a steering method inside a sampling-based motion planner.

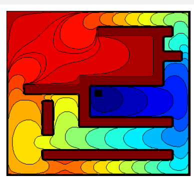


10:19–10:22 MoA2.15

Optimal Navigation Functions for Nonlinear Stochastic Systems

Matanya B Horowitz, Joel W Burdick,
California Institute of Technology

- Connection between navigation functions and Hamilton Jacobi Bellman equation
- Generalizes existing results in literature
- New methods to incorporate stochasticity, nonlinear dynamics



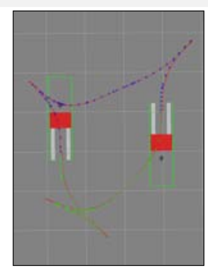
Optimal Nav. Function

10:22–10:25 MoA2.16

A Lattice-Based Approach to Multi-Robot Motion Planning for Non-Holonomic V.

Marcello Cirillo[1], Tansel Uras[2] and Sven Koenig[2]
[1]Örebro University
[2]University of Southern California

- New framework for multi-robot motion planning under non-holonomic constraints
- Kinematically feasible motions guaranteed to be executable
- New approach tested in simulation and as part of a complete fleet management system

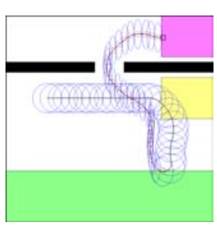


10:25–10:28 MoA2.17

Multi-cost Robotic Motion Planning Under Uncertainty

Richard Simpson[1], James Revell[2], Anders Johansson[1] and Arthur Richards[1]
[1]University of Bristol [2]BAE Systems ATC

- Motion planning with multiple costs to overcome mission constraints and position uncertainty.
- e.g. distance travelled, position uncertainty, fuel remaining
- Uses a graph of waypoints, best-first graph search, Pareto front, EKF, LQR and non-linear motion models.

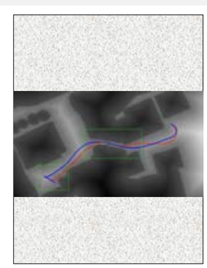


10:28–10:31 MoA2.18

Constrained Path Optimization with Bezier Curve Primitives

Ji-Wung Choi[1] and Kalevi Huhtala[1]
[1]Tampere University of Technology, Finland

- Bezier curve parametric path efficiently solves the constrained path optimization problem.
- Path regularization merging consecutive segments leads to fast computation.
- Cusp points are adjustable to refine the planned path.



Localization and Mapping I / Motion and Path Planning I

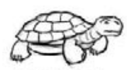
Chair *Giuseppe Oriolo, Sapienza University of Rome*
Co-Chair

10:31–10:34	MoA2.19

Distance Metric Approximation for State-Space RRTs using Supervised Learning

M. Bharatheesha[1], W. Caarls[1], W.J. Wolfslag[1] and M. Wisse[1]
[1]Delft University of Technology, The Netherlands

- RRT for planning in state-space
- Distance = optimal cost
  - ➢ Time intensive
- Cost approximation via Learning
  - ➢ 1000x quicker

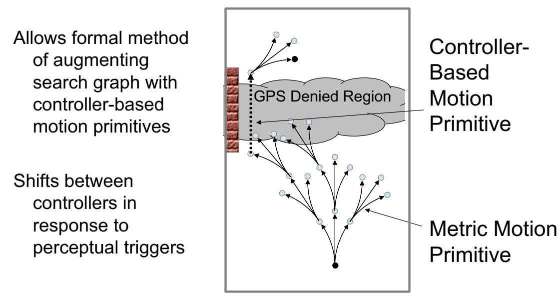

Optimal Cost

Approximate Optimal Cost

10:34–10:37	MoA2.20

State Lattice with Controllers: Augmenting Lattice-Based Path Planning with Controller-Based Motion Primitives

Jonathan Butzke, Krishna Sapkota, Kush Prasad, Brian MacAllister, Max Likhachev



Carnegie Mellon University – Robotics Institute

10:37–10:40	MoA2.21

Sponsor Talk: Motion Planning for Collaborative Robots

Jennifer Barry
Rethink Robotics

- Trajectory Requirements
  - Smooth, efficient, predictable
  - Safe
  - Easy to train
- Constraints
  - Non-expert users
  - No 3D sensor

Bioinspired Robots I / Multi-Robot Coordination

Chair *Maria Gini, University of Minnesota*
Co-Chair

09:20–09:40 MoA3.1

Keynote: Bio-inspired Multi-modal Flying Robots

Dario Floreano
EPFL

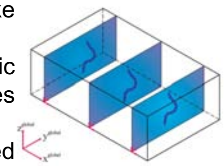
I will describe flying robots that are capable of withstanding and exploiting collisions for better navigation in cluttered environments, and that can adapt their morphology to transition between aerial and ground locomotion. The technologies are inspired by biological principles of multi-modal navigation.

09:40–09:43 MoA3.2

Modeling of underwater snake robots moving in a vertical plane in 3D

E. Kelasidi, K. Y. Pettersen and J. T. Gravdahl
Dept. of Engineering Cybernetics, NTNU

- A model of the kinematics and the dynamics of underwater snake robot is presented
- The combination of hydrodynamic and hydrostatic forces and torques are considered
- A closed form solution is proposed avoiding the numerical evaluation of drag effects



09:43–09:46 MoA3.3

Actuation strategies for underactuated anthropomorphic hands

M.Tavakoli[1], B. Enes[1], L. Marques[1] and A.T. de Almeida[1]
[1]Institute of Systems and Robotics, University of Coimbra, Portugal

- Proposal of **16 actuation strategies** compared in two analysis:
  - –Grasp **Diversity**, out of a list of 33 grasp
  - –Grasp **Funcionality**, compared to the top10 grasps with the highest usage frequency

09:46–09:49 MoA3.4

New Rolling and Crawling Gaits for Snake-like Robots

Richard Primerano and Stephen Wolfe
Drexel University Electrical and Computer Engineering Department Philadelphia, PA 19104

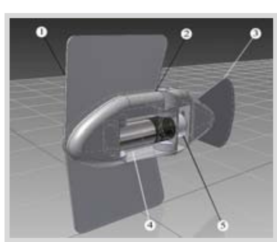
- Each segment incorporates two translational and one rotational degree, giving rise to several new gaits.
- These degrees of freedom give rise to several new gaits

09:49–09:52 MoA3.5

iSplash-MICRO: A 50mm Robotic Fish Generating the Maximum Velocity of Real Fish

Richard James Clapham and Huosheng Hu
School of Computer Science and Electronic Engineering, University of Essex, United Kingdom

- The small fish with a length of 50mm has generated an equivalent average maximum velocity to real fish, measured in body lengths/ second (BL/s).
- Achieving a consistent free swimming speed of 10.4BL/s (0.52m/s) at 19Hz.



09:52–09:55 MoA3.6

Mamba - A Waterproof Snake Robot with Tactile Sensing

Pål Liljebäck[1,2], Øyvind Stavdahl[1], Kristin Y. Pettersen[1] and Jan Tommy Gravdahl[1]
[1]NTNU [2]SINTEF ICT

- We present a modular and waterproof snake robot.
- A force/torque sensor in each joint module enables contact forces along the body to be measured.
- Applications: Adaptive locomotion in cluttered environments and underwater locomotion.

Bioinspired Robots I / Multi-Robot Coordination

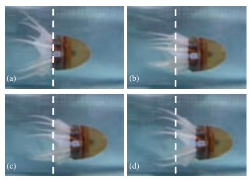
Chair *Maria Gini, University of Minnesota*
Co-Chair

09:55–09:58 MoA3.7

Multi-arm Robotic Swimming with Octopus-inspired Compliant Web

M. Sfakiotakis, A. Kazakidi, A. Chatzidaki, T. Evdaimon, D.P. Tsakiris
Institute of Computer Science – FORTH, Heraklion, Greece

- The propulsive capabilities of an **8-arm robotic swimmer** with ***compliant*** arms and web, inspired by the octopus *arm-swimming behavior*, are investigated.
- Different arm sculling patterns produce different forward swimming gaits.
- A dynamical model, which considers arm and web compliance, was used to study the effect of the sculling parameters on forward swimming propulsion.
- An 8-arm compliant robotic swimmer was used to generate the swimming gaits, and evaluate this novel mode of propulsion. Speeds of 0.5 body lengths per second and propulsive forces of up to 10.5 N were achieved, with a cost of transport as low as 0.62.



09:58–10:01 MoA3.8

ReBiS – Reconfigurable Bipedal Snake Robot

Rohan Thakker, Ajinkya Kamat, Sachin Bharambe, S. Chiddarwar, and K. Bhurchandi
Visvesvaraya National Institute of Technology, Nagpur, India

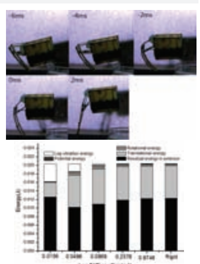
- Novel Modular Reconfigurable Robot Design
- Reconfiguration without rearrangement of modules
- Transforming, Walking and Snake gaits.

10:01–10:04 MoA3.9

Role of Compliant Leg in the Flea-Inspired Jumping Robot

Gwang-Pil Jung[1], Je-Sung Koh[1], Ji-Suk Kim[1], Sun-Pil Jung and Kyu-Jin Cho[1]
[1]Seoul National University, Biorobotics Lab.

- Jumping robot's legs experience extremely large acceleration during take-off, which induces bending in the jumping leg.
- We study how the bending of the leg affects the jumping performance by switching five legs having different stiffness.



10:04–10:07 MoA3.10

Optimal Force Mapping for Obstacle-Aided Locomotion in 2D Snake Robots

Christian Holden[1], Øyvind Stavdahl[1], Jan Tommy Gravdahl[1]
[1]Norwegian Univ. of Science And Technology

- In obstacle-aided locomotion, a snake pushes against the environment to achieve propulsion.
- We optimally determine the motor inputs giving desired obstacle forces achieving a desired path for the snake.
- We present an explicit algebraic relationship between input and obstacle forces.
- We formulate an optimization problem that minimizes energy consumption while achieving the control goal.

10:07–10:10 MoA3.11

Empirical Investigation of Closed-Loop Control of Extensible Continuum Manipulators

Apoorva Kapadia, Katelyn Fry, and Ian Walker
Clemson University

- First closed-loop experimental results for extensible continuum manipulators.
- 3 controllers analyzed: 2 C-space controllers (PID and sliding mode) and 1 task-space controller

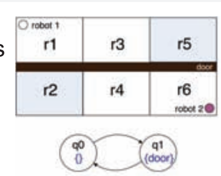
Image from Octarm video with the paper.

10:10–10:13 MoA3.12

Reactive Switching Protocols for Multi-Robot High-Level Tasks

Vasumathi Raman
California Institute of Technology

- Correct-by-construction controllers for teams of interchangeable robots in a nondeterministic environment
- Team modeled as a switched system, allowing dynamic goal reassignment
- Resulting controllers satisfy reactive specifications in linear temporal logic



Demonstrated in simulation for a surveillance task in a workspace with non-deterministic obstacles.

Bioinspired Robots I / Multi-Robot Coordination

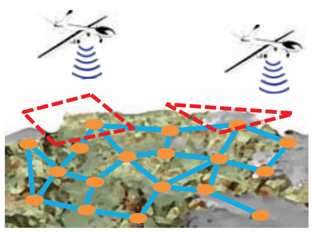
Chair *Maria Gini, University of Minnesota*
Co-Chair

10:13–10:16 MoA3.13

Correlated Orienteering Problem and its Application to Informative Path Planning for Persistent Monitoring Tasks

Jingjin Yu* **, Mac Schwager*, and Daniela Rus**
* Boston University ** Massachusetts Institute of Technology

- We introduce ***Correlated Orienteering Problem (COP)*** as a quadratic extension of the linear Orienteering Problem (OP)
- COP allows ***optimal informative path/tour planning*** for single or multiple mobile sensors with limited travel distance budget for estimating a spatially correlated field
- COP is solvable using Mixed Integer Quadratic Programming (MIQP)

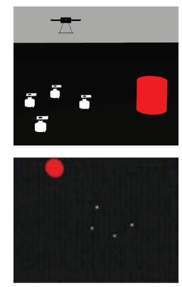


10:16–10:19 MoA3.14

Cooperative Control of a Heterogeneous Multi-Robot System based on Relative Localization

M.Cognetti[1], G.Oriolo[1], P.Peliti[1], L.Rosa[1], P.Stegagno[2]
[1]Sapienza University of Rome, Italy
[2]MPI for Biological Cybernetics, Germany

- Multi-robot system composed of an UAV carrying a camera and several UGVs
- Primary task: keep UGVs in camera FOV. Additional tasks: formation control, navigation, obstacle avoidance
- Primary task allows relative visual localization and identification of UGVs
- Different cooperation levels

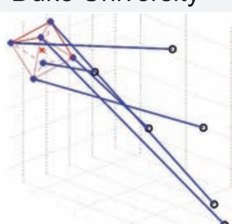


10:19–10:22 MoA3.15

Three-Dimensional Multirobot Formation Control for Target Enclosing

Miguel Aranda[1], Gonzalo López-Nicolás[1], Carlos Sagüés[1] and Michael M. Zavlanos[2]
[1]Universidad de Zaragoza [2]Duke University

- Relative position measurements are used, the method relies on a locally computed rotation matrix
- Any 3D enclosing pattern can be achieved, with arbitrary rotation
- A global coordinate frame for the robots is not required
- Exponentially stable controller



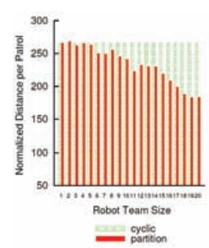
Octahedron-shaped enclosing pattern

10:22–10:25 MoA3.16

Finding Optimal Routes for Multi-Robot Patrolling in Generic Graphs

David Portugal and Rui P. Rocha
Institute of Systems and Robotics, University of Coimbra, Portugal
Charles Pippin and Henrik Christensen
Georgia Tech Research Institute, Georgia Institute of Technology, USA

- Trade-off in performance, travel cost and coordination of multi-robot patrolling strategies.
- Graph topology and team size determine the best choice for a patrolling strategy.
- Cyclic strategies are superior when small teams are used, but have greater travel cost.
- Partitioning is suitable for larger teams and unbalanced graphs, yielding small travel cost.
- Theoretical analysis and results across multiple environments.

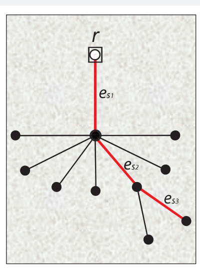


10:25–10:28 MoA3.17

Fleet Size of Multi-Robot Systems for Exploration of Structured Environments

Flavio Cabrera-Mora[1] and Jizhong Xiao[2],
[1]Vaughn College of Aeronautics and Technology
[2]The City College of New York

- Fleet size of a multi-robot system is an important parameter that determines cost and execution time of any given task.
- Analyze how changing the fleet size affects the exploration time.
- Analyze how to bound the fleet size using the size of the environment.

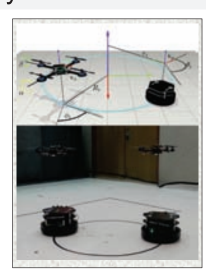


10:28–10:31 MoA3.18

Stable Formation of Groups of Robots Via Synchronization

L. Valbuena[1], P. Cruz[2], R. Figueroa[2], F. Sorrentino[1], and R. Fierro[2]
[1]ME Dept., [2]ECE Dept., University of New Mexico

- Decentralized formation control of two different groups of robots.
- Stability analysis of the desired intra-group and inter-group phase synchronization.
- Experimentally verified using a group of quadrotors and a group of ground nonholonomic robots.



Bioinspired Robots I / Multi-Robot Coordination

Chair *Maria Gini, University of Minnesota*
Co-Chair

10:31–10:34	MoA3.19

RoboCup Drop-In Player Challenges: Experiments in Ad Hoc Teamwork

Patrick MacAlpine, Katie Genter,
Samuel Barrett and Peter Stone
University of Texas at Austin

- Series of pick-up robot soccer games held across three leagues at RoboCup robot soccer competition
- Robots programmed by different labs are put on teams and play soccer together with no pre-coordination
- Ad hoc teamwork challenge

10:34–10:37	MoA3.20

Aligning Coordinate Frames in Multi-Robot Systems with Relative Sensing Information

Sasanka Nagavalli, Andrew Lybarger,
Lingzhi Luo, Nilanjan Chakraborty, Katia Sycara
Robotics Institute, Carnegie Mellon University

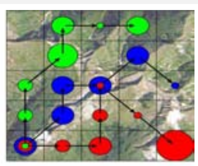
- **Problem:** Establish common reference frame for a multi-robot system with each robot equipped with range-limited sensors that measure only positions of other robots within its field of view
- Centralized and **asynchronous distributed** algorithms that make no assumptions about sensor noise model
- Provably optimal if (1) measurements are noiseless **or** (2) communication graph has a tree structure and measurements are noisy
- Simulation results show our method outperforms conventional techniques (e.g. Gauss-Newton)
- Preliminary testing on multi-robot system (6 TurtleBots)

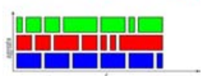
10:37–10:40	MoA3.21

A Mathematical Programming Approach to Collaborative Missions with Heterogeneous Teams

E. F. Flushing, L. M. Gambardella, G.A. Di Caro
Dalle Molle Institute for Artificial Intelligence (IDSIA),
Lugano, Switzerland

- Joint mission planning as a Mixed-Integer Linear Program.
- Modeling realistic aspects from real-world scenarios: deviations in plan execution, agents' spatio-temporal relations, incremental and collaborative completion of tasks.
- Validation in search and rescue





Calibration and Identification / Kinematics and Mechanism Design I

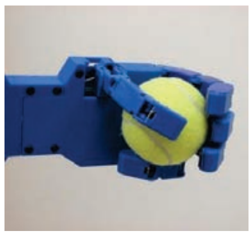
Chair *Anthony A. Maciejewski, Colorado State University*
Co-Chair

11:10–11:30 MoB1.1

Keynote: Innovative Mechanical Systems to Address Current Robotics Challenges

Clément Gosselin
Université Laval, Québec, Canada

- Robotics challenges: advanced manipulation, variety of working conditions, locomotion, collaboration with humans
- **The design of novel robotic mechanical systems is a key component of future progress**
- Several illustrative examples provided in this talk



11:30–11:33 MoB1.2

Locally-weighted Homographies for Calibration of Imaging Systems

Pradeep Ranganathan, Edwin Olson
University of Michigan - Ann Arbor

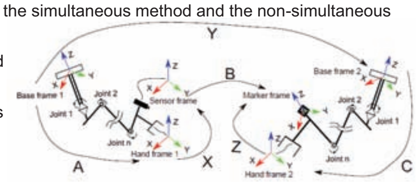
- Novel **non-parametric** non-linear homography technique
- Independent estimate of lens distortion from a single image
- Distortion estimate improves stability of classic camera calibration
- Allows rectification of arbitrary sources of image distortion

11:33–11:36 MoB1.3

Towards Simultaneous Coordinate Calibrations for Cooperative Multiple Robots

Jiaole Wang[1,2], Liao Wu[2], Max Meng[1] and Hongliang Ren*[2]
[1]The Chinese University of Hong Kong
[2]National University of Singapore
*Corresponding author: ren@nus.edu.sg

- A fundamental calibration problem for multi-robot cooperation is modeled and formulated as an **AXB=YCZ** problem.
- An efficient iterative solution is presented to simultaneously solve X, Y, Z.
- A comparison between the simultaneous method and the non-simultaneous ones are carried out to show the efficiency and robustness of the proposed simultaneous method.

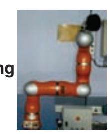


11:36–11:39 MoB1.4

Force calibration of KUKA LWR-like robots including embedded joint torque sensors and robot structure

Maxime Gautier[1] and Anthony Jubien[1,2]
[1]University of Nantes, IRCCyN, France
[2]ONERA, The French Aerospace Lab, Toulouse, France

- **Calibration** (gain,offset) of the Kuka LightWeightRobot **torque sensors** mounted on the link side of the actuated joints
- **Usual**: special test for each sensor separately, **before mounting**
- **New**: simultaneous **in situ** identification of the mounted torque sensors + dynamic parameters of the links
- trajectories without load + trajectories with a known weighed payload, collecting internal control joint **torque sensor and position data**
- Inverse Dynamic Identification Model + total least squares
- **Experimental validation** on the Kuka LWR4+ robot



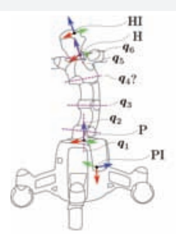
Kuka LWR4+
With payload
4.6136(kg)

11:39–11:42 MoB1.5

Calibrating a Pair of Inertial Sensors at Opposite Ends of an Imperfect Kinematic Chain

Oliver Birbach and Berthold Bäuml
Institute of Robotics and Mechatronics, German Aerospace Center (DLR)

- Agile Justin's kinematic state of torso not known to required precision.
- Groundwork for obtaining its kinematic state from a pair of IMUs.
- Calibration routine and model to obtain required pose of IMUs (HI & PI) mounted at opposite ends (H & P) of the torso kinematic chain.

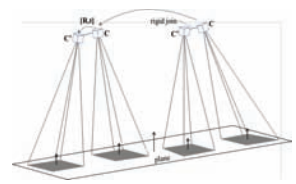


11:42–11:45 MoB1.6

Extrinsic calibration of a set of range cameras in 5 seconds without pattern

Eduardo Fernández-Moral[1], Javier González[1], Patrick Rives[2] and Vicente Arévalo[1]
[1]Universidad de Málaga [2]INRIA Sophia-Antipolis

- **Easy and quick** calibration
- **No pattern** required
- A single observation can be sufficient for calibration
- No overlapping required.
- The **covariance** of the calibration is provided.



Calibration and Identification / Kinematics and Mechanism Design I

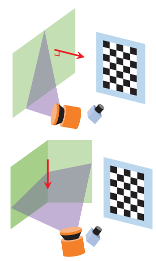
Chair *Anthony A. Maciejewski, Colorado State University*
Co-Chair

11:45–11:48 MoB1.7

Extrinsic Calibration of Non-overlapping Camera-Laser System using Struct. Env.

Yunsu Bok[1], Dong-Geol Choi[1],
Pascal Vasseur[2] and In So Kweon[1]
[1]KAIST, Korea [2]Univ. de Rouen, France

- Two methods of computing relative pose between a camera and a 2D laser sensor 'without overlap'
- No 'bridging' sensor
- Normal vector of a plane or intersecting line of two planes parallel to any axis of world coordinate system

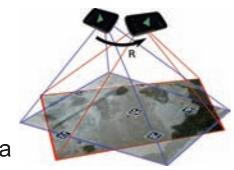


11:48–11:51 MoB1.8

Magnetometer Bias Calibration Based on Relative Angular Position

Giancarlo Troni and Ryan M. Eustice
University of Michigan, USA

- Relative angular position (from image registration or laser scan-matching) used to estimate the magnetometer bias.
- Two methods are proposed based on batch linear least squares and a real-time discrete Kalman filter.
- Simulation and experimental evaluation under different conditions.



Vision-based magnetometer calibration

11:51–11:54 MoB1.9

Automatic Calibration of RGBD and Thermal Cameras

Jake T. Lussier[1], Sebastian Thrun[1]
[1]Stanford University

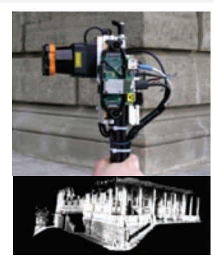
- Automatic method for synchronization and calibration of RGBD & thermal cameras in arbitrary environments.
- Aligns edges in thermal and depth images.
- No checkerboard needed.
- Results in high-quality RGBDT data.

11:54–11:57 MoB1.10

Spatio-Temporal Laser to Visual/Inertial Calibration with Applications to Hand-Held, Large Scale Scanning

Joern Rehder[1,2], Paul Beardsley[2],
Roland Siegwart[1] and Paul Furgale[1]
[1]ETH Zurich [2]Disney Research Zurich

- Introducing a novel approach for laser range finder to camera/IMU calibration
- Capable of estimating the rigid transformation along with the time delay between sensors
- Demonstrated effectiveness in hand-held scanning of large scale structures

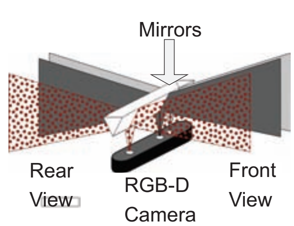


11:57–12:00 MoB1.11

A Catadioptric Extension for RGB-D Cameras

Felix Endres[1], Christoph Sprunk[1],
Rainer Kümmerle[2] and Wolfram Burgard[1]
[1]University of Freiburg [2]KUKA Laboratories

- RGB-D cameras have a small field of view
- Planar mirrors split the view into front and back
- Auto-calibration from planar motion
- Improves SLAM results compared to regular sensor

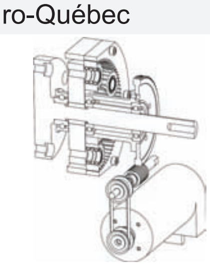


12:00–12:03 MoB1.12

A Dual-Motor Robot Joint Mechanism With Epicyclic Gear Train

Vincent Babin[1], Clément Gosselin[1]
and Jean-François Allan[2]
[1]Université Laval [2]Hydro-Québec

- Improving performances of field robots with the use of a two DOF epicyclic gear train with dual input single output.
- Preventing backdrivability with the use of a worm-set.
- Prototype and simulation data presented as proof of concept.



Proposed Mechanism

Calibration and Identification / Kinematics and Mechanism Design I

Chair *Anthony A. Maciejewski, Colorado State University*
Co-Chair

12:03–12:06 MoB1.13

Kinematic Design and Analysis for a Macaque Upper-Limb Exoskeleton

K. Haninger[1], J. Lu[1], W. Chen[1] and M. Tomizuka[1]
[1]Department of Mechanical Engineering, University of California, Berkeley

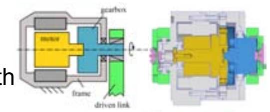
- Algorithm presented to infer joint center location from motion capture data
- Motion capture data of macaque upper-limb is used to validate a joint model
- Validated joint model used to motivate an ergonomic exoskeleton
- Bounds on required joint speed found from desired end effector speeds

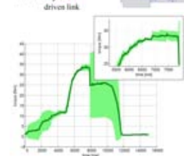
12:06–12:09 MoB1.14

An alternative approach to robot safety

Alberto Parmiggiani[1], Marco Randazzo[1], Lorenzo Natale[1] and Giorgio Metta[1]
[1]iCub Facility, Fondazione Istituto Italiano di Tecnologia

- We addressed the issue of robot safety by proposing a novel design of actuators with an overload protection.
- We constructed a prototype implementing this approach; quantitative evaluations demonstrate the effectiveness of the approach





12:09–12:12 MoB1.15

On the Performance Evaluation and Analysis of General Robots with Mixed DoFs

S. SHAYYA[1,2], S. KRUT[2], O. COMPANY[2], C. BARADAT[1], and F. PIERROT[2]
[1]Tecnalia France [2]LIRMM-Université Montpellier 2-France

- Clarifies the problematic regarding performance evaluation of mixed dofs robots
- Suggests a relevant approach based on proper separation of translation and rotation
- The approach suits all robots regardless of their type (serial, parallel or hybrid...) and whether actuatedly or kinematically redundant
- It focuses on kinetostatic analysis based on isotropic performances in velocity and force
- Also suggests relevant precision related measures (operational resolution)
- Provides a case study on DUAL V (3 dof , 2T-1R) actuatedly redundant robot to clarify the approach

12:12–12:15 MoB1.16

Closed-Loop Inverse Kinematics under Inequality Constraints: Application to Concentric-Tube Manipulators

H. Azimian[1], T. Looi[1] and J. Drake[1]
[1]CIGITI, Hospital for Sick Children, Toronto

- A closed-form solution for real-time inverse kinematics under inequality constraints is proposed.
- The solution is based on using slack variables and is efficient and stable.
- Efficacy of the solution is shown for kinematic control of a concentric-tube manipulator.

concentric-tube robot prototype

12:15–12:18 MoB1.17

Novel 3-DOF Ankle Mechanism for Lower-Limb Exoskeleton

Man Bok Hong[1], Young June Shin[1], and Ji-Hyeun Wang[1]
[1]Agency for Defense Development

- **Fully passive-type 3-DOF ankle module** of a lower-limb exoskeleton designed for rough-terrain tasks is presented with kinematic analyses.

12:18–12:21 MoB1.18

Robust Solution of Prioritized Inverse Kinematics Based On Hestenes-Powell Multiplier Method

Tomomichi Sugihara
Osaka University, Japan

- A novel solution to prioritized IK based on Hestenes-Powell's multiplier method
- Pros1: Light implementation and computation cost … weighted IK + error accumulation of high-priority constraint + estimation of Lagrange's multiplier
- Pros2: Solvability-unconcerned … robust as long as original weighted IK solver is robust
- Cons: Lagrange's multiplier linearly converges, while joint displacement superlinearly converges … slow

Calibration and Identification / Kinematics and Mechanism Design I

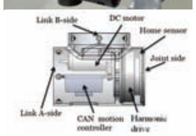
Chair *Anthony A. Maciejewski, Colorado State University*
Co-Chair

12:21–12:24	MoB1.19

Analytical Inverse Kinematic Solution for Modularized 7-DoF Redundant Manipulators with Offsets at Shoulder and Wrist

Ren C. Luo, Tsung-Wei Lin, Yun-Hsuan Tsai
International Center of Excellence in Intelligent Robotics and Automation Research, National Taiwan University, Taiwan (R.O.C)

- An analytical inverse kinematic solution is derived for a 7-DoF redundant manipulator with offsets at shoulder and wrist
- Two sets of equations are derived with different joints seen as redundancy, while method to select proper joint as redundant is also proposed.
- Video demonstration for the developed experimental modularized 7-DoF redundant manipulator is presented.



12:24–12:27	MoB1.20

A Flexible and Robust Robotic Arm Design and Skill Learning by Using RNN

Boon Hwa Tan[1], Huajin Tang[1],
Rui Yan[1] and Jun Tani[2] [1]Institute for Infocomm Research, Singapore [2]KAIST,Korea

- Flexible robotic arm design mimicked from the kinematic redundancy of human arm.
- Human-guided motion teaching and behavior learning via S-CTRNN.
- Motion generalization through grasping an object from an arbitrary position.

NECO-III

12:27–12:30	MoB1.21

Sponsor Talk: The *da Vinci Xi* Surgical System

Simon DiMaio
Intuitive Surgical

The *da Vinci Xi* Surgical System enables surgeons to perform delicate and complex operations minimally-invasively, with increased vision, precision, dexterity and control. State-of-the-art robotic technology allows the surgeon's hand movements to be scaled, filtered and translated into precise movements of the instruments working inside the patient's body.

The end result:
a breakthrough in surgical capabilities.

Soft-Bodied Robotics / Robot Learning I

Chair *Jamie Paik, Ecole Polytechnique Federale de Lausanne*
Co-Chair

11:10–11:30	MoB2.1

Keynote: Soft Robotics

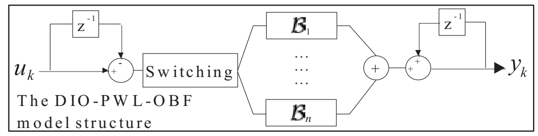
Cecilia Laschi
The BioRobotics Institute, Scuola Superiore Sant'Anna, Pisa, Italy

- Soft materials and components in robotics
- From biological inspiration to soft robot prototypes
- Applications of soft robotics, from the biomedical field to underwater tasks

11:30–11:33	MoB2.2

A new coefficient-adaptive orthonormal basis function model structure for identifying a class of pneumatic actuators

X. Wang[1], T. Geng[1], Y. Elsayed[1]
T. Ranzani[2] C. Saaj[1] C. Lekakou[1]
[1]University of Surrey,
[2]Sant'Anna School of Advanced Studies



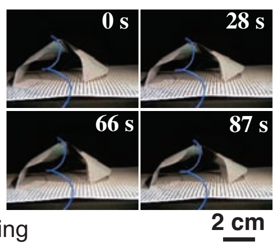
- A direction-dependent multisegement piecewise-linear identification method is proposed.
- A Difference-Input-Output PieceWise-Linear Orthonormal Basis Function (DIO-PWL-OBF) model structure is developed.

11:33–11:36	MoB2.3

Design of Paper Mechatronics - Towards a Fully Printed Robot -

Hiroki Shigemune[1], Shingo Maeda[2] , Yusuke Hara[3] and Shuji Hashimoto [1]
[1]Waseda University
[2]Shibaura Institute of Technology [3]AIST

- The fabrication of **printed self-folding paper robot**
- Self-folding of paper printed by a **commercial ink jet printer**
- Driven by **electro thermal actuator** printed on the paper
- **Rapid** and **low-cost** prototyping



11:36–11:39	MoB2.4

Development of A Meal Assistive Exoskeleton made of Soft Materials for polymyositis patients

I. Koo[1], C. Yun[1], M. Costa, J. Scognamiglio, T. Yangali[1], D. Park[1] and Kyu-Jin Cho[1]
[1]Seoul National University

- Soft wearable exoskeleton
- Target task is meal assistance
- Made of Soft materials (fabric, wire, vinyl and flexible plate)

11:39–11:42	MoB2.5

Spatial Parallel Soft Robotic Architectures

Charles Kim[1] and Jordan Rivera[1],
[1]Bucknell University

- Many fully soft robotic systems suffer from an inability to support significant loads
- Parallel architectures offer significantly increased stiffness and a wider range of possible dramatic motions for a soft system

11:42–11:45	MoB2.6

Whole Arm Planning for a Soft and Highly Compliant 2D Robotic Manipulator

Andrew Marchese, Robert Katzschmann, and Daniela Rus
EECS, Massachusetts Institute of Technology, USA

- A planner for whole body motion of a soft planar manipulator that considers the tasks of both controlling end effector pose while minimizing collisions between the whole arm's changing envelop and a confining environment.
- A modular design for a pneumatic highly compliant planar manipulator that is composed entirely of soft silicone rubber.

Entirely soft planer manipulator using whole are planning to move its entire body through a confined pipe-like environment.

Soft-Bodied Robotics / Robot Learning I

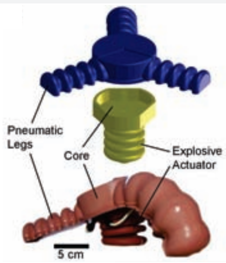
Chair *Jamie Paik, Ecole Polytechnique Federale de Lausanne*
Co-Chair

11:45–11:48 MoB2.7

An Untethered Jumping Soft Robot

Michael T. Tolley[1], Robert F. Shepherd[2], Michael Karpelson[1], Nicholas W. Bartlett[1], Kevin C. Galloway[1], Michael Wehner[1], Rui Nunes[1], George M. Whitesides[1], Robert J. Wood[1]
[1]Harvard University [2]Cornell University

- We present an untethered soft-bodied robot that uses a combination of pneumatic and explosive actuators for directional jumping
- This robot can jump 0.6 m (7.5 times it's body height)
- We also present a thermodynamic model for the combustion of butane used to power jumping

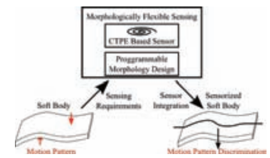


11:48–11:51 MoB2.8

Motion Pattern Discrimination for Soft Robots with Morphologically Flexible Sensors

Utku Culha, Umar Wani, Surya G. Nurzaman[1], Frank Clemens[2] and Fumiya Iida[1]
[1]Institute of Robotics and Intelligent Systems , ETH Zurich, Switzerland
[2]EMPA Dubendorf, Switzerland

- Suggested approach designs custom sensor morphologies for soft robots.
- Sensors are fabricated out of conductive thermoplastic elastomers.
- Body integrated sensors can discriminate twisting and serpentine motion patterns.

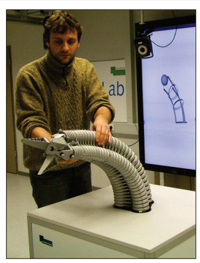


11:51–11:54 MoB2.9

Active Compliant Control Mode for a Pneumatic Soft Robot

Jeffrey Queißer[1], Klaus Neumann[1], Matthias Rolf[2], Felix Reinhart[1] and Jochen Steil[1]
[1]University of Bielefeld [2]Osaka University

- Passive compliant air-actuated "Bionic Handling Assistant" (Festo)
- Accurate models not available
- Hybrid control with learned equilibrium model and classical feedback control enables
  - Fast and agile control
  - Compliant control mode

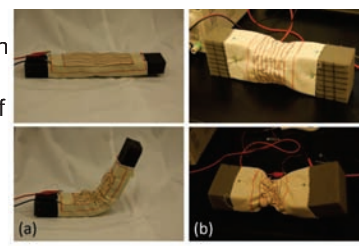


11:54–11:57 MoB2.10

Conformable Actuation and Sensing with Robotic Fabric

M. Yuen[1], A. Cherian[1], J.C. Case[1], J. Seipel[1] and R.K. Kramer[1]
[1]Purdue University

- Thread-like actuators and sensors are sewn onto a fabric base
- Two distinct modes of motion (bending (a), compression (b)) are controlled by varying the orientation of the fabric

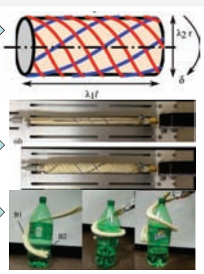


11:57–12:00 MoB2.11

Kinematics of a New Class of Soft Actuators based on generalized PAMs

Girish Krishnan[1]
[1]University of Illinois Urbana-Champaign

- A **Configuration Memory effect,** analogous to the shape memory effect is proposed to explain the behavior.
- The behavior is validated by FEA and prototype testing.
- Design implications of the configuration memory effect are explored

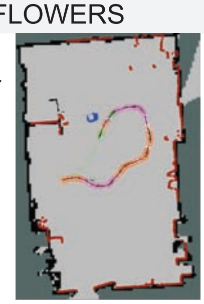


12:00–12:03 MoB2.12

Unsupervised and online non-stationary obstacle discovery and modeling using a laser range finder

G. Duceux, D. Filliat
ENSTA ParisTech - INRIA FLOWERS

- Detect, learn and recognize dynamic objects using standard laser scanner
- Multi-view model based on bags of laser scan descriptors
- 89% recognition rate on 22 objects using supervised learning
- Discover coherent object models without supervision



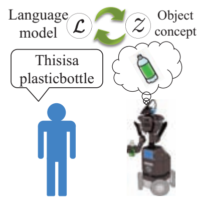
Soft-Bodied Robotics / Robot Learning I

Chair *Jamie Paik, Ecole Polytechnique Federale de Lausanne*
Co-Chair

12:03–12:06 MoB2.13

Mutual Learning of an Object Concept and Language Model Based on MLDA and NPYLM

Tomoaki Nakamura[1,2], Takayuki Nagai[2], Kotaro Funakoshi[1], Shogo Nagasaka[3], Tadahiro Taniguchi[3], and Naoto Iwahashi[4]
[1]Honda Research Institute Japan Co., Ltd, [2]University of Electro-Communications
[3]Ritsumeikan University, [4]Okayama Prefectural University



- We propose a stochastic model by which a robot can mutually learn a language model and object concepts
- The object concept is formed by classifying multimodal information, and the language model is acquired from human speech
- The accuracy of speech recognition and object concept can be improved by the mutual learning

12:06–12:09 MoB2.14

Object Manifold Learning with Action Features for Active Tactile Object Recognition

Daisuke Tanaka, Takamitsu Matsubara, Kentaro Ichien and Kenji Sugimoto
Nara Institute of Science and Technology, Japan

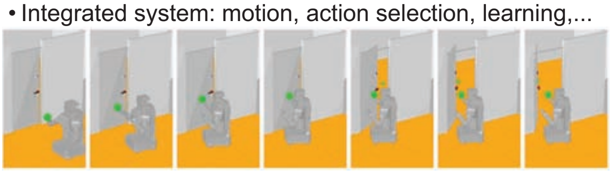
- Tactile object recognition by active exploratory movements
- *Object Manifold Learning* to extract low-dimensional object features from tactile data and action features
- Sequential object's belief update on the manifold with information-maximizing movements

12:09–12:12 MoB2.15

Entropy-Based Strategies for Physical Exploration of the Environment's Degrees of Freedom

Stefan Otte[1], Johannes Kulick[1], Marc Toussaint[1] and Oliver Brock[2]
University Stuttgart[1], Technical University Berlin[2]

- *The Exploration Challenge*: minimizing the entropy of the environment's degrees of freedom by exploration
- Integrated system: motion, action selection, learning,...

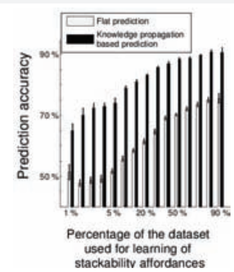


12:12–12:15 MoB2.16

Knowledge Propagation and Relation Learning for Predicting Action Effects

Sandor Szedmak, Emre Ugur, and Justus Piater
University of Innsbruck

- Complex affordances are learned from large amount of sparse data via Max-Margin based methods from recommender systems.
- Predictions are propagated by superposing all paths in the underlying object interaction graph.



12:15–12:18 MoB2.17

Learning to Reach into the Unknown: Selecting Initial Conditions When Reaching in Clutter

Daehyung Park, Ariel Kapusta, Youkeun Kim, James M. Rehg and Charles C. Kemp
Georgia Institute of Technology

- **Learning Initial Conditions (LIC)** is a data-driven approach.
- LIC learns a probabilistic model with only a few features from a library of previous experiences using the behavior in similar context.
- LIC selects a good initial configuration that greatly improves a robot's success at reaching to a goal.

12:18–12:21 MoB2.18

Haptic Representation for Manipulating Deformable Food Objects

Mevlana Gemici and Ashutosh Saxena
Cornell University

- Goal: Have robot prepare a salad!
- Input: Haptic sensory signals (force and touch).
- Machine learning for modeling the physical properties of food objects.
- Unsupervised learning of beliefs about haptic properties of an object.

Soft-Bodied Robotics / Robot Learning I

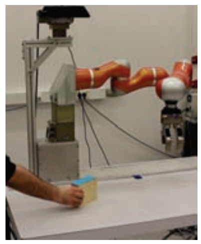
Chair *Jamie Paik, Ecole Polytechnique Federale de Lausanne*
Co-Chair

12:21–12:24 MoB2.19

A neural dynamics architecture for grasping that integrates […]

G. Knips[1], S. K. U. Zibner[1],
H. Reimann[1], I. Popova[1] and G. Schöner[1]
[1]Ruhr-Universität Bochum

- Integrative grasping architecture based solely on **neural dynamics**
- **Autonomous** organization of scene representation, pose estimation, object classification, and movement generation
- **On-line updating** as an emergent feature

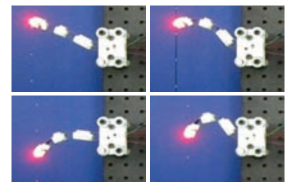


12:24–12:27 MoB2.20

Control in the Reliable Region of a Statistical Model with Gaussian Process Regression

Youngmok Yun and Ashish D. Deshpande
Dept of Mechanical Engineering, The University of Texas at Austin, USA

- We present a novel statistical model-based control algorithm, called Control in the Reliable Region of a Statistical Model (CRROS)
- CRROS is to track a desired output $\mathbf{y}$ by using the pseudoinverse of the Jacobian of the GPR model, and simultaneously regulate the null space to drive $\mathbf{x}$ toward a region of low uncertainty.



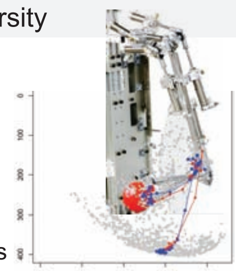
A manipulator called the Flex-finger, for which it is challenging to build an analytical model, was controlled to validate CRROS

12:27–12:30 MoB2.21

Confidence-based roadmap using Gaussian process regression for a robot control

Y. Okadome[1], Y. Nakamura[1], K. Urai[1],
Y. Nakata[1] and H. Ishiguro[1]
[1]Osaka university

- \`Sample'-based motion planning
  - Inverse dynamics: estimated by **Gaussian process regression**
  - Edge cost: confidence interval
- Application: control of an actual robotic arm driven by air-actuators



Navigation / Visual Servoing

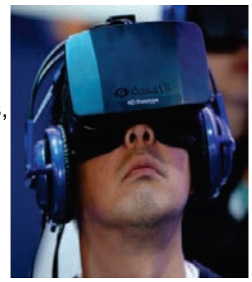
Chair *Seth Hutchinson, University of Illinois*
Co-Chair

11:10–11:30 MoB3.1

Keynote: From Robotics to VR and Back

Steve LaValle
Oculus VR and University of Illinois

- Finally, current technology can support compelling VR
- VR challenges are familiar to roboticists: configuration spaces, sensing, localization, collision detection, HCI, algorithms
- VR + robots = fun!



11:30–11:33 MoB3.2

Environment-based Trajectory Clustering for Autonomous Vehicles

Georg Tanzmeister[1,2], Dirk Wollherr[2], Martin Buss[2]
[1]BMW Group Research and Technology,
[2]Inst. Automatic Control Engineering, TU München

- Similar to homotopy, but without same-goal-state requirement, thus for local motion planner
- Closed curve is formed by sampling intermediate trajectories
- O(n) in the number of paths for non-overlapping clusters

11:33–11:36 MoB3.3

Wide-Field Optical Flow Aided Inertial Navigation for Unmanned Aerial Vehicles

Matthew B. Rhudy[1], Haiyang Chao[2], and Yu Gu[3]
[1]Lafayette College [2]University of Kansas
[3]West Virginia University

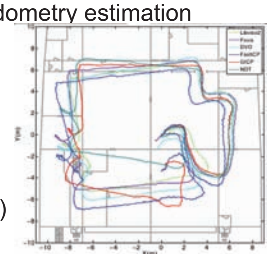
- An integration of wide-field optical flow and Inertial measurements was performed for UAV ground speed and attitude estimation;
- Non-drifting estimates were obtained with approximately 1.4 m/s of error for velocity and 1.4 degrees of standard deviation of error for pitch and roll attitude angles.

11:36–11:39 MoB3.4

Experimental Study of Odometry Estimation Methods using RGB-D Cameras

Zheng Fang[1], Sebastian Scherer[2]
[1]Northeastern University, China [2]Carnegie Mellon University, USA

- Six real-time RGB-D visual odometry estimation methods are evaluated.
  - Libviso2 (Visual Feature)
  - Fovis (Visual & Depth)
  - DVO (Intensity & Depth)
  - FastICP (Point Cloud)
  - GICP (Geometric & Cloud)
  - NDT (Visual & Cloud)

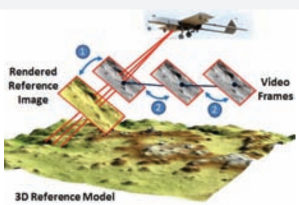


11:39–11:42 MoB3.5

Precise Vision-Aided Aerial Navigation

Han-Pang Chiu, Aveek Das, Phillip Miller,
Supun Samarasekera, Rakesh (Teddy) Kumar
Center for Vision Technologies, SRI International, USA

- We proposes a novel aerial navigation approach to continuously estimates precise 3D absolute pose using only IMU and mono. cameras.
- All sensor measurements are fully optimized in a smoother-based inference framework over a constant-length of sliding window.
- Experimental results demonstrate that our approach provides accurate (3D RMS error < 10 meters) and consistent solutions on large-scale GPS-denied scenarios.



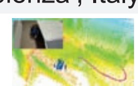
- Geo-registered information are incorporated into two kinds of visual measurements: (1) 2D-3D tie-points (2) geo-registered feature tracks.

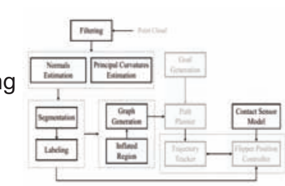
11:42–11:45 MoB3.6

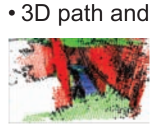
Real-time Autonomous 3D Navigation for Tracked Vehicles in Rescue Environments

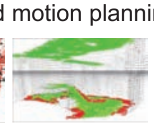
Matteo Menna[1], Mario Gianni[1],
Federico Ferri[1] and Fiora Pirri[1]
[1]ALCOR Lab, University of Rome ‘Sapienza‘, Italy

- Flipper contact sensor model
- Curvatures and normals estimation
- Segmentation and labeling
- Traversability
- 3D path and motion planning









Navigation / Visual Servoing

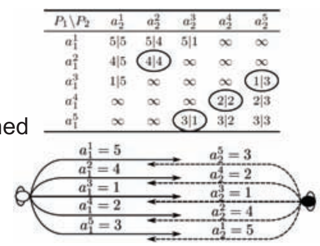
Chair *Seth Hutchinson, University of Illinois*
Co-Chair

11:45–11:48 MoB3.7

Interactive Navigation of Humans from a Game Theoretic Perspective

Annemarie Turnwald, Wiktor Olszowy,
Dirk Wollherr and Martin Buss
LSR, Technische Universität München, Germany

- **Interactive** navigation of humans → mutual avoidance
- Interaction can be explained with the **theory of Nash equilibria** in **non-cooperative games**.

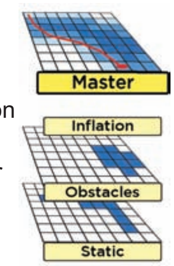


11:48–11:51 MoB3.8

Layered Costmaps For Contextualized Navigation

David V. Lu[1], D.Hershberger[2] and W.D. Smart[3]
[1]Washington University in St. Louis
[2]Willow Garage [3]Oregon State University

- Robot navigation requires many types of information
- Monolithic costmaps are unsuited for tracking complex contextual information
- Layered costmaps semantically separate obstacle, proxemic and other data into modularized layers.
- Integrated into ROS Navigation Stack

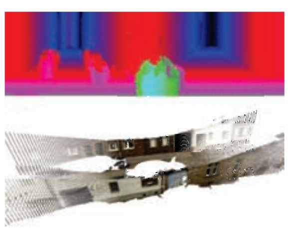


11:51–11:54 MoB3.9

Omnidirectional 3D Reconstruction in Augmented Manhattan Worlds

Miriam Schönbein[1], Andreas Geiger[2],
[1]MRT, Karlsruhe Institute of Technology, Germany
[2]MPI for Intelligent Systems, Tübingen, Germany

- 360° reconstruction from catadioptric stereo pairs.
- Hough voting-based plane hypotheses.
- Slanted-plane MRF.
- Novel omnidirectional data set with 3D ground truth.

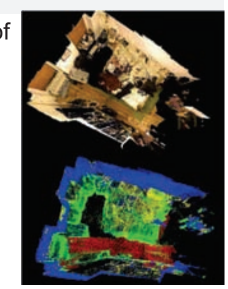


11:54–11:57 MoB3.10

Semantic Mapping for Object Category and Structural Class

Zhe Zhao, Xiaoping Chen
University of Science and Technology of China

- We want to build a semantic map of the indoor scene with object category and structural class.
- Each RGB-D image is labeled by a CRF model and the camera poses are estimated by RGB-D SLAM.
- The final semantic map is built through the semantic label fusion step.

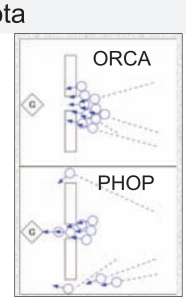


11:57–12:00 MoB3.11

Anytime Navigation with Progressive Hindsight Optimization

Julio Godoy, Ioannis Karamouzas,
Stephen J. Guy and Maria Gini
University of Minnesota

- We propose an anytime algorithm (PHOP) to plan paths of agents in an environment with many other agents.
- An agent predicts the motion of other agents and plans its path accordingly. It executes one step of the plan and repeats the process.
- PHOP increases the energy and time efficiency of the agents' motion.

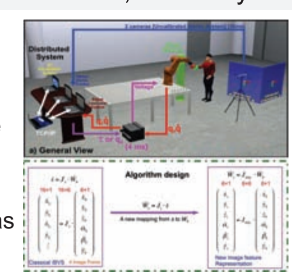


12:00–12:03 MoB3.12

6D Image-based Visual Servoing with uncalibrated Stereo Cameras

Caixia Cai, Emmanuel Dean-Leon,
Nikhil Somani and Alois Knoll
Technische Universität München, Germany

- New 6D image features for dynamic IBVS
- New full-rank square Image Jacobian
- Singularity-free
- Uncalibrated stereo cameras



Navigation / Visual Servoing

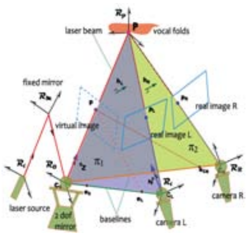
Chair *Seth Hutchinson, University of Illinois*
Co-Chair

12:03–12:06	MoB3.13

Weakly Calibrated Stereoscopic Visual Servoing for Laser Steering: Application to Phonomicrosurgery

Brahim Tamadazte and Nicolas Andreff
FEMTO-ST Institute, AS2M department
24 rue Savary, 25000 Besançon,

- Stereoscopic visual servoing
- Multiple view geometry
- Automatic laser steering for laser surgery
- Weak eye-to-hand and camera calibration
- Decoupled controller, stable and easy to implement

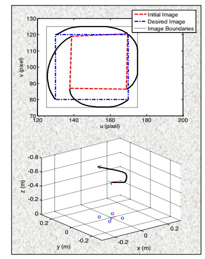


12:06–12:09	MoB3.14

Novel Two-Stage Control Scheme for Robust Constrained Visual Servoing

Akbar Assa, Farrokh Janabi-Sharifi
Department of Mechanical and Industrial Engineering
Ryerson University

- A two-stage controller is proposed for constraint-aware robust visual servoing.
- A model predictive controller is exploited for constraint handling.
- The effect of uncertainties are minimized through a proper cost function.

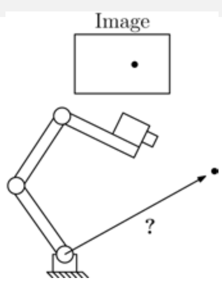


12:09–12:12	MoB3.15

Lyapunov-stable Eye-in-hand Kinematic Visual Servoing with Unstructured Static Feature Points

David Navarro-Alarcon and Yun-hui Liu
The Chinese University of Hong Kong

- We present two visual servoing methods to regulate the image position of unstructured feature points
- We prove the stability of these image-based controllers with Lyapunov theory



12:12–12:15	MoB3.16

A Sequence of Micro-assembly for Irregular Objects Based on a Multiple Manipulator Platform

Dengpeng Xing, De Xu, and Haipeng Li,
Institute of Automation, Chinese Academy of Sciences

- Design a micro-operational platform with multiple manipulators to accomplish a sequence of microassembly for irregular components
- Desire to solve the soft assembly with contact
- Propose a hybrid control strategy to achieve high precision and protect objects

12:15–12:18	MoB3.17

Visual Servoing Based Trajectory Tracking of Underactuated Water Surface Robots without Direct Position Measurement

Kai Wang, Yunhui Liu and Luyang Li
The Chinese University of Hong Kong

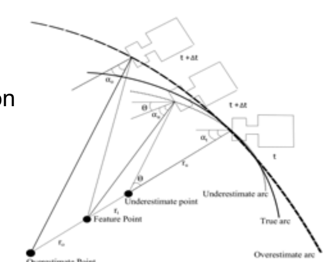
- Estimate the global position of the robot online using natural visual features and AHRS sensors
- Proved asymptotic tracking of a desired trajectory and convergence of the position estimation to the actual position
- The experiment demonstrated the validity of the proposed controller

12:18–12:21	MoB3.18

Image Jacobian Estimation Using Structure from Motion on a Centralized Point

Victor Nevarez[1] and Ron Lumia[1]
[1]University of New Mexico

- A centralized motion algorithm (CMA) is proposed as a fast and efficient online calibration method.
- By exploiting a "centralized motion" a chosen feature point should have little to no change in pixel coordinates.



CMA error model

Navigation / Visual Servoing

Chair *Seth Hutchinson, University of Illinois*
Co-Chair

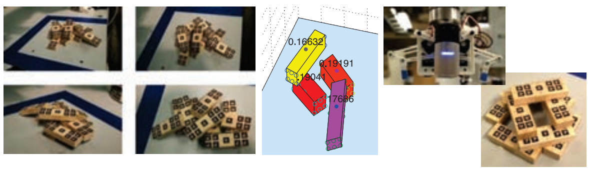
12:21–12:24	MoB3.19

Vision Guided Robotic Block Stacking

Nathanael Macias
Applied Physics Laboratory

John T. Wen
Rensselaer Polytechnic Institute

- Goal: Robust vision-based block pick-up and stacking using webcam and industrial robot
- Approach: Binary marker for block identification/localization; Custom gripper for flexible & reliable grasp; Optimization-based pick-up strategy; Robot Raconteur distributed middleware architecture

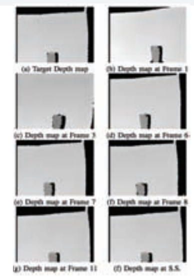


12:24–12:27	MoB3.20

A Two Phase RGB-D Visual Servoing Controller

Abdullah Hojaij[1], John Zelek[1], Daniel Asmar[2]
[1]University of Waterloo, [2]AUB

- Two-phase visual servoing using a Kinect RGB-D sensor
- Phase 1 is a quick alignment phase using registration of image features
- Phase 2 is a refinement based on depth-map error minimization
- Experiments performed on a Barret WAM manipulator

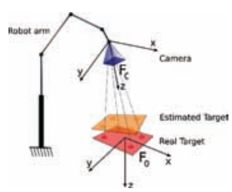


12:27–12:30	MoB3.21

Pose Error Correction For Visual Features Prediction

Nicolas Cazy Irisa/Inria, Rennes, France
Claire Dune University Sud Toulon-Var La Garde at HandiBio, France
Pierre-Brice Wieber Inria, Grenobles, France
Paolo Robuffo Giordano CNRS at Irisa/Inria, Rennes, France
François Chaumette Irisa/Inria, Rennes, France

- Novel nonlinear correction strategy to **correct** the relative **pose** between the **camera** and the **target**
- Comparison of the **improvements** obtained during the **feature prediction** phase
- Simulation results for a **eye-in hand camera** and **four point** features



Micro/Nano Robotics I / Manipulation and Grasping II

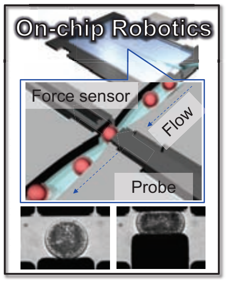
Chair *Oliver Brock, Technische Universität Berlin*
Co-Chair

13:50–14:10 MoC1.1

Keynote: Micro and Nano Robotics for Biomedical Innovations

Fumihito Arai
Nagoya University

- **Micro and Nano Robotics**: What is expected in **biomedical field**? Why Robotics??
- **On-chip Robotics**: Key issues!
- **Essential** micro-nano fabrication: present and future
- **Open Question**: How do you control floating cells on a chip?



14:10–14:13 MoC1.2

Three Dimensional Multi-cell Spheroids Assembly using Thermoresponsive Gel Probe

Masaru Takeuchi[1], Masahiro Nakajima[1], Toshio Fukuda[1,2,3] and Yasuhisa Hasegawa[1]
[1]Nagoya University [2]Meijo University
[3]Beijing Institute of Technology

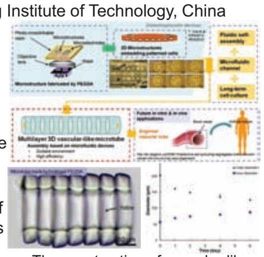
- Spheroids manipulation was achieved by the Thermoresponsive Gel probe
- Cell viability was checked after manipulation of spheroids by the probe
- Patterning of multi-cell spheroids in 2D and 3D was achieved.
- Cells were grown in the assembled spheroid structures

14:13–14:16 MoC1.3

Construction of Vascular-like Microtubes via Fluidic Axis-translation Self-assembly based on Multiple Hydrogels

Tao Yue, Masahiro Nakajima, Masaru Takeuchi, Toshio Fukuda
Dept. Micro-Nano Systems Engr., Nagoya University, Japan
Qiang Huang, and Toshio Fukuda
School of Mechatronical Engr., Beijing Institute of Technology, China

- A method of constructing 3D multilayered vascular-like microtubes based on fluidic axis-translation self-assembly of 2D microstructures was presented.
- Microtubes with alternating cell layers were constructed based on multiple hydrogels.
- The fabrication of GelMa microstructures was demonstrated and the degradability of cell embedded GelMa microstructures was evaluated.



The construction of vascular-like microtubes by multiple hydrogels

14:16–14:19 MoC1.4

Magnetic Actuation of Ultra-Compliant Micro Robotic Mechanisms

Dana Vogtmann[1] and Sarah Bergbreiter[1]
[1]University of Maryland, College Park

- Microfabricated mechanisms with integrated elastomeric hinges are actuated using embedded magnetic features in an external magnetic field

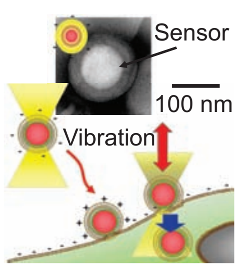
- Simple in- and out-of-plane mechanisms and a magnetically actuated compliant gripper are demonstrated

14:19–14:22 MoC1.5

Selective and Rapid Cell Injection of Fluorescence Sensor Encapsulated in Liposome Using Optical Control of Zeta Potential and Local Mechanical Stimulus by Optical Tweezers

Hisataka Maruyama, Taisuke Masuda, Liu Hengjun and Fumihito Arai
Nagoya University

- Selective adhesion and injection of micro-nanoparticle sensor into a specific cell
- Optical control of zeta potential using photoisomerization of photochromic material
- Local vibration stimulus using optical tweezers for rapid and local injection of the sensor

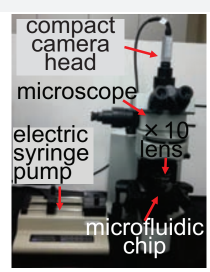


14:22–14:25 MoC1.6

Real-Time LOC-based Morphological Cell Analysis System Using High-Speed Vision

Qingyi Gu, Tadayoshi Aoyama, Takeshi Takaki, Idaku Ishii, Ayumi Takemoto, and N. Sakamoto
Hiroshima University

- Real-time Vision-based Morphological Analysis System
  - Multi-object extraction by hardware on HFR vision system
  - Cell tracking and analysis on PC
- Morphological analysis of fertilized sea urchin eggs in microchannel
  - Size, eccentricity, transparency
  - 500 cells/second



Micro/Nano Robotics I / Manipulation and Grasping II

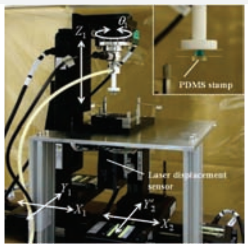
Chair *Oliver Brock, Technische Universität Berlin*
Co-Chair

14:25–14:28 MoC1.7

Noncontact Fine Alignment for Multiple Microcontact Printing

Nobuyuki Tanaka[1, 2], Hiroki Ota[2], Kazuhiro Fukumori[2], Masayuki Yamato[2], Teruo Okano[2], and Jun Miyake[1]
[1]Osaka Univ. [2]Tokyo Women's Medical Univ.

- PDMS stamp was adjusted by integrated linear/rotation stages within a maximum error of 33 μm.
- Three-time microcontact printing was performed for single cell culture dish.

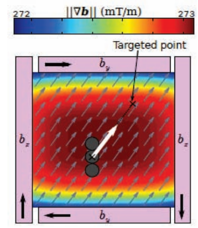


14:28–14:31 MoC1.8

Study on Rotational an Unclogging Motions of Magnetic Chain-Like Microrobot

Karim Belharet[1], David Folio[2] and Antoine Ferreira[2]
[1]HEI campus Centre [2]INSA-CVL

- Modeling of magnetic microrobot navigating in viscous flow
- Experimental setup
- Magnetic rotation of chain-like microrobot in viscous flow
- An unclogging strategy for the chain-like magnetic microrobot

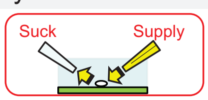


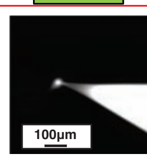
14:31–14:34 MoC1.9

Development of Chemical Stimulation System for Local Environment Control by Using Combination of Spout and Suction from Dual-pipettes

T.Motoyoshi[1], M.Kojima[1], K.Ohara[1], M.Horade[1] K.Kamiyama[1],Y.Mae[1] and T.Arai[1]
[1]Osaka University

- **Chemical Stimulation System** for single cell analysis
- **Control the concentration of the solution** between pipettes
- Observing by the **fluorescent substance**





14:34–14:37 MoC1.10

A Stick-Slip Omnidirectional Powertrain for Low-Cost Swarm Robotics

John Klingner[1], Anshul Kanakia[1], Nicholas Farrow[1], Dustin Reishus, and Nikolaus Correll[1]
[1]University of Colorado Boulder

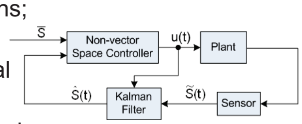
- We present a mechanism using simple vibration motors for omnidirectional motion in a physical robot.
- We also present an approach for calibration and control of this mechanism.

14:37–14:40 MoC1.11

Non-vector Space Stochastic Control for Nano Robotic Manipulations

Jianguo Zhao[1], Bo Song[1], and Ning Xi[1]
[1]Michigan State University

- With image feedback, non-vector space control is applied to nano robotic manipulations;
- Combined with stochastic control, the method can deal with noisy image feedback;
- The precision can be as good as image resolution without position sensors.

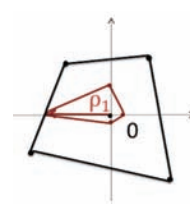


14:40–14:43 MoC1.12

Task Specific Robust Grasping For Multifingered Robot Hands

George Boutselis, Charalampos Bechlioulis, Minas Liarokapis and Kostas Kyriakopoulos
NTUA, School Of Mechanical Engineering

- Determination of task oriented optimal configuration using the Q-distance
- Dealing with grasping uncertainties
- Computation of sufficient contact forces
- Experimental validation utilizing tactile sensing



Micro/Nano Robotics I / Manipulation and Grasping II

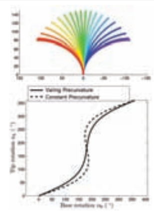
Chair *Oliver Brock, Technische Universität Berlin*
Co-Chair

14:43–14:46 MoC1.13

Achieving Elastic Stability of Concentric Tube Robots Through Optimization of Tube Precurvature

Junhyoung Ha[1], Frank C. Park[1] and Pierre E. Dupont[2]
[1]Seoul National Univ. [2]Harvard Medical School

- Varying tube pre-curvature as a function of arc length is used as a means to enhance stability.
- Stability conditions for a planar tube pair are presented.
- Optimal design problem is defined to maximize stability.



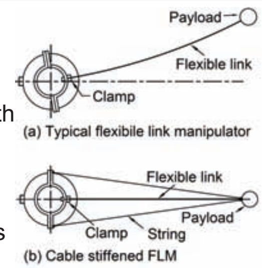
Enhanced stability by varying pre-curvature

14:46–14:49 MoC1.14

Cable Stiffened Flexible Link Manipulator

Rahul Dixit[1,2], R Prasanth Kumar[2]
[1]Research Center Imarat, DRDO, Hyderabad
[2]Indian Institute of Technology Hyderabad

- Bending stiffness is much less than axial stiffness in tension
- Using cables/strings, deflection can be reduced significantly with marginal increase in inertia
- Drawback of acceleration induced buckling could be overcome using multiple strings

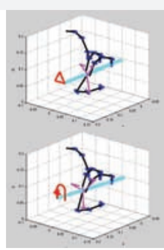


14:49–14:52 MoC1.15

Robotic Handwriting: Multi-contact Manipulation Based on Reactional Internal Contact

S.-K. Kim[1], J. Jo[2], Y. Oh[2], S.-R. Oh[2], S. Srinivasa[1], M. Likhachev[1],
[1]Carnegie Mellon University [2]KIST

- Multi-contact manipulation
  = stable object-body grasping
  + dexterous object-end manipulation
- Difficult due to internal link contact
- By utilizing the internal contact force that works as a reaction force, desired fingertip forces can be reduced for handwriting tasks

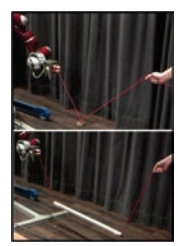


14:52–14:55 MoC1.16

Cooperative Suspended Object Manipulation Using Reinforcement Learning and Energy-based Control

Ivana Palunko[1], Philine Donner[2], Martin Buss[2] and Sandra Hirche[3]
[1]UNIZG-FER [2]TUM-IAS [3]TUM-ITR

- Adaptive controller which combines reinforcement learning with energy based swing-up control.
- It is successfully verified in a single robot and human-robot experimental setup for different suspended objects.



14:55–14:58 MoC1.17

Robotic Dual Probe Setup for Reliable Pick and Place Processing on the Nanoscale

Tobias Tiemerding[1], Sören Zimmermann[1], Sergej Fatikow[1,2]
[1]University of Oldenburg, [2]OFFIS

- Due to adhesive forces pick and place handling of nanoparticles is not highly reproducible
- Dual AFM tip technique with tailored end effectors to purposefully utilize forces is presented
- Reliable handling is possible, allowing for 2D- and 3D (hetero-)structures

14:58–15:01 MoC1.18

Optimal Parameter Identification for Discrete Mechanical System with Application to Flexible Object Manipulation

T. M. Caldwell[1], D. Coleman[1] and N. Correll[1]
[1]University of Colorado, Boulder

- Stiffness identification of flexible loop using Rethink Robotics Baxter robot.
- Formulates model parameter identification of flexible objects with variational integrators.
- Discrete-time adjoint based gradient calculation for optimal parameter identification.

Micro/Nano Robotics I / Manipulation and Grasping II

Chair *Oliver Brock, Technische Universität Berlin*
Co-Chair

15:01–15:04 MoC1.19

The Joint Coordination in Reach-to-grasp Movements

Zhi Li[1], Kierstin Gray[1], Jay Ryan Roldan[1], Dejan Milutinovic[1], and Jacob Rosen[1]
University of California, Santa Cruz, USA

- Motion analysis based on kinematic modeling of human arm
- Coordination of grasping-relevant joints by their task-relevance
- Synergetic coordination of the macro- and micro-structures
- Guidelines for the control of the upper limb exoskeleton

15:04–15:07 MoC1.20

A Robot System Design for Low-Cost Multi-Robot Manipulation

James McLurkin[1], A.M.[1], N.R.[1], G.H.[1], A.B.[1], A.C.[1], H.L.[1], M.J.[1],N.O.[1], J.R.[2], S.K., et al.
[1]Rice University, [2]USMA

- Established open-source platform with vast sensor suite
- Omni-directional gripper simplifies manipulation
- Enables scalable environmental interaction
- Cost-effective design allows for large swarms

15:07–15:10 MoC1.21

Declarative Specification of Task-based Grasping with Constraint Validation

Sven Schneider[1], Nico Hochgeschwender[1] and Gerhard K. Kraetzschmar[1]
[1]Bonn-Rhein-Sieg University

- Grasping objects in a task-oriented manner is challenging for a robot
- It requires an understanding of

the *object*, the *task* and the robot's *capabilities*

- We capture this knowledge in the

Grasp Domain Definition Language (GDDL)

- Formal constraints allow validation of the specifications

Humanoids and Bipeds I / Computer Vision I

Chair *Rüdiger Dillmann, Karlsruhe Institute of Technology (KIT)*
Co-Chair

13:50–14:10 MoC2.1

Keynote: What is a humanoid robot good for?

Kazuhito Yokoi
AIST

- R&D of humanoid robots are very active all around the world in order to open up a new application besides research tool and crowd puller.
- Is it true that a future humanoid robot will execute complex tasks in dangerous, degraded, human-engineered environments or evaluate human assistive device?

14:10–14:13 MoC2.2

Identification of HRP-2 Foot's Dynamics

Yuya Mikami[1], Thomas Moulard[2], Eichi Yoshida[2] and Gentiane Venture[1]
[1]TUAT [2]CNRS-AIST

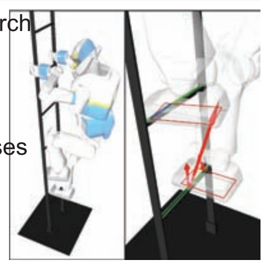
- Identified about the viscoelasticity of the sole rubber bush of HRP-2
- Used some simple active motions and composed these motions
- Compare the identified parameters using the experimental results and simulator results

14:13–14:16 MoC2.3

Integration of Non-Inclusive Contacts in Posture Generation

S. Brossette, A. Escande, J. Vaillant, F. Keith, T. Moulard and A. Kheddar
CNRS-UM2 LIRMM, CNRS-AIST JRL

- Novel approach for contact search
- Smooth optimization of contact patch positioning by modeling contact region as ellipse
- Allows richer set of feasible poses
- Allows contact between non-inclusive polygons

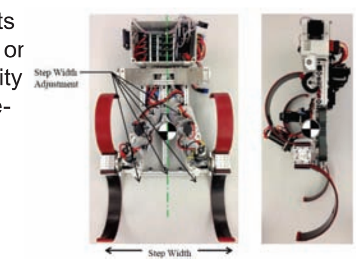


14:16–14:19 MoC2.4

3D Dynamics of Bipedal Running: Effects of Step Width on an Amputee-Inspired Robot

Timothy Sullivan[1] and Justin Seipel[1]
[1]Purdue University

- We studied the effects of varying step width on the 3D running stability of a bipedal amputee-inspired robot.
- As the step width is decreased towards human-like values, stability decreases.



14:19–14:22 MoC2.5

Lyapunov Stability Margins for Humanoid Robot Balancing

E. Spyrakos-Papastavridis†, N. Perrin$, N. G. Tsagarakis†, J. S. Dai* and D. G. Caldwell†
†Department of Advanced Robotics, Istituto Italiano di Tecnologia, Italy
$ Institut des Systèmes Intelligents et de Robotique, CNRS UMR 7222 & Université Pierre et Marie Curie, France
* Centre for Robotics Research, King's College London, United Kingdom

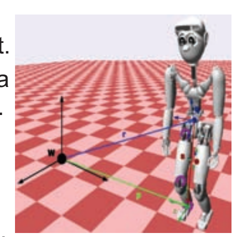
- Lyapunov Stability Margins are used to monitor a humanoid's state of balance.
- A relationship between the system's closed-loop Lyapunov energy and its center-of-pressure has been established.
- This result ensures both Lyapunov stability and dynamical balance of the system.
- Experimental results demonstrating the concept have been performed using the Compliant Humanoid (COMAN).

14:22–14:25 MoC2.6

State Estimation for a Humanoid Robot

Nicholas Rotella[1], Michael Bloesch[2], Ludovic Righetti[3] and Stefan Schaal[1,3]
[1]USC [2]ETH Zurich [3]Max Planck Institute

- State estimation framework agnostic of task, terrain and robot.
- Fuses integrated IMU sensor data with knowledge of leg kinematics.
- Utilizes full 6DOF pose of feet to improve observability properties and performance over prior work.
- Verified in simulated walking task.



Humanoids and Bipeds I / Computer Vision I

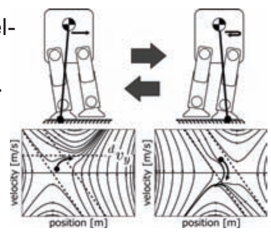
Chair *Rüdiger Dillmann, Karlsruhe Institute of Technology (KIT)*
Co-Chair

14:25–14:28	MoC2.7

Sideward Locomotion Control of Biped Robots Based on Dynamics Morphing

Hiroshi Atsuta[1] and Tomomichi Sugihara[1]
[1]Osaka University, Japan

- A trajectory-free sideward locomotion controller for biped robots is proposed.
- A cyclic acceleration and deceleration is needed for avoiding the collision of the pair of legs.
- This is realized by alternating the velocity-following control and the self-excited oscillating control in accordance with the supporting condition.



14:28–14:31	MoC2.8

Modular Low-Cost Humanoid Platform For Disaster Response

S. –J. Yi[1], S. McGill[1], L. Vadakedathu[1], Q. He[1], I. Ha[2], M. Rouleau[3], D. Hong[4], and D. D. Lee[1]
[1]U. of Penn [2]Robotis [3]Virginia Tech [4]UCLA

- Modular, general purpose actuators and structural components
- Low development and manufacture cost, rapid field repairability
- Modular and multi-layered software structure
- Acquired the finalist status at DRC Trials 2013

14:31–14:34	MoC2.9

Control Strategies for Driving Utility Vehicles with a Humanoid Robot

Christopher Rasmussen[1], Kiwon Sohn[2], Qiaosong Wang[1] and Paul Oh[2]
[1]University of Delaware [2]Drexel University

- Sensor head & driving software for DRC-Hubo
- Vehicle recognition, robot pose estimate from point clouds
- Steering & speed actuation
- Velocity control, trajectory following
- Results from simulation, 5+ km of offline data, integrated live tests

14:34–14:37	MoC2.10

Balancing experiments on a torque-controlled humanoid with hierarchical inverse dynamics

Alexander Herzog[1], Ludovic Righetti[1,2], Felix Grimminger[1] Peter Pastor[2], Stefan Schaal[1,2]
[1]Max-Planck IS, AMD [2]Uni. South. Calif., CLMC

- we express **desired closed-loop dynamics** and constraints on sub-parts of a torque controlled humanoid
- the **full robot model** is used in a **cascade of QPs** and run in a 1 kHz control-loop
- the control framework is evaluated on the real robot together with **model-uncertainties**, **sensor noise**, etc

14:37–14:40	MoC2.11

Dynamic State Estimation using Quadratic Programming

X Xinjilefu
Siyuan Feng and Christopher G. Atkeson
Carnegie Mellon University

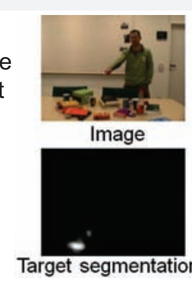
- Using full-body dynamics for humanoid state estimation
- Advantages of a QP estimator over a nonlinear Kalman filter
  - Does not require the dynamic system in the state space form
  - Handles constraints naturally
  - Considers modeling error

14:40–14:43	MoC2.12

“Look at this!” Learning to Guide Visual Saliency in Human-Robot Interaction

Boris Schauerte[1], Rainer Stiefelhagen[1]
[1]Karlsruhe Institute of Technology

- We train CRFs to identify and segment (unknown) objects that have been pointed at and/or spoken about
- Here, saliency highlights potential candidate objects (or parts) and we do not require detectors for specific objects or object classes
- We select the correct object in over 80% of the evaluation samples



Humanoids and Bipeds I / Computer Vision I

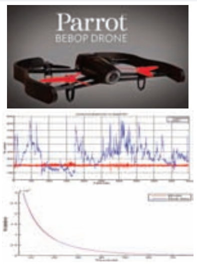
Chair *Rüdiger Dillmann, Karlsruhe Institute of Technology (KIT)*
Co-Chair

14:43–14:46 MoC2.13

SuperFAST : Model-Based Adaptive Corner Detection for Scalable Robotic Vision

Gaspard Florentz[1] and Emanuel Aldea[2]
[1]Parrot SA, [2]Paris Sud U.

- Predict an optimal threshold for FAST detector to extract a constant number of corner
- Based on an occurrence **Model**
- Uses **temporal** and **inter-scale** analysis
- **1ms** for detection + **bucketing**
- Relevant for highly-optimized **SLAM**



14:46–14:49 MoC2.14

Auto-adjusting Camera Exposure for Outdoor Robotics using Gradient Information

Inwook Shim, Joon-Young Lee, In So Kweon
Robotics and Computer Vision Lab, KAIST

- Adjusting camera exposure to maximize image features in the gradient domain.
- Robust against illumination conditions.
- Proposed method is designed for outdoor robotics application.

14:49–14:52 MoC2.15

SLAM with Object Discovery, Modeling and Mapping

Siddharth Choudhary, Alexander J. B. Trevor, Henrik I. Christensen and Frank Dellaert
Georgia Institute of Technology

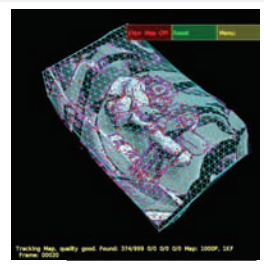
- Integrates object discovery and modeling in a SLAM framework.
- Online learning paradigm.
- An object database is produced along with the map.
- Discovered objects used as landmarks during SLAM, producing improved mapping result.

14:52–14:55 MoC2.16

Real-Time Sequential Model-Based Non-Rigid SFM

S. Bronte[1], M. Paladini[2],
L. M. Bergasa[1], L. Agapito[3] and R. Arroyo[1]
[1]UAH [2]Ocado Tech. [3]UCL

- The method, based on PTAM, is capable of giving pose and deformation coefficients of an object for each frame based in the previous frame estimation.
- Processing time meets real time constrains (~30 fps).
- Maintains a good balance performance-accuracy.

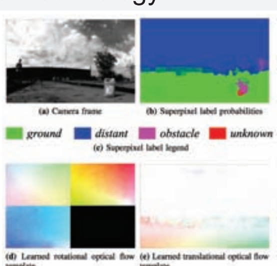


14:55–14:58 MoC2.17

Direct Superpixel Labeling for Mobile Robot Navigation Using Learned General Optical Flow Templates

Richard Roberts[1], Frank Dellaert[1],
[1]Institute for Robotics and Intelligent Machines, Georgia Institute of Technology

- Semantic superpixel labeling for obstacle detection.
- For uncalibrated cameras with arbitrary optics.
- Informed by optical flow templates learned unsupervised from data.



14:58–15:01 MoC2.18

A Directional Visual Descriptor for Large-Scale Coverage Problems

M. Tamassia[1], A. Farinelli[3], V. Murino[2] and A. Del Bue[2]
[1]RMIT Univ., [2]Istituto Italiano di Tecnologia, [3]Univ. of Verona

- How to visually **cover** 3D environments **autonomously?**
- Define the **visibility of the camera** in terms of FoV, focus, resolution, viewing angle, etc.
- We propose a **directional coverage descriptor** for visual based navigation.
- Experiments in a simulated environment using real world data.

Humanoids and Bipeds I / Computer Vision I

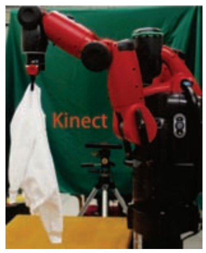
Chair *Rüdiger Dillmann, Karlsruhe Institute of Technology (KIT)*
Co-Chair

15:01–15:04 MoC2.19

Real-time Pose Estimation of Deformable Objects Using a Volumetric Approach

Yinxiao Li, Yan Wang, Michael Case,
Shih-Fu Chang, Peter K. Allen
Columbia University

- A real-time approach to reconstruct a smooth 3D model of a moving deformable object
- 3D real-time shape matching with a learned distance metric
- A Database of deformable objects that can be used for efficient data-driven pose recognition



15:04–15:07 MoC2.20

PAS: Visual Odometry with Perspective Alignment Search

Andrew Richardson and Edwin Olson
University of Michigan

- Multi-scale search over pose for motion estimation
- Descriptorless and implicit data association when matching over unknown motion
- Joint alignment of all features
- Evaluated in visual odometry system for a small ground robot

15:07–15:10 MoC2.21

Planar Building Facade Segmentation and Mapping Using Appearance and Geometric Constraints

Joseph Lee, Yan Lu, and Dezhen Song
Texas A&M University

- Planar building facade segmentation using appearance and geometric data
- Planar building facade mapping using reprojection error, orientation, and coplanarity constraints
- Reduces angular error of reprojection error-based 3D mapping by an average of 82.82%

Bioinspired Robots II / Distributed Robotics

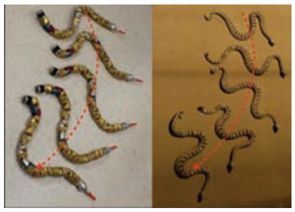
Chair *M. Ani Hsieh, Drexel University*
Co-Chair

13:50–14:10	MoC3.1

Keynote: From Biology to Robot and Back

Howie Choset
Carnegie Mellon

- Bio-Inspired robotic locomotion
- Successful locomotion on granular medium
- Low dimensional control of high dimensional systems
- Robotic validation of biological principles

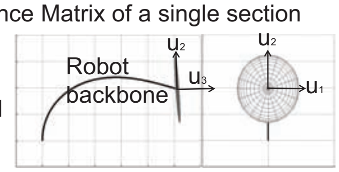


14:10–14:13	MoC3.2

Compliance Computation for Continuum Types of Robots

G. Smoljkic, D. Reynaerts,
J. Vander Sloten and E. Vander Poorten
KU Leuven, dept. of mech. eng., Leuven, Belgium

- Calculation the Compliance Matrix of a single section continuum robot
- Analytic formulation
- Experimentally validated



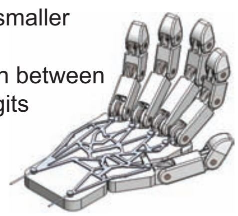
Compliance ellipsoid for force of 0.625N exerted on robot tip

14:13–14:16	MoC3.3

Multiport Modeling of Force and Displacement in Elastic Transmissions

Michael Martell and Joshua Schultz
University of Tulsa

- Construction of an elastic transmission mechanism for a compliant underactuated robotic hand from the interconnection of smaller compliant mechanisms
- Mathematical model for interaction between multiple actuators and multiple digits
- Positive definiteness of a transmission's stiffness matrix and grasp stability



14:16–14:19	MoC3.4

iSplash-II: Realizing Fast Carangiform Swimming to Outperform a Real Fish

Richard James Clapham and Huosheng Hu
School of Computer Science and Electronic Engineering,
University of Essex, United Kingdom

- Outperforming real fish in terms of average maximum velocity (measured in BL/s) and endurance, the duration that top speed is maintained.
- Achieving a maximum velocity of 11.6BL/s (i.e. 3.7m/s) at 20Hz with a stride rate of 0.58 and a force production of 9N.

14:19–14:22	MoC3.5

Multi-functional Bio-inspired Leg for Underwater Robots

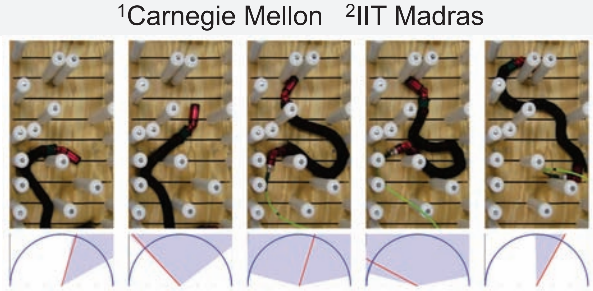
Hee Joong Kim[1], Bong Huan Jun[2] and Jihong Lee[3] [1,3]Chungnam National University, [2]Korea Ocean Research and Development Institute

- Bio-inspired legged underwater robot
- Mimicking the locomotion of diving beetles
- Designing multi-functional legs
- Performance verification for the designed leg in the water

14:22–14:25	MoC3.6

Torque Control Strategies For Snake Robots

David Rollinson[1], Kalyan Vasudev Alwala[2],
Nico Zevallos[1] and Howie Choset[1]
[1]Carnegie Mellon [2]IIT Madras



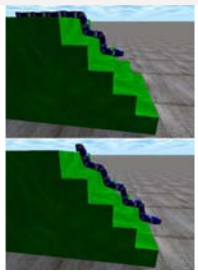
Bioinspired Robots II / Distributed Robotics

Chair *M. Ani Hsieh, Drexel University*
Co-Chair

14:25–14:28 MoC3.7

A 3D Motion Planning Framework for Snake Robots

Pål Liljebäck[1,2], Kristin Y. Pettersen[1], Øyvind Stavdahl[1] and Jan Tommy Gravdahl[1]
[1]NTNU [2]SINTEF ICT

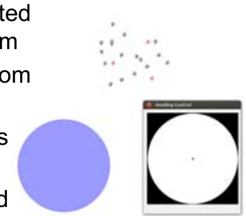


- We present a motion planning framework for 3D body shape control of snake robots.
- Instead of joint angles, the body shape is defined in terms of Cartesian coordinates, which gives a more intuitive parameterization.
- The framework can be applied to design complex motion patterns.

14:28–14:31 MoC3.8

Human Control of Robot Swarms with Dynamic Leaders

Phillip Walker[1],Saman Amirpour Amraii[1],Nilanjan Chakraborty[2],Michael Lewis[1] and Katia Sycara[2]
[1]Univeristy of Pittsburgh
[2]Carnegie Mellon University



- Investigated dynamically-selected leaders in human-swarm system
- Also restricted information to/from the leaders of the swarm
- Results show that more leaders were better, but only to a point
- Restricting information also had no effect on user performance

14:31–14:34 MoC3.9

Snakes on an Inclined Plane: Learning an Adaptive Sidewinding Motion for Changing Slopes

Chaohui Gong, Matthew Tesch, David Rollinson and Howie Choset
Carnegie Mellon University

- Efficient offline learning for optimal policy
- Robust state estimation for terrain shape inference
- Online execution by combining optimal policy and state estimation

14:34–14:37 MoC3.10

Flapping Actuator Inspired by Lepidotrichia of Ray-Finned Fishes

K.S. Sekar[1], M.S. Triantafyllou[1,2], and P. Valdivia y Alvarado[1,2]
[1]Singapore-MIT Alliance for Research and Technology
[2]Massachusetts Institute of Technology

Actuated flapper

- Flapping actuator capable of producing lengthwise curvature is designed and modeled
- Model predictions (deflection, force, and energy consumption) are compared to experiments in two flapper configurations

14:37–14:40 MoC3.11

Design and Implementation of a Low Cost, Pump-Based, Depth Control of a Small Robotic Fish

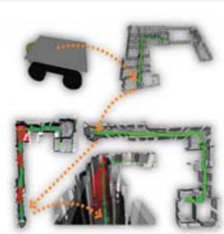
M. Macrodimitris, I. Aliprantis, E. Papadopoulos,
National Technical University of Athens

- Developed depth control of a small biomimetic fish, even at zero speed
- Control implemented using a small DC pump, pump encoder and pressure sensor
- Partial state feedback controller with nonlinearity compensation yields good response both in simulation and experimentally

14:40–14:43 MoC3.12

Distributed Management and Representation of Data and Context in Robotic Applications

André Dietrich, Sebastian Zug, Siba Mohammad and Jörg Kaiser
Otto-von-Guericke-Universität Magdeburg



- General classification of data in smart environments
- Bottom-up approach of distributed data organization
- Dynamic reconstruction of world models, as a basis for further abstractions and data interpretation

Bioinspired Robots II / Distributed Robotics

Chair *M. Ani Hsieh, Drexel University*

Co-Chair

14:43–14:46	MoC3.13

Environment-independent Formation Flight for Micro Aerial Vehicles

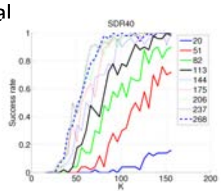
Tobias Nägeli, Christian Conte, Alexander Domahidi, Manfred Morari, Otmar Hilliges

- Precise relative formation flight relying only onboard cameras, IMU and agent-to-agent communication.
- In particular, an on-board monocular camera is used to acquire relative distance measurements in combination with a consensus-based distributed Kalman filter.

14:46–14:49	MoC3.14

Rapid Multirobot Deployment with Time Constraints

Stefano Carpin[1] Marco Pavone[2] Brian Sadler[3]
[1]Univ. California Merced [2]Stanford University
[3]Army Research Lb

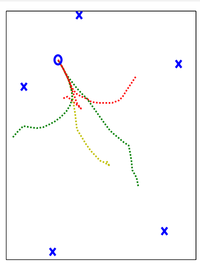


- Swarm deployment under temporal deadlines
- Provably optimal strategies based on Constrained Markov Decision Processes
- Exact failure probability
- Simulations confirm theoretical predictions

14:49–14:52	MoC3.15

A distributed optimal strategy for rendezvous of multi-robots with random node failures

Hyongju Park[1], Seth Hutchinson[1],
[1]Beckman Institute, University of Illinois at Urbana-Champaign

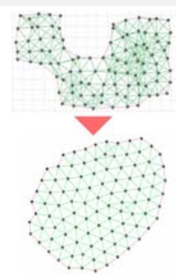


- We present a distributed rendezvous algorithm resilient to random node failures
- We formulate our problem as 1-step sequential optimal control
- We show via simulation results that our proposed algorithm provides better rendezvous performance in cases for which failures occur

14:52–14:55	MoC3.16

Distributed Cohesive Configuration Control for Swarm Robots with Boundary Information and Network Sensing

Seoung Kyou Lee and James McLurkin,
Rice University

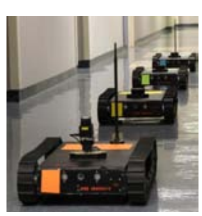


- Aim to achieve flock formation and heading consensus while maintaining connectivity
- Combine boundary force algorithm and clump remover to form convex boundary and dense network
- Propose network sensing and mode switching to maintain connectivity from initially vulnerable network

14:55–14:58	MoC3.17

Decentralized and Complete Multi-Robot Motion Planning in Confined Spaces

Adam Wiktor[1], Dexter Scobee[1],
Sean Messenger[2] and Christopher Clark[2]
[1]Princeton University [2]Harvey Mudd College



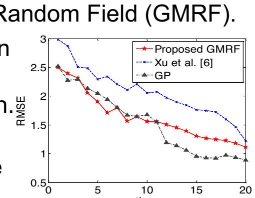
- Tree-based Multi Robot Motion Planning
- Decentralized
- Complete
- Validated in simulations and multi-robot experiments

14:58–15:01	MoC3.18

Mobile Robotic Wireless Sensor Networks for Efficient Spatial Prediction

Linh V. Nguyen[1], Sarath Kodagoda[1],
Ravindra Ranasinghe[1] and Gamini Dissanayake[1]
[1]University of Technology, Sydney, Australia

- A network of mobile, wireless and noisy sensors is utilized to monitor physical spatial phenomenon that is modelled by Gaussian Markov Random Field (GMRF).
- Due to the sparsity of a precision matrix, GMRF gains remarkable benefits in real-time computation.
- Linearly-computed and novel optimal criterion for the adaptive sampling strategy is proposed.



Bioinspired Robots II / Distributed Robotics

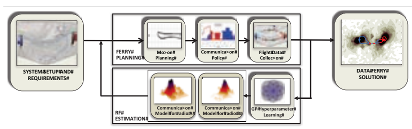
Chair *M. Ani Hsieh, Drexel University*
Co-Chair

15:01–15:04 MoC3.19

Improving Data Ferrying by Iteratively Learning the RF Environment

Anthony J. Carfang[1], Neeti Wagle[1], and Eric W. Frew[1]
[1]University of Colorado Boulder

- Using a GP, opportunistically learn the radio frequency environment while data-ferrying with UA.
- After 9 iterations, effective throughput improves from 30% to 93% of optimal, leading to better ferry paths.

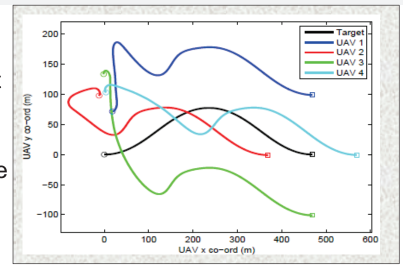


15:04–15:07 MoC3.20

A Cooperative Formation Control Strategy Maintaining Connectivity

Rajdeep Dutta[1], Liang Sun[1], M K[2], R S[3] and Daniel Pack[1]
[1]U T S A [2]IIT K [3]U S U

- A team of 4 UAVs making formation around one target
- The network connectivity changes over time depending on the agents dynamics

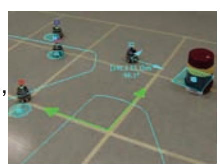


15:07–15:10 MoC3.21

Interactive AR for understanding and analyzing multi-robot systems

F. Ghiringhelli[1], J. Guzzi[2], G.A. Di Caro[2], V. Caglioti[1], L.M. Gambardella[2], and A. Giusti[2]
[1]Politecnico Milano [2]IDSIA USI/SUPSI Lugano

- Localizes, identifies and tracks ground robots in the scene
- Augments the camera view with live information exposed by robots, such as textual message and spatially situated data
- Provides simple tools to customize the AR view



Tuesday September 16

Haptics / Surgical Robotics I

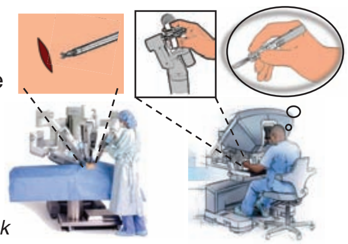
Chair *Jing Xiao, UNC-Charlotte*
Co-Chair

15:20–15:40 MoD1.1

Keynote: Haptics in Robot-Assisted Surgery

Allison Okamura, Stanford University

- Haptic feedback in robot-assisted surgery presents challenges in sensing, actuation, control, and operating room compatibility.
- This talk will describe recent research results and future directions.



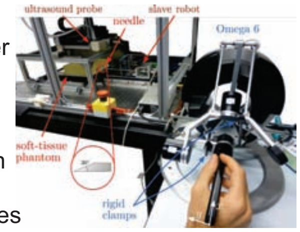
Images courtesy of Intuitive Surgical and Zhan Fan Quek

15:40–15:43 MoD1.2

Steering of Flexible Needles Combining Kinesthetic and Vibratory Force Feedback

Claudio Pacchierotti[1,2], Momen Abayazid[3], Sarthak Misra[3] and Domenico Prattichizzo[1,2]
[1]University of Siena [2]Istituto Italiano di Tecnologia
[3]University of Twente

- We present a teleoperated robotic system able to steer flexible needles.
- The system computes needle's ideal position and orientation to reach a given target.
- The haptic interface provides kinesthetic-vibratory navigation cues to the clinician.

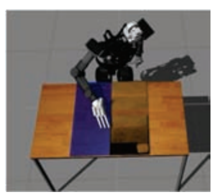


15:43–15:46 MoD1.3

Touch attention Bayesian models for robotic active haptic exploration

Ricardo Martins[1], João Filipe Ferreira[1]
Jorge Dias[1,2]
[1]University of Coimbra [2]Khalifa University

- Active haptic exploration of surfaces using robotic hands.
- Capability to deal with uncertainty and sensory noise (environments with an unknown structure).
- Haptic exploration strategy with generalization capability (different configurations of the surfaces).

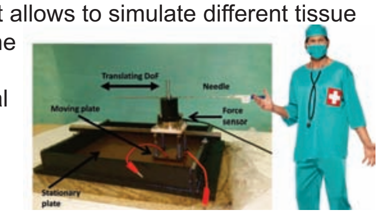


15:46–15:49 MoD1.4

Design and evaluation of a 1DoF ERF-based Needle Insertion Haptic Platform

A. G. Sánchez, A. Sanchez, N. Zemiti, P. Poignet,
LIRMM, Univ. Montpellier 2 - CNRS

- A passive 1 DoF needle insertion haptic interface based on Electro-Rheological Fluid (ERF) brakes,
- Force controller that allows to simulate different tissue behaviors against the needle movement
- Very low mechanical impedance

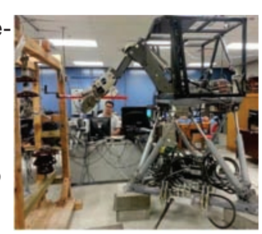


15:49–15:52 MoD1.5

Haptic-Enabled Teleoperation for Live-Line Maintenance

Vikram Banthia, Yaser Maddahi,
Subramaniam Balakrishnan and Nariman Sepehri
University of Mantioba

- This paper investigates haptic-enabled teleoperation of a base-excited hydraulic manipulator working under a wireless communication channel.
- Results indicate that adding a speed regulating haptic force to the system helps linemen function more effectively.

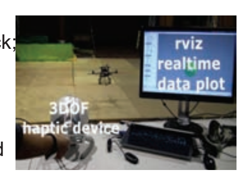


15:52–15:55 MoD1.6

A Mixed-Initiative Control System for an Aerial Service Vehicle supported by force feedback

Jonathan Cacace[1], Alberto Finzi[1],
Vincenzo Lippiello[1]
[1]University of Naples "Federico II"

- Mixed initiative control system for UAVs combining continuous mixed initiative planning/replanning and haptic feedback;
- The force feedback gives an intuitive feeling of the robot deviation from the generated path avoiding replanning;
- The approach is assessed in virtual and real environments considering simple navigation tasks to be achieved in a mixed initiative control mode.



Haptics / Surgical Robotics I

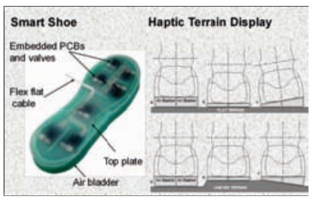
Chair *Jing Xiao, UNC-Charlotte*
Co-Chair

15:55–15:58 MoD1.7

Design of a Bladder Based Elastomeric Smart Shoe for Haptic Terrain Display

Yue Wang, Mark A. Minor
University of Utah

- Introducing an innovative haptic terrain display footwear;
- Capable of rendering slopes and subtle features;
- Passive air bladder;
- Fabricated with silicone rubber and embedded mechatronics;
- Used in VR and potentially used as a rehab device.

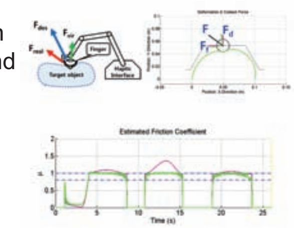


15:58–16:01 MoD1.8

Contact Force Decomposition Using Tactile Information for Haptic Augmented Reality

Hyoungkyun Kim[1], Seungmoon Choi[1] and Wan Kyun Chung[1] [1]POSTECH

- Decomposing contact force into deformation and friction force using contact force and pressure for haptic AR
- Simulation result showed remarkable performance of proposed decomposition method



16:01–16:04 MoD1.9

ROBOPuppet: 3D Printed Miniatures for Teleoperating Full-Size Robots

Anna Eilering, Giulia Franchi, and Kris Hauser
School of Informatics and Computing, Indiana University

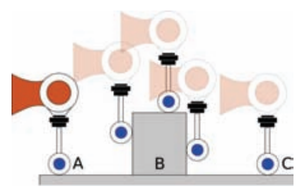
- Table-top teleoperation devices that require near-zero training
- One-to-one mapping facilitates kinesthetic learning
- Uses 3D printing, inexpensive components and free software
- Cost < $100
- Plans freely available

16:04–16:07 MoD1.10

Haptic Exploration of Unknown Surfaces with Discontinuities

Rodrigo S. Jamisola Jr., Petar Kormushev, Antonio Bicchi, and Darwin G. Caldwell
Italian Institute of Technology

- Builds information map of unknown objects
- Surfaces with sharp turns and abrupt dips
- Superposition of motion and force control
- Rotation of control axes for force and motion control
- Implemented on KUKA LWR 7-DOF robot

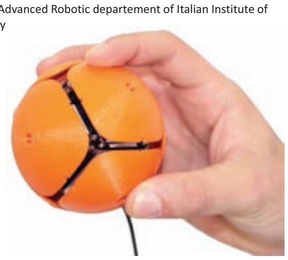


16:07–16:10 MoD1.11

The Patched Intrinsic Tactile Object: a Tool to Investigate Human Grasps

Alessandro Serio, Emanuele Riccomini,Vincenzo Tartaglia, Ioannis Sarakoglou, Marco Gabiccini, Nikos Tsagarakis and Antonio Bicchi
Reasearch Center "E. Piaggio", University of Pisa, & ADVR IIT, Advanced Robotic departement of Italian Institute of Technology

- The Patched Intrinsic Tactile Object is a sensorized object capable of multi-touch detection. The sensor is composed of six 6-axis F/T sensors spatially organized on the faces of a cube. Thanks to the modular design and the possibility to cover the sensitive faces with surface patches a variety of sensorized objects with different shapes can be realized.
- This work addresses the problem of calibrating the multi-DoF F/T sensor, evaluate its performances, and present results from trials of multi-fingered human grasps.



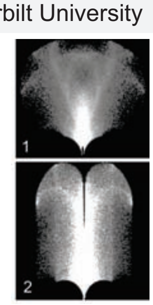
The Patched Intrinsic Tactile Object

16:10–16:13 MoD1.12

Workspace Characterization for Concentric Tube Continuum Robots

J. Burgner[1], H. B. Gilbert[2], J. Granna[1], P. J. Swaney[2] and R. J. Webster III[2]
[1]Leibniz University Hannover [2]Vanderbilt University

- Compute and characterize workspace
- Monte Carlo random samples of configuration space
- Discrete volumetric representation for
  - Reachability
  - Redundancy
- Experimental evaluation on 2 physical robot prototypes



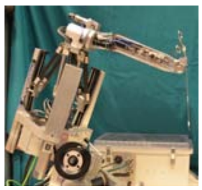
Haptics / Surgical Robotics I

Chair *Jing Xiao, UNC-Charlotte*
Co-Chair

16:13–16:16 MoD1.13

Preliminary Evaluation of a New Microsurgical Robotic System for Head and Neck Surgery

K. Olds[1], P. Chalasani[1], P. Pacheco-Lopez M.D.[2], I. Iordachita[1], L. M. Akst M.D.[2], R. H. Taylor[1]
[1]Johns Hopkins University [2]Johns Hopkins Hospital

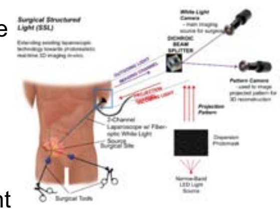


- Robotic Ear Nose and Throat Microsurgery System (REMS)
- Precision needle insertion evaluation modeling microlaryngeal phonosurgery
- REMS improves performance over manual operation ($p<0.01$)
- Preliminary technical evaluation

16:16–16:19 MoD1.14

Surgical Structured Light for 3D Minimally Invasive Surgical Imaging

Austin Reiter, Alexandros Sigaras, Dennis Fowler and Peter K. Allen
Columbia University



Uses standard laparoscopes
Builds 3D model of surgical site
Structured Light pattern is invisible to the surgeon
User Interface allows 3D & 2D side-by-side visualizations
System provides metrology, allowing precise measurement of anatomy in-vivo

16:19–16:22 MoD1.15

Cooperative Teleoperation with Projection-Based Force Reflection for MIS

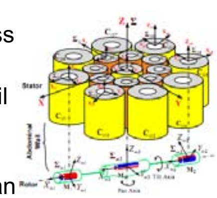
Amir Takhmar, Ilia G. Polushin, Ali Talasaz, Rajni V. Patel
Western University

- This work studies the effect of a special type of force reflection algorithms, called projection-based force reflection, on the stability and performance of a dual-arm haptics-enabled teleoperation system for minimally-invasive surgical applications.

16:22–16:25 MoD1.16

Design of A Unified Active Locomotion Mechanism for A Wireless Laparoscopic Camera System

Xiaolong Liu[1], Gregory Mancini[2], Jindong Tan[1]
[1]UTK, Department of BME
[2]UTK, Departmetn of Surgery



- This paper proposes an active locomotion mechanism for a wireless laparoscopic camera.
- The mechanism consists of a 17 coil stator and a rotor with 3 permanent magnets.
- The design achieves 360 degree pan motion and 127~164 degree tilt motion.

16:25–16:28 MoD1.17

Toward Automated Intraocular Laser Surgery Using a Handheld Micromanipulator

Sungwook Yang, Robert A, MacLachlan, and Cameron N. Riviere
Carnegie Mellon University

- Micron enables the automated scanning of a laser probe.
- Visual servoing of an aiming beam with virtual-fixture and tracking eye movement by EyeSLAM.
- Reduces the average error and execution time by 63.6% and 28.5%, respectively, compared to the unaided trials.

16:28–16:31 MoD1.18

Quasi-Static Modeling of the da Vinci Instrument

Farshad Anooshahpour, Ilia G. Polushin, Rajni V. Patel
Western University, London, Ontario, Canada

- Two simplified quasi-static models for the da Vinci instrument are proposed which take into account distributed frictions and compliance of the tendons
- The key parameters of the models are identified, and the performance of the models is experimentally evaluated.

Haptics / Surgical Robotics I

Chair *Jing Xiao, UNC-Charlotte*
Co-Chair

16:31–16:34	MoD1.19

Design and Evaluation of a Novel Flexible Robot for Transluminal and Endoluminal Surgery

Carlo A. Seneci[1], Jianzhong Shang[1], Konrad Leibrandt[1], Valentina Vitiello[1], Nisha Patel[1], Ara Darzi[1], Julian Teare[1] and Guang-Zhong Yang[1], [1]Imperial College London

- Snake-like robot for endoluminal and transluminal surgeries
- KUKA LWR for insertion
- High dexterity, flexibility and stability
- Intuitive control algorithms
- Precise and repetitive positioning
- Experiment simulating transoral gastric procedure

16:34–16:37	MoD1.20

Design of a Spine-Inspired Kinematic for the Guidance of Flexible Instruments in MIS

Mattias F. Traeger, Daniel B. Roppenecker, Matthias R. Leininger, Florian Schnoes and Tim C. Lueth
MIMED, TU München, Germany

- Laser sintered robotic system for endoscopic surgery
- Constant Curvature Model and Workspace Simulation
- Actuation concept
- Triangulation and force application tests

prototype for endoscopic interventions with the spine-inspired kinematic structure actuated with push rods

16:37–16:40	MoD1.21

Hybrid Control of Master-slave Control and Admittance Control for Safe Remote Surgery

Takayuki Osa[1], Satoshi Uchida[1], Naohiko Sugita[1] and Mamoru Mitsuishi[1]
[1]The University of Tokyo

- The system autonomously avoids the excessive contact force by switching master-slave control and admittance control.
- Contact force between a surgical instrument and an object was limited within an acceptable range in a stable manner

Human-Robot Interaction I / Robot Learning II

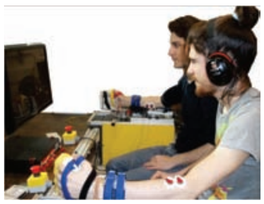
Chair *Alessandro De Luca, Sapienza University of Rome*
Co-Chair

15:20–15:40 MoD2.1

Keynote: Overview of Motor Interaction with Robots and Other Humans

Etienne Burdet
Imperial College London, UK

- Motor learning: in humans, for robot
- A framework to analyze and design interactive control between humans and robots
- Sensory mechanism of motor interactions between humans



15:40–15:43 MoD2.2

A peer pressure experiment: Recreation of Asch conformity study with robots

J. Brandstetter,[1], P. Racz[2], C. Beckner[2], E. Sandoval[1], J. Hay[2], and C. Bartneck[1].
[1]HITLabNZ [2]NZILBB

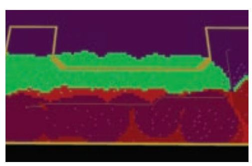
- Question: Can robot peers create conformity via group pressure (Asch 1951)?
- Tasks: Visual vs. verbal, ambiguous vs. nonambiguous.
- In contrast with human peers, robot peers did not prompt conformity in any task.

15:43–15:46 MoD2.3

IRL Algorithms and Features for Robot Navigation in Crowds

Dizan Vasquez[1,2], Billy Okal[1]
and Kai O. Arras[1]
[1]University of Freiburg, [2]Inria Grenoble

- IRL algorithm and feature comparison.
- Objective/subjective evaluation metrics.
- Open experimental platform:
  - Simulator (PedSim).
  - Algorithms.
  - Features.



15:46–15:49 MoD2.4

Extraction of Person-specific Motion Style based on a Task Model and Imitation by Humanoid Robot

T. Okamoto[1], T. Shiratori[2], M. Glisson[3], K. Yamane[3], S. Kudoh[4], and K. Ikeuchi[1]
[1] Institute of Industrial Science, The University of Tokyo, Japan
[2] Microsoft Research Asia, Microsoft Corporation, China
[3] Disney Research, Pittsburgh, US
[4] The University of Electro-Communications, Japan

- We present a humanoid robot which extracts and imitates the person-specific differences in motions, which we will call *style*.
- We formulated the representation of styles in the context of a learning from observation (LFO) paradigm , and then introduced a framework of generating robot motions that reflect styles which are automatically extracted from human demonstrations.
- To verify our proposed method we applied it to a ring toss game, and generated robot motions for a physical humanoid robot.

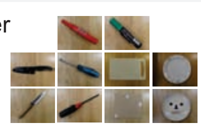
An example of person-specific styles in ring toss motions.

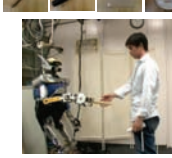
15:49–15:52 MoD2.5

Determining Proper Grasp Configurations for Handovers

Wesley P. Chan, Yohei Kakiuchi,
Kei Okada, and Masayuki Inaba
University of Tokyo

- Grasp configuration affects handover safety, efficiency, and comfort.
- Proper grasp configuration depends on object affordances.
- Learn affordances of everyday objects from usage demonstrations.
- Generalize known handover grasp configurations for new objects based on recognized affordances.





15:52–15:55 MoD2.6

Using Spatial Language to Drive a Robot for an Indoor Environment Fetch Task

Zhiyu Huo, Tatiana Alexenko,
and Marjorie Skubic
University of Missouri Columbia

- Using natural language to navigate a robot for a object fetch task in an indoor environment.
- Spatial language grounding model and robot behavior model proposed.
- Simulation Physical indoor environment experiment were performed.

Human-Robot Interaction I / Robot Learning II

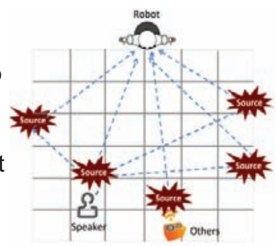
Chair *Alessandro De Luca, Sapienza University of Rome*
Co-Chair

15:55–15:58 MoD2.7

Speech-based Human-Robot Interaction Robust to Acoustic Reflections in Real Environment

Randy Gomez[1], Koji Inoue[2], Keisuke Nakamura[1], Takeshi Mizumoto[1] and Kazuhiro Nakadai[1]
[1]Honda Research Institute Japan [2]Kyoto University

- Human-robot interaction
- Sound source localization based using video and audio modalities
- Experimental evaluation in real reverberant environment conditions
- Robustness to acoustic reflection

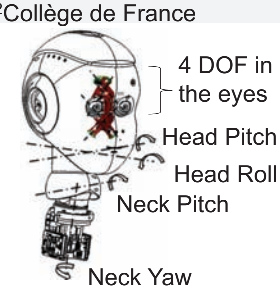


15:58–16:01 MoD2.8

Head-eyes system and gaze analysis of the humanoid robot Romeo

N.Pateromichelakis[1], A.Mazel[1], M.A.Hache[1], T.Koumpogiannis[1], R.Gelin[1], B.Maisonnier[1] and A.Berthoz[2]
[1]Aldebaran Robotics [2]Collège de France

- Robotic head with 4 DOF
- Eyes mechanism with 4 DOF
- Human-like gaze speed



16:01–16:04 MoD2.9

Development of a Rehabilitation Robot Suit with Velocity and Torque-based Mechanical Safety Devices

Y. Kai[1], S. Kitaguchi[1], S. Kanno[1], W. Zhang[2], and M. Tomizuka[2]
[1]Tokai University [2]UC Berkeley

- In this paper, we develop **a rehabilitation robot suit with mechanical safety devices** to guarantee safety **even when the computer fails** to operate functionally.
- The safety devices consist of **only passive components** without actuators, controllers, or batteries.

Robot Suit

16:04–16:07 MoD2.10

Modeling and Controller Design of Cooperative Robots in Human-Robot Assembly Teams

Changliu Liu[1], Masayoshi Tomizuka[1],
[1]University of California, Berkeley

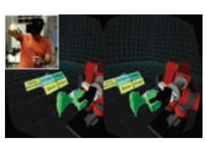
Human workers and robots are two major workforces in modern factories, which are normally separated. It is promising if we can combine human's flexibility and robot's productivity in manufacturing. We investigates the modeling and controller design method in human-robot assembly teams. An integrated method concerning online learning of human behavior and receding horizon control in a safe set is proposed. Simulation results confirm the safety and efficiency of the algorithm.

16:07–16:10 MoD2.11

Adjutant: A Framework for Flexible Human-Machine Collaborative Systems

Kelleher Guerin and Gregory D. Hager
Department of Computer Science, Johns Hopkins University, USA
Jonathan Bohren
Department of Mechanical Engineering, Johns Hopkins University, USA
Sebastian Riedel
Dept. of Informatics, Technische Universitat Munchen, Germany

- Adjutant addresses the problem of reusable task information in the context of human robot collaboration
- Adjutant introduces robot *capabilities* - reusable actions that can be generalized to novel tasks.
- Capabilities are then mapped to specific user interfaces to fully enable task execution
- We demonstrate Adjutant on two real world industrial manufacturing tasks



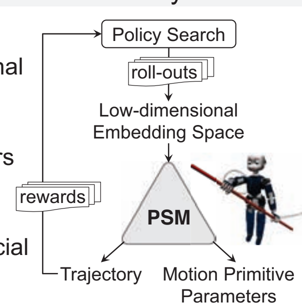
Instructing a robot capability in Virtual Reality

16:10–16:13 MoD2.12

Efficient Policy Search with a Parameterized Skill Memory (PSM)

Felix Reinhart and Jochen Steil
CoR-Lab, Bielefeld University

- PSMs organize motion primitives in low-dimensional embedding spaces
- PSMs link embeddings to motion primitive parameters and complete trajectories
- Low-dimensional skill parameterization is beneficial for efficient policy search



Human-Robot Interaction I / Robot Learning II

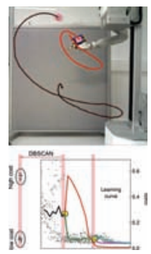
Chair *Alessandro De Luca, Sapienza University of Rome*
Co-Chair

16:13–16:16 MoD2.13

Simultaneous On-line Discovery and Improvement of Robotic Skill Options

Freek Stulp[12], Laura Herlant[3],
Antoine Hoarau[12], and Gennaro Raiola[1]
[1]ENSTA-ParisTech [2]INRIA [3]CMU

- Key idea: Learn skill options for task variations autonomously and on-line
- Cluster costs in learning curves, and make new skill options for variations
- Optimize all skill options in parallel with policy improvement
- Evaluation in simulation and on Meka humanoid with ball-in-cup task

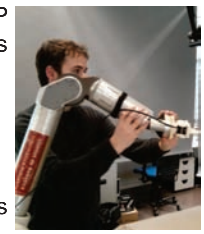


16:16–16:19 MoD2.14

Dimensionality Reduction and Motion Coordination in Learning with Dynamic Movement Primitives

Adrià Colomé[1] and Carme Torras[1],
[1]Inst. de Robòtica i Inf. Ind., CSIC-UPC, Spain

- Reinforcement Learning with DMP may involve too many parameters and DoF to be of practical use.
- We propose **3 speed-up strategies:**
  - detect unnecessary parameters
  - establish layers of parameters
  - automatically find couplings between joints



16:19–16:22 MoD2.15

OrigamiBot-I: A Thread-Actuated Origami Robot for Manipulation and Locomotion

Evan Vander Hoff, Donghwa Jeong, and Kiju Lee
Department of Mechanical and Aerospace Engineering,
Case Western Reserve University, USA

- The **OrigamiBot-I** is developed based on an origami design called "twisted tower"
- The kinematics for each twisting and bending motions is derived based on estimated parameters.
- Stiffness and durability tests are performed to validate the paper-based structure as a robotic manipulator and worm-like crawling robot.
- Physical demonstrations such as robotic manipulation and locomotion are provided.

16:22–16:25 MoD2.16

Decoding sEMG into dynamic state to extract dynamic motor control strategy

Seongsik Park[1], Wan Kyun Chung[1]
[1]POSTECH

- Propose a method of decoding sEMG into the dynamic state to extract dynamic motor control strategy
- Dynamic state established in the augmented space characterizes the dynamic motor control of human
- Decoding result only from sEMG showed each dynamic motion consisting of 2~4 states temporally
- Also, it can distinguish the difference of the temporal patterns of the state according to its speed of motion

16:25–16:28 MoD2.17

Latent Space Policy Search for Robotics

Kevin Sebastian Luck[1], Gerhard Neumann[1],
Erik Berger[2], Jan Peters[1] and Heni Ben Amor[3]
[1]TU Darmstadt [2]TU Freiberg [3]Georgia Tech

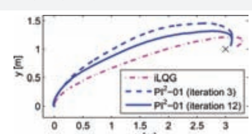
- PePPEr is a novel algorithm for policy search in low-dimensional latent spaces
- Merges dimensionality reduction and reinforcement learning
- Experiments were done with a NAO robot that learned to stand on one leg

16:28–16:31 MoD2.18

Learning of Closed-Loop Motion Control

Farbod Farshidian[1], Michael Neunert[1]
and Jonas Buchli[1]
[1]ETH Zurich, Switzerland

- Simultaneous derivation of reference trajectory and controller
- Two-step design process:
  1) Model-based approach leverages system model knowledge
  2) Reinforcement learning method refines controller based on samples derived from real system



Human-Robot Interaction I / Robot Learning II

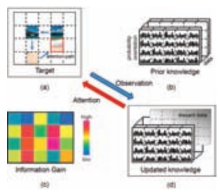
Chair *Alessandro De Luca, Sapienza University of Rome*
Co-Chair

16:31–16:34 MoD2.19

Unsupervised Learning Approach to Attention-Path Planning for Large-scale Environment Classification

Hosun Lee[1], Sungmoon Jeong[1] and Nak Young Chong[1]
[1]Japan Advanced Institute of Science and Technology

- Visual attention planning for unknown area classification.
- Unsupervised sequential feature selection to recursively plan the fixation and update the prior knowledge
- A near-optimal solution to the classification with adaptive submodular optimization
- Demonstrated the effectiveness of the proposed framework through large area classification under small field-of-view conditions



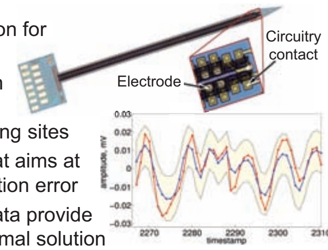
Attention-Path Planning

16:34–16:37 MoD2.20

Automatic Channel Selection and Neural Signal Estimation across Channels of Neural Probes

Olga Vysotska[1,2], Barbara Frank[1], Istvan Ulbert[3], Oliver Paul[1], Patrick Ruther[1], Cyrill Stachniss[2], Wolfram Burgard[1]
[1]University of Freiburg [2]University of Bonn [3]University of Budapest

- Autonomous channel selection for high-resolution microprobes
- Gaussian process regression for predicting neural signals based on recorded neighboring sites
- Greedy channel selection that aims at minimizing the overall prediction error
- Evaluations on real neural data provide accurate results close to optimal solution



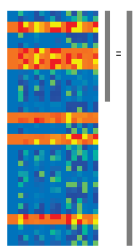
Predicted neural signal

16:37–16:40 MoD2.21

Fast Planning of Well Conditioned Trajectories for Model Learning

Cong Wang, Yu Zhao,
Chung-Yen Lin, and Masayoshi Tomizuka
University of California, Berkeley

- An efficient procedure to generate well conditioned data for model learning in the feature space
- Using low-discrepancy sequences and matrix subset selection
- Can be applied to various problems with little ad hoc formulation
- Does not require an initial design



Formal Methods / Software and Architecture

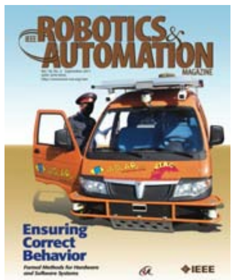
Chair *Jana Tumova, Royal Institute of Technology*
Co-Chair

15:20–15:40 MoD3.1

Keynote: Formal methods in robotics

George J. Pappas
University of Pennsylvania

- Formal task description logics for DARPA Challenge like missions
- **Provable translation of high level symbolic tasks to low level real-time control**
- Powerful computational tools for plan generation and controller compositions

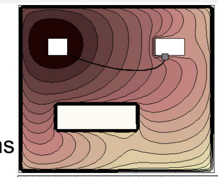


15:40–15:43 MoD3.2

A Compositional Approach to Stochastic Optimal Control with Co-safe Temporal Logic Specifications

Matanya B. Horowitz, Eric M. Wolff, Richard M. Murray
California Institute of Technology

- Solve temporal logic planning problems using stochastic optimal control methods
- Complex tasks solved by efficient composition of reachability problems
- Linear Hamilton-Jacobi-Bellman equation allows for composition via superposition



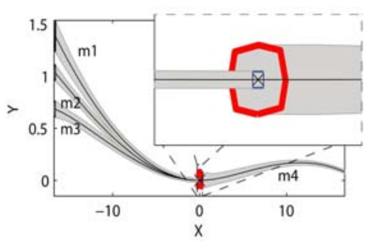
Temporal solutions via composition

15:43–15:46 MoD3.3

Formal Verification of Maneuver Automata for Parameterized Motion Primitives

Daniel Heß[1], Matthias Althoff[2], Thomas Sattel[1]
[1]TU Ilmenau, Germany [2]TU München, Germany

- Formal verification of planned motions using reachability analysis
- Computations are mostly performed offline, resulting in a fast online approach

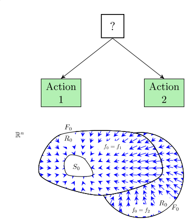


15:46–15:49 MoD3.4

How Behavior Trees Modularize Robustness and Safety in Hybrid Systems

Michele Colledanchise and Petter Ögren
KTH -The Royal Institute of Technology

- Behavior Trees (BTs) make hybrid systems modular.
- We study safety and robustness of BT module compositions.



15:49–15:52 MoD3.5

Verification and testing of mobile robot navigation algorithms with SPARK

Piotr Trojanek, Kerstin Eder
University of Bristol

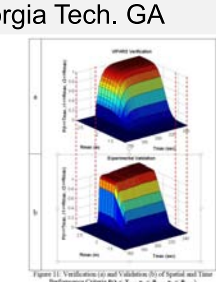
- Three open-source implementations of navigation algorithms translated from C/C++ to SPARK – a formally defined programming language
- Code annotated with pre- and postconditions
- Bugs automatically detected by run-time checks
- Run-time safety can be proven automatically
- **Conclusion**: SPARK is as fast as C/C++ and is much easier to test and verify

15:52–15:55 MoD3.6

Verifying and Validating Multirobot Missions

Damian Lyons[1], Ronald Arkin[2], Shu Jiang[2], Dagan Harrington[1] & Tsung-Ming Liu[1]
[1]Fordham Univ. NY, [2]Georgia Tech. GA

- Formal process algebra method to verify performance guarantees for autonomous, behavior-based multirobot mission software.
- Predicted results successfully validated in multiple trials of bounding overwatch mission with a range of performance criteria values.



Formal Methods / Software and Architecture

Chair *Jana Tumova, Royal Institute of Technology*
Co-Chair

15:55–15:58	MoD3.7

Maximally Satisfying LTL Action Planning

Jana Tumova, Alejandro Marzinotto, Dimos V. Dimarogonas and Danica Kragic
Royal Institute of Technology (KTH)

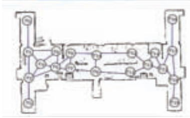
- **Problem:** Planning under linear temporal logic task with reactivity to the task infeasibility caused by the robot's action execution failures
- **Solution:** Maximally satisfying plan synthesis and its implementation through a behavior tree
- **Experiments**: NAO humanoid

15:58–16:01	MoD3.8

Optimal and Dynamic Planning for MDPs with Co-Safe LTL Specifications

Bruno Lacerda, David Parker and Nick Hawes
School of Computer Science
University of Birmingham, United Kingdom

- Generation of cost-optimal policies for MDPs, with goals stated in co-safe LTL
- Re-planning mechanism allows for addition of tasks during execution
- Application example to motion planning of a mobile service robot

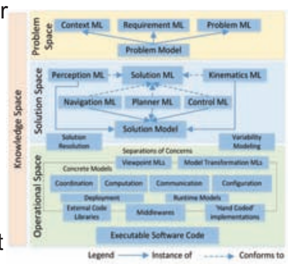


16:01–16:04	MoD3.9

SafeRobots: A Model-Driven Framework for Developing Robotic Systems

Arunkumar Ramaswamy[12], Bruno Monsuez[1], and Adriana Tapus[1]
[1]ENSTA-ParisTech, [2]Vedecom Institute, France

- The core concepts behind our framework: Self Adaptive Framework for Robotic Systems (SafeRobots) is presented
- System integration and knowledge representation issues that are common in robotic software development are addressed.

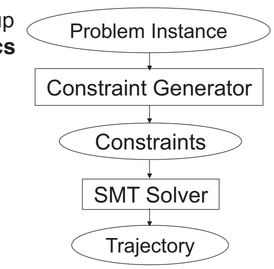


16:04–16:07	MoD3.10

Automated Composition of Motion Primitives for Multi-Robot Systems from Safe LTL Specifications

I. Saha[1,2], R. Ramaithitima[2], V. Kumar[2], G. J. Pappas[2], S. A. Seshia[1]
[1]UC Berkeley, [2]UPenn

- Path planning problem for a group of robots with **complex dynamics** and **complex specification**
- Reduced to an **SMT solving problem**
- Decision variables represent the motion primitives
- Optimal trajectories for 4 UAVs found in a few minutes

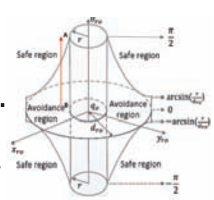


16:07–16:10	MoD3.11

A Stable Switched-System Approach to Obstacle Avoidance for Mobile Robots in SE(2)

Jingfu Jin and Nicholas Gans
The University of Texas at Dallas, USA

- We divide the configuration space into two sub-regions on SE(2).
- The switching signal is based on the robot position **and orientation.**
- Two switching signals are proposed to investigate chattering.
- Lyapunov analysis proves the robot will converge to goal pose.
- Multiple simulations and experiments are conducted



The avoidance region, which depends on the distance and the relative angle between a robot and an obstacle.

16:10–16:13	MoD3.12

eTaSL/eTC: A constraint-based Task Specif. Language and Robot Controller

Erwin Aertbeliën[1], Joris De Schutter[1]
[1] KU Leuven – Dep. Of Mech. Eng.

- A language (**eTaSL**) for constraint-based task specification of robot **controllers**.
- Flexible and composable, using:
  - Using **expression graphs**
  - Using **feature variables**
- Controller implementation (**eTC**) that realizes specifications written in eTaSL.
- Demonstrated with **bi-manual task** on PR2.

Formal Methods / Software and Architecture

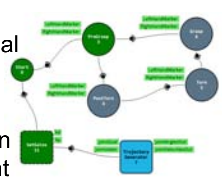
Chair *Jana Tumova, Royal Institute of Technology*
Co-Chair

16:13–16:16 MoD3.13

Robot Task Commander

S. Hart[1], P. Dinh[2],
J.D. Yamokoski[3], B. Wightman[2], and N. Radford[4]
[1]G.M. [2]IHMC [3]Oceaneering [4]NASA-JSC

- A novel framework & IDE for robot application development
- Integrates distributed computational nodes & control FSMs
- Usable by experts & non-experts
- Facilitates hierarchical composition & re-use of applications to different robots and different contexts

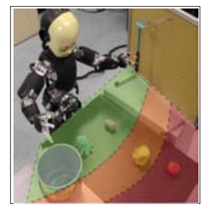


16:16–16:19 MoD3.14

Enhancing software module reusability using port plug-ins (an experiment with the iCub robot)

Ali Paikan[1], Vadim Tikhanoff[1], Giorgio Metta[1]
and Lorenzo Natale[1]
[1]Istituto Italiano di Tecnologia (IIT)

- Application–dependent functionalities are implemented using a scripting language and plugged into the ports of components.
- Port monitoring, data filtering and arbitration
- Promoting simpler and more reusable components



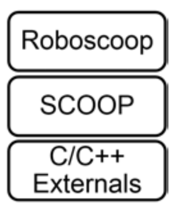
16:19–16:22 MoD3.15

Simple Concurrency for Robotics with the Roboscoop Framework

Andrey Rusakov, Jiwon Shin, Bertrand Meyer
Chair of Software Engineering
ETH Zürich, Switzerland

Roboscoop: concurrent robotics framework:

- Robotics library
- Easy creation and coordination of robotic tasks
- Simple and safe concurrency
- Easy translation of behaviors into code
- Support for external libraries and frameworks

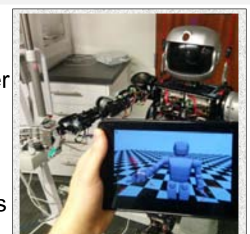


16:22–16:25 MoD3.16

A lightweight, cross-platform, multiuser robot visualization using the cloud

William Hilton[1], Daniel M. Lofaro[2]
and Youngmoo Kim[1]
[1]Drexel University [2]George Mason University

- Cloud based robot monitoring
- Runs through a standard browser
- No third-party software required
- Supported/Tested Systems:
  Mobile - Android and iOS;
  Computer - Mac, Linux, Windows
  Cloud - Public and Private


Monitor in Browser

16:25–16:28 MoD3.17

RrFrESH: A Self-Adaptation Framework to Support Fault Tolerance in Robots

Yanzhe Cui[1], Richard Voyles[1],
Joshua Lane[1] and Mohammad Mahoor[2]
[1]Purdue University [2]University of Denver

- Provision of fault detection and mitigation infrastructure support;
- Built into the Port-Based Object real time operating system;
- Management of task performance in the presence of unexpected uncertainties;
- Provision of self-adaptation support for software and hardware functionality.

16:28–16:31 MoD3.18

Speeding Up Rao-Blackwellized Particle Filter SLAM with a Multithreaded Architecture

Bruno D. Gouveia, David Portugal and Lino Marques
Insitute of Systems and Robotics, University of Coimbra, Portugal

- Explore multiprocessor computer architectures to solve the SLAM problem.
- Multithreading was used to parallelize a Rao-Blackwellized Particle Filter (RBPF) approach.
- Gain in efficiency enables to raise the number of particles, yielding higher localization precision and map accuracy.
- Frequently used datasets in the Robotics community validate our results.

Formal Methods / Software and Architecture

Chair *Jana Tumova, Royal Institute of Technology*
Co-Chair

16:31–16:34	MoD3.19

Developing Virtual Testbeds for Intelligent Robot Manipulators

Eric G. Kaigom, Jürgen Roßmann
RWTH-Aachen University,
Institute for Man-Machine-Interaction

- **eRobotics** lays the foundation for
  - cross-cutting, versatile multi-body systems simulation and control
  - holistic 3D simulation of robots endowed with compliance control
  - in-depth assessment of robots down to actuation
  - control by 3D simulation

Simulation of an interaction maneuver

16:34–16:37	MoD3.20

Crowdsourcing as a methodology to obtain large and varied robotic data sets

Guido de Croon[1,2], Paul K. Gerke[1,3], and Ida Sprinkhuizen-Kuyper[3]
[1]European Space Agency [2]TU Delft [3]RUN

- First scientific crowdsourcing experiment involving real robots. See: http://www.astrodrone.org/

Manipulation and Grasping III / Parallel Robotics

Chair *Eugenio Guglielmelli, Universita' Campus Bio-Medico*
Co-Chair

09:00–09:20 TuA1.1

Keynote: Grasping and Manipulation by Humans and by Robots

Oliver Brock
Technische Universität Berlin

- The manipulation performance of robots is nowhere near that of humans
- A comparison of human and robot manipulation reveals important and fundamental differences
- These differences should drive robot hand design, manipulation planning, and perception

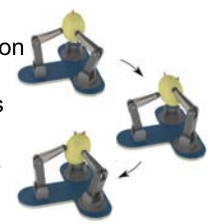
09:20–09:23 TuA1.2

Characterization of the Precision Manipulation Capabilities of Robot Hands via the Continuous Group of Displacements

Nicolas Rojas and Aaron M. Dollar
Yale University

Precision manipulation: *repositioning of a grasped object without breaking or changing contact*

- A method to characterize the precision manipulation capabilities of a robot hand regardless of the particularities of the grasped object is presented
- The approach is general and can be applied to any finger/palm layout or subset of it

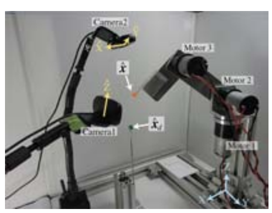


09:23–09:26 TuA1.3

Encoderless Robot Motion Control using Vision Sensor and Back Electromotive Force

Akihiro Kawamura, Miyako Tachibana, Soichiro Yamate, Sadao Kawamura
Ritsumeikan University, JAPAN

- A robotic arm system without encoders that achieve precise motion control is proposed.
- Joint angles are calculated from estimation using back electromotive force of motors.
- The system allows errors on camera and robot calibrations.

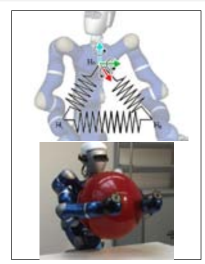


09:26–09:29 TuA1.4

Humanoid compliant whole arm dexterous manipulation: Control design and experiments

M. Florek-Jasinska[1,2], T. Wimboeck[2] and Ch. Ott[2]
[1]AGH, Poland [2]Inst. of Rob. and Mech., DLR

- Use structural parts of the body to support the grasp
- impedance controller on object level including contacts on the (passive) robot chest of a two-armed robot system
- Object frame at passive contact
- Dexterous object manipulation

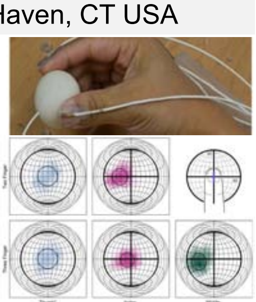


09:29–09:32 TuA1.5

Analyzing Human Fingertip Usage in Dexterous Precision Manipulation: Implications for Robotic Finger Design

Ian M. Bullock[1], Thomas Feix[1], and Aaron M. Dollar[1]
[1]Yale University, New Haven, CT USA

- **Finger surface use** during manipulation rarely studied
- Sphere manipulated in fingertips by 19 participants
- Frequent human **lateral surface use** suggests robotic fingertips which can be used on their sides could enhance robotic manipulation capability

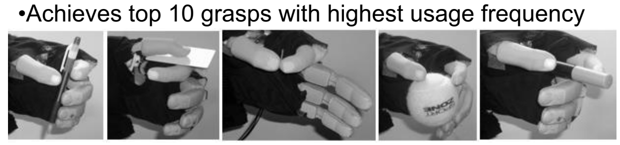


09:32–09:35 TuA1.6

Adaptive Underactuated Anthropomorphic Hand: ISR-SoftHand

Mahmoud Tavakoli,Anibal T. de Almeida
Institute of Systems and Robotics, University of Coimbra, Portugal

•Compliant joints: Adaptive Grasps- Adaptive Synergies
•Tendon based actuation of all fingers- 3 Actuators
•Under 500$ (3D Printed Parts, Actuators, Drivers, etc.)
•Natural Looking
•Achieves top 10 grasps with highest usage frequency



Manipulation and Grasping III / Parallel Robotics

Chair *Eugenio Guglielmelli, Universita' Campus Bio-Medico*
Co-Chair

09:35–09:38 TuA1.7

Coordinated Motion Control of A Nonholonomic Mobile Manipulator for Accurate Motion Tracking

Yunyi Jia, Ning Xi, Yu Cheng and Siyang Liang
Electrical and Computer Engineering Department
Michigan State University, East Lansing, USA

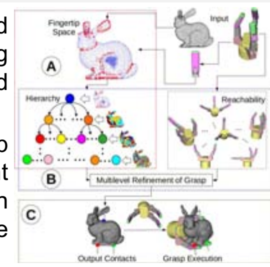
- Accurate motion control of the nonholonomic mobile manipulator by considering the differences between the mobile platform and the manipulator
- Adaptive motion distribution and coordination design between the mobile platform and the manipulator

09:38–09:41 TuA1.8

Hierarchical Fingertip Space for Multi-fingered Precision Grasping

Kaiyu Hang, Johannes A. Stork and Danica Kragic
Centre for Autonomous Systems/CVAP,
KTH Royal Institute of Technology, Sweden

- Fingertip Space: an integrated representation considering both object geometry and fingertip shape.
- A hierarchy of the Fingertip Space for multilevel refinement of grasps allowing for an efficient search of stable grasps.

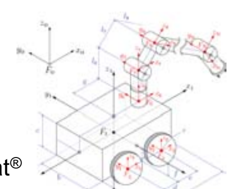


09:41–09:44 TuA1.9

Modeling of Skid-Steer Mobile Manipulator and Experimental Validation

S. Aguilera[1], M. Torres-Torriti[1] and F. Auat[2]
[1]Pontificia Universidad Católica de Chile
[2]Universidad Técnica Federico Santa María

- Skid-Steer mobile manipulator model through spatial vector algebra.
- Arm-vehicle and vehicle-ground dynamic interaction.
- Experimental verification using Cat® 262C compact-skid steer loader.

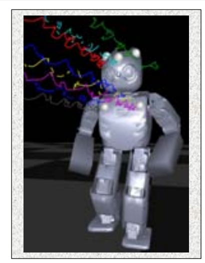


09:44–09:47 TuA1.10

Physically-Consistent Sensor Fusion in Contact-Rich Behaviors

Kendall Lowrey[1], Svetoslav Kolev[1], Yuval Tassa[1], Tom Erez[1], Emanuel Todorov[1]
[1]University of Washington

- Combining fixed-lag smoothing and recursive estimation makes for a computationally expensive but accurate robot state estimator without over-fitting.
- A physics engine makes accelerations and inferred contact forces physically consistent.

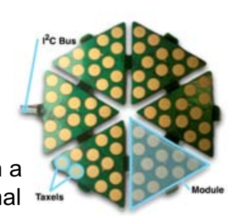


09:47–09:50 TuA1.11

A Real-Time Distributed Architecture for Large-Scale Tactile Sensing

Emanuele Baglini[1], Shahbaz Youssefi[1], Fulvio Mastrogiovanni[1] and Giorgio Cannata[1]
[1]University of Genova, Italy

- A real-time EtherCAT-based networking infrastructure for large scale tactile systems
- Both theoretical and experimental analyses are carried out
- We show real-time performance in a network of distributed computational nodes, each one managing a skin *patch*



09:50–09:53 TuA1.12

A New Extension of DCAL and its Real-Time Application to RA-PKMs

Moussab Bennehar, Ahmed Chemori and François Pierrot
LIRMM, Univ. Montpellier 2 - CNRS, France

- An Extended DCAL controller is developed.
- Static feedback gains in DCAL are replaced by nonlinear ones.
- This solution allows to achieve better tracking performance.
- Experiments on Dual-V show the relevance of the contribution.


Dual-V RA-PKM

Manipulation and Grasping III / Parallel Robotics

Chair *Eugenio Guglielmelli, Universita' Campus Bio-Medico*
Co-Chair

09:53–09:56 TuA1.13

Structural Synthesis of Dexterous Hands

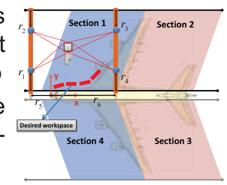
Erol Özgür, Grigore Gogu, Youcef Mezouar
Pascal Institute / IFMA

- Adapting the theory of structural synthesis of parallel robots to the dexterous hands.
- Synthesis of dexterous hands with desired mobility, connectivity, overconstraint and redundancy.

09:56–09:59 TuA1.14

Study of Reconfigurable Suspended Cable-Driven Parallel Robots for Airplane Maintenance

Dinh Quan Nguyen[1], Marc Gouttefarde[1],
[1]Laboratoire d'Informatique, de Robotique et de Micro-électronique de Montpellier (LIRMM), CNRS - University of Montpellier 2, France

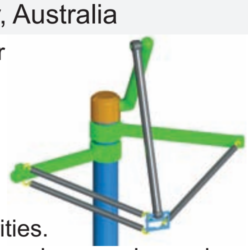


- Reconfigurable suspended CDPRs to replace telescopic platforms that carry workers in airplane workshop
- Systematic procedure to solve the CDPR reconfiguration as a multi-objective optimization problem
- Two criteria are used to quantify the CDPR performance in terms of power consumption and stiffness

09:59–10:02 TuA1.15

Workspace Analysis of Two Similar 3-DOF Axis-Symmetric Parallel Manipulators

Kristan Marlow, Mats Isaksson,
Hamid Abdi and Saeid Nahavandi
Deakin University, Australia

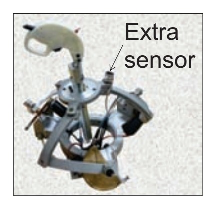


- This paper analyses two similar 3-DOF axis-symmetric parallel manipulators.
- It presents an analysis of the manipulators' workspace properties, highlighting the locations and types of singularities. Followed by an exanimation of workspace size and conditioning.

10:02–10:05 TuA1.16

Improvement of the DKM of a haptic device for medical application in real time using an extra sensor

Houssem Saafi, Med Amine Laribi and Saïd Zeghloul
Pprime Institute, Poitiers France



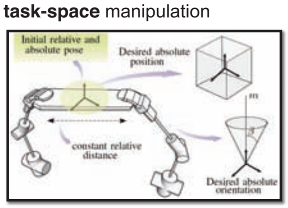
- An extra sensor is added in a passive joint of a spherical parallel manipulator (SPM) to simplify the calculation of the Direct kinematic model (DKM).
- This SPM will be used as a master device for a medical tele-operation system.

10:05–10:08 TuA1.17

Switching Strategy for Flexible Task Execution using the Cooperative Dual Task-Space Framework

L.F.C. Figueredo[1,3], B.V. Adorno[2], J.Y. Ishihara[3], and G.A. Borges[3]
[1]Massachusetts Institute of Technology (MIT) [2]Federal University of Minas Gerais (UFMG) [3]University of Brasilia (UnB)

- New strategy for **cooperative dual task-space** manipulation framework.
- **Flexible task execution** enriches the Jacobian null space with additional degrees of freedom by relaxing control requirements upon specific geometric task objectives.

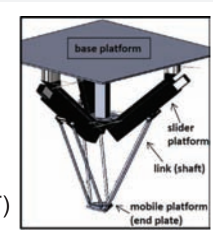


- Hysteresis-based **switching strategy** ensures stability and convergence

10:08–10:11 TuA1.18

Vibration Control of 3P(S)4 Class Parallel Mechanisms for High Speed Applications Using Quantitative Feedback Design

Ebubekir Avci[1], Masanori Kenmochi[1], Michihiro Kawanishi[1],
Tatsuo Narikiyo, Shinji Kawakami[2] and Yumi Saitou[2]
[1]TTI, [2]Omron Corporation



- **Residual vibration** is the challenge for the high speed parallel mechanisms.
- By using Lagrangian formulation, inverse dynamics of the system is derived.
- Quantitative Feedback Theory (QFT) is applied for the reduction of the vibration as a robust control method.

Manipulation and Grasping III / Parallel Robotics

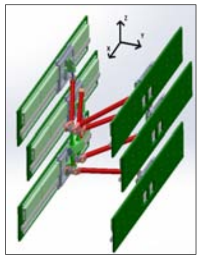
Chair *Eugenio Guglielmelli, Universita' Campus Bio-Medico*
Co-Chair

10:11–10:14 TuA1.19

Dimensional Synthesis of 4 DoFs (3T-1R) Actuatedly Redundant Parallel Manipulator Based on Dual Criteria: Dynamics and Precision

S. SHAYYA[1,2], S. KRUT[2], O. COMPANY[2], C. BARADAT[1], and F. PIERROT[2]
[1]Tecnalia France [2]LIRMM-Université Montpellier 2-France

- Presents Dimensional Synthesis of Redundant 4 dofs (3T-1R) PKM
- Synthesis Based on Dynamic and Precision Criteria: Isotropic Linear Acceleration and Translational Resolution Amplification Factor
- Other Kinetostatic & Dynamic Measures are also evaluated for synthesized parameters...
- Results show a highly performant PKM

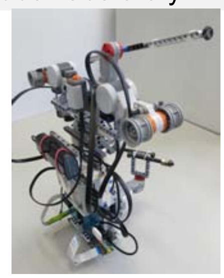


10:14–10:17 TuA1.20

Active vibration canceling of a cable-driven parallel robot using reaction wheels

Xavier Weber[1], Loic Cuvillon[1] and Jacques Gangloff[1]
[1]University of Strasbourg, Icube Laboratory

- Rapid prototyping of CDPR
  - ➢ Lego Mindstorms, Raspberry Pi and Simulink Coder
- Active vibration damping (4 DoF)
  - ➢ Robotized platform
  - ➢ Embedded reaction wheels



Motion and Path Planning II / Localization and Mapping II

Chair *Steven M LaValle, Oculus VR*
Co-Chair

09:00–09:20	TuA2.1

Keynote: Sampling-Based Planning: Foundations & Applications

Nancy M. Amato
Texas A&M University

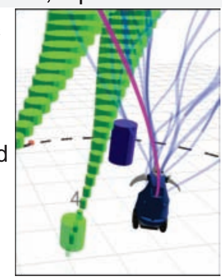
- Sampling-Based methods have dominated motion planning for nearly two decades
- Foundations: practically and often provably efficient and even optimal
- Applications: many & varied ranging from robots, to CAD, to animation, to molecules

09:20–09:23	TuA2.2

Proactive kinodynamic planning using the extended social force model and human motion prediction in urban environments

Gonzalo Ferrer[1], Alberto Sanfeliu[1]
[1]IRI (CSIC-UPC), Barcelona, Spain

- Autonomous navigation in dynamic urban environments.
- Proactive: every robot propagation entails a prediction of the scene.
- Human motion prediction integrated in the planning scheme.
- Kinodynamic robot constraints and strong time restrictions.

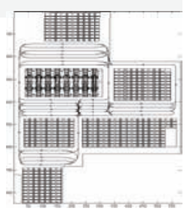


09:23–09:26	TuA2.3

An Automatic Approach for the Generation of the Roadmap for Multi-AGV Systems in an Industrial Environment

V. Digani, L. Sabattini, C. Secchi, C. Fantuzzi
Department of Science and Methods for Engineering (DISMI), University of Modena and Reggio Emilia, Italy

- Goal: Automatic Roadmap Generation for AGV Systems
- Maximization of coverage, redundancy and connectivity
- Comparison with real roadmaps currently used in real warehouses

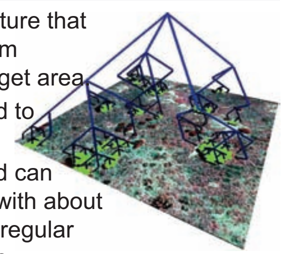


09:26–09:29	TuA2.4

Recursive Non-Uniform Coverage of Unknown Terrains for UAVs

Seyed Abbas Sadat, Jens Wawerla
Richard Vaughan
Autonomy Lab, Simon Fraser University

- We use a coverage tree structure that can accommodate non-uniform coverage of regions in the target area
- Three strategies are proposed to traverse the coverage tree.
- In some situations our method can cover the interesting regions with about half the travel time of a naive regular `lawnmower' coverage pattern.

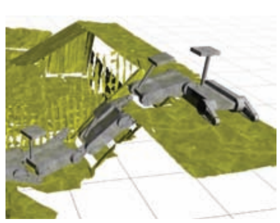


09:29–09:32	TuA2.5

Path Planning with Stability Uncertainty for Articulated Mobile Vehicles in Challenging Environments

M.Norouzi[1], J. Valls Miro[1],
G. Dissanayake[1] and T. Vidal-Calleja[1]
[1]University of Technology, Sydney, Australia

- A novel probabilistic tip-over stability criterion
- Considers uncertainty in the localisation, the robot model and the 3D terrain model
- Generates a dynamic safety constraint
- Stable paths in rough terrains

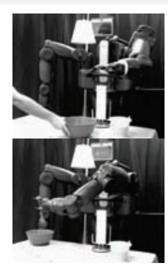


09:32–09:35	TuA2.6

Closed-Loop Global Motion Planning for Reactive Execution of Learned Tasks

Chris Bowen and Ron Alterovitz
University of North Carolina at Chapel Hill

- Problem: perform a learned task while avoiding obstacles and reacting to the movement of task-relevant objects
- Sampling-based motion planner maximizes similarity to demonstrations
- React to object movement in a global, asymptotically optimal manner
- Real-time replanning on Baxter robot



Motion and Path Planning II / Localization and Mapping II

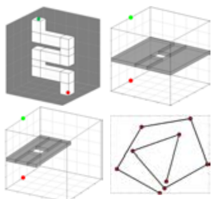
Chair *Steven M LaValle, Oculus VR*
Co-Chair

09:35–09:38 TuA2.7

An Empirical Study of Optimal Motion Planning

Jingru Luo, Kris Hauser
Indiana University Bloomington

- Systematic benchmarking study
- Sampling-based vs grid search vs trajectory optimization
- Benchmarks vary dimensionality, # homotopy classes, narrow passage geometry
- Some surprising results
- Recommendations made for future planning research



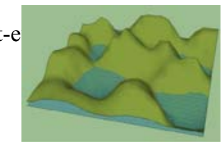
Four Benchmark Problems

09:38–09:41 TuA2.8

The Lion and Man Game on Polyhedral Surfaces with Boundary

Narges Noori, Volkan Isler
University of Minnesota

- We study pursuit-e piecewise linear 2D surfaces.
- Players have the They see each other at all times.
- Our result: Three pursuers can capture the evader on surfaces that are homeomorphic to a disk with holes.
- Such surfaces include terrains with holes (see figure).

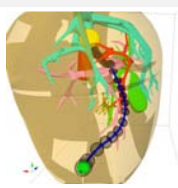


09:41–09:44 TuA2.9

Motion Planning under Uncertainty for Medical Needle Steering Using Optimization in Belief Space

Wen Sun, Ron Alterovitz,
University of North Carolina at Chapel Hill, USA

- New optimization-based motion planner for steerable needles explicitly considers uncertainty.
- Formulate problem as POMDP.
- Solve POMDP by optimizing plan in needle's belief space.
- Our method outputs a locally optimal plan and associated control policy.



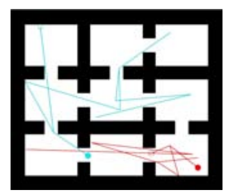
A locally optimal motion plan in a liver

09:44–09:47 TuA2.10

A Sampling-Based Algorithm for Multi-Robot Visibility-Based Pursuit-Evasion

Nicholas M. Stiffler and Jason M. O'Kane
Computer Science and Engineering, University of South Carolina, USA

- Goal is to compute a joint solution strategy for the pursuers.
- Introduce a graph that maintains a representation of the reachable parts of the pursuers' joint I-space.
- Utilizes an abstract sampler generates points in the pursuers' joint configuration space.
- Probabilistically complete



A pursuer strategy generated by our algorithm.

09:47–09:50 TuA2.11

Online Learning of Task-Specific Dynamics for Periodic Tasks

Tadej Petrič, Andrej Gams, Leon Žlajpah and Aleš Ude
Jožef Stefan Institute (JSI), Ljubljana, Slovenia

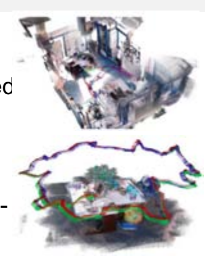
- On-line learning of task-specific dynamics with Dynamic Torque Primitives (**DTPs**).
- High tracking accuracy and compliant behavior.
- Safe for interaction with humans.
- Demonstrated on crank turning.

09:50–09:53 TuA2.12

Towards Consistent Reconstructions of Indoor Spaces Based on 6D RGB-D Odometry and Kinect Fusion

H. Dong[1], N. Figueroa[2] and A. El Saddik[1]
[1]University of Ottawa [2]EPFL

- A robust 6D RGB-D odometry algorithm was proposed;
- KinectFusion algorithm was improved by combining it with our proposed odometry estimation;
- The proposed approach was evaluated by publicly available RGB-D benchmark datasets.



Motion and Path Planning II / Localization and Mapping II

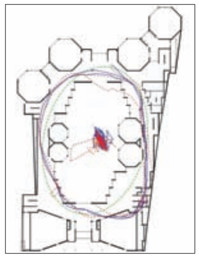
Chair *Steven M LaValle, Oculus VR*
Co-Chair

09:53–09:56 TuA2.13

Biologically Inspired SLAM Using Wi-Fi

Rafael Berkvens[1], Adam Jacobson[2], Michael Milford[2], Herbert Peremans[1] and Maarten Weyn[1]
[1]UAntwerp [2]QUT

We leverage the low quality sensory requirements and coarse metric properties of RatSLAM to localize using Wi-Fi fingerprints. We present a novel sensor fusion technique that integrates camera and Wi-Fi, and we show the use of compass sensor data to remove orientation drift.

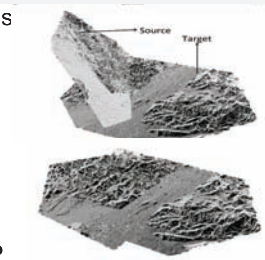


09:56–09:59 TuA2.14

Point Cloud Registration using Congruent Pyramids

Aravindhan K Krishnan, Srikanth Saripalli
Arizona State University

- Idea : Find congruent structures in the Point Clouds
- We find congruent pyramids based on the properties of a rigid body transformation
- Initial alignment is computed from the corresponding points of the congruent pyramids, which is then refined using ICP

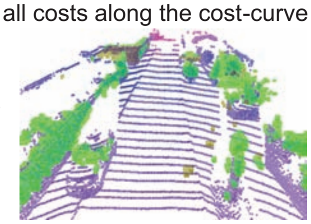


09:59–10:02 TuA2.15

On the formulation, performance and design choices of Cost-Curve Occupancy Grids

Martim Brandao[1], Ricardo Ferreira[2], Kenji Hashimoto[1], Jose Santos-Victor[2] and Atsuo Takanishi[1] [1]Waseda University [2]IST, ULisboa

- Occupancy grid formulation for stereo
- Uses likelihood model of all costs along the cost-curve
- Evaluation of different likelihood models in different noise conditions
- High precision, decreases with power of image noise

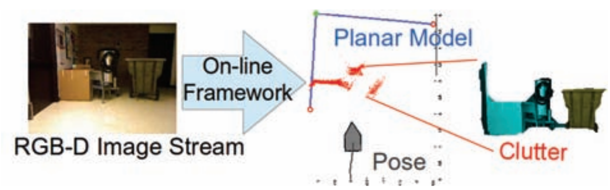


10:02–10:05 TuA2.16

Handling Perceptual Clutter for Robot Vision with Partial Model Based Interpretations

Grace Tsai and Benjamin Kuipers,
Electrical Engineering and Computer Science,
University of Michigan, Ann Arbor

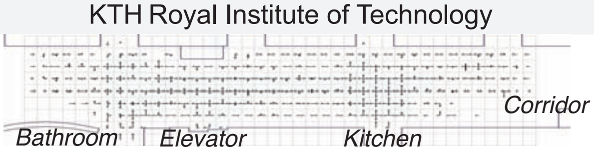
- Interpret indoor scene by a planar model + clutter
- Present likelihood function to address 3-way trade-off among coverage, accuracy, and simplicity of the model



10:05–10:08 TuA2.17

Modeling motion patterns of dynamic objects by IOHMM

Zhan Wang, Rares Ambrus,
Patric Jensfelt and John Folkesson
KTH Royal Institute of Technology



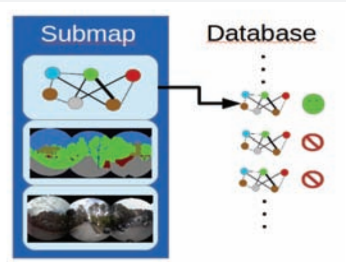
- Modeling motion patterns by capturing spatial correlation across IOHMM processes corresponding to different occupancy grids
- Improving each IOHMM process by incorporating external information from neighboring IOHMMs

10:08–10:11 TuA2.18

Fast Hybrid Relocation in Large Scale Metric-Topologic-Semantic Map

Romain Drouilly[1,2], Patrick Rives[1],
Benoit Morisset[2]
[1]INRIA Méditerranée, France [2]ECA Robotics

- New structured hybrid map model to speed up localization
- Fast content request through semantic graphs comparison
- High-level content request ability



Motion and Path Planning II / Localization and Mapping II

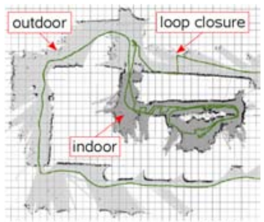
Chair *Steven M LaValle, Oculus VR*
Co-Chair

10:11–10:14 TuA2.19

Stereo-Vision Based Obstacle Mapping for Indoor/Outdoor SLAM

Christoph Brand, Martin J. Schuster,
Heiko Hirschmüller and Michael Suppa
German Aerospace Center (DLR)

- Fast local obstacle mapping
- Adaptive to stereo error
- Detection of negative edges
- Integration in SLAM framework
- 0.08% final position error



Mixed Indoor/Outdoor Path & Map

10:14–10:17 TuA2.20

Meta-rooms: Building and Maintaining Long Term Spatial Models in a Dynamic World

Rares Ambrus[1], Nils Bore[1],
John Folkesson[1] and Patric Jensfelt[1]
[1]KTH Royal Institute of Technology

- Meta-rooms – local maps representing the static structure of the environment; built incrementally through a stable and convergent method in long-term autonomy scenarios
- Used to extract dynamic objects which can be matched across observations

Meta-rooms and dynamic objects

10:17–10:20 TuA2.21

Sponsor Talk: BRIN: Benchmark for Robotic Indoor Navigation

Gershon Parent
Microsoft Robotics

- BRIN is an experimental protocol and tools for evaluating a mobile robot navigation system deployed in a real indoor environment.
- BRIN provides detailed specifications and controls of the interactions and environment dynamics to ensure repeatability and reproducibility of experiments.
- BRIN includes the use of a reference robot to allow comparison between different navigation systems at different experimentation sites.

Search, Rescue, and Audition / Field Robotics

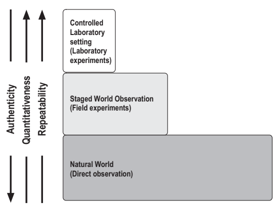
Chair *Satoshi Tadokoro, Tohoku University*
Co-Chair

09:00–09:20 TuA3.1

Keynote: Lessons Learned in Field Robotics from Disasters

Robin R. Murphy
Texas A&M University

- Data from field work differs from laboratory in terms of authenticity, quantitative measurability, and repeatability
- Helpful data: log of activity, context, robot's eye, robot state, external view of robot, human-robot interaction



09:20–09:23 TuA3.2

The Response Robotics Summer School 2013

R. Sheh[1,2,3], B. Collidge[4], M. Lazarescu[1], H. Komsuoglu[2,3] and A. Jacoff[2]
[1]Curtin University [2]NIST [3]Robolit [4]WA Police

- Co-located with Bomb Response Technology Seminar, bringing Responders and Researchers Together to Advance Response Robotics
- Leveraged DHS-NIST-ASTM International Standard Test Methods for Response Robots as a common language
- Disseminated Best-in-Class capabilities from RoboCup Rescue

09:23–09:26 TuA3.3

Design of a Hybrid Exploration Robot for Air and Land Deployment (H.E.R.A.L.D)

Stella Latscha, M. Kofron, A. Stroffolino, L. Davis, G. Merritt, M. Piccoli and M. Yim
University of Pennsylvania

- Joint system with two "snake" robots and one quadrotor
- Combines snake cluttered environment access with aerial surveillance and mobility
- Potential for rapid USAR site exploration and victim location

09:26–09:29 TuA3.4

Approaches to Robotic Teleoperation in a Disaster Scenario

K. Katyal, C. Brown, S. Hechtman, M. Para, T. McGee, K. Wolfe, R. Murphy, M. Kutzer, E. Tunstel, M. McLoughlin, M. Johannes
Johns Hopkins University Applied Physics Laboratory

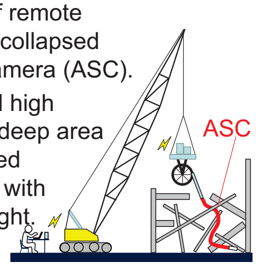
- Bimanual anthropomorphic manipulation system
  - 41 Total DOF
- ROS-based perception and path planning modules
- Supervised autonomous manipulation capabilities in a casualty evacuation scenario

09:29–09:32 TuA3.5

Remote Vertical Exploration By Active Scope Camera into Collapsed Buildings

Junichi Fukuda[1], Masashi Konyo[1], Eijiro Takeuchi[1] and Satoshi Tadokoro[1]
[1]Tohoku University

- We developed the prototype of remote vertical exploration system for collapsed buildings with Active Scope Camera (ASC).
- We confirmed this system had high potential to get inserted in the deep area by experiments at the simulated collapsed building constructed with temporary scaffolds of 6 m height.

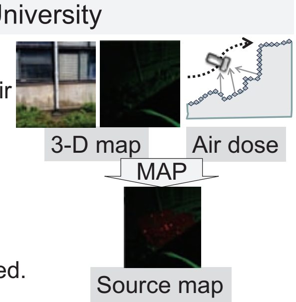


09:32–09:35 TuA3.6

Estimation of Ground Surface Radiation Sources from Dose Map Measured by Moving Dosimeter and 3D Map

Gaku Minamoto[1], Eijiro Takeuchi[1] and Satoshi Tadokoro[1]
[1]Tohoku University

- Proposed method estimates intensities of sources from air dose measured by moving dosimeters.
- The estimation is based on probabilistic approach.
- Experiments in real environments were conducted.



Search, Rescue, and Audition / Field Robotics

Chair *Satoshi Tadokoro, Tohoku University*
Co-Chair

09:35–09:38	TuA3.7

Making a Robot Dance to Diverse Musical Genre in Noisy Environments

J. Oliveira[1], K. Nakamura[2], T. Langlois[3], F. Gouyon[4], K. Nakadai[2], A. Lim[5], L. Reis[1,6], H. Okuno[5]
[1]FEUP [2]Honda [3]ULisbon [4]TEC [5]Kyoto U [6]UMinho

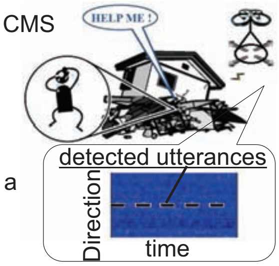
- Two state-of-the-art algorithms
- Six musical genres
- Multiple audio sources, including music and speech
- Multiple noise sources
- Improved genre recognition, by 43.6 pp, when considering noisy acoustic models

09:38–09:41	TuA3.8

Improvement in Outdoor Sound Source Detection Using a Quadrotor-Embedded Microphone Array

Takuma Ohata[1], Keisuke Nakamura[2], Takeshi Mizumoto[2], Tezuka Taiki[1], and Kazuhiro Nakadai[1,2]
[1]Tokyo Institure of Technology
[2]Honda Research Institute Japan Co., Ltd.

Proposed iGSVD-MUSIC with CMS
- Low computational cost
- High noise-robustness due to soft-whitening
- Achieved outdoor speech localization and detection with a 16ch quadrotor-embedded microphone array

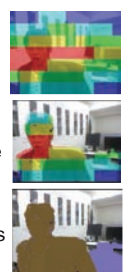


09:41–09:44	TuA3.9

Visualization of auditory awareness based on sound source positions estimated by depth sensor and microphone array

Takahiro Iyama[1], Osamu Sugiyama[1], Takuma Otsuka[1], Katsutoshi Itoyama[1], and Hiroshi G. Okuno[1]
[1]Graduate School of Informatics, Kyoto University, Japan

- We designed and developed **a three-layer visualization model** for auditory awareness
- **Layer 1: Sound Distribution Layer**
  - Visualize MUSIC spectrum on RGB Image
- **Layer 2: Sound Location Layer**
  - Visualize MUSIC spectrum on the clustered image on the basis of depth image
- **Layer 3: Sound Saliency Layer**
  - Visualize the saliency of the sound source which is the time differences of depth and sound distribution

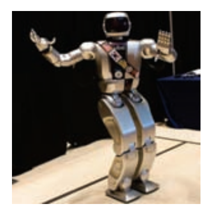


09:44–09:47	TuA3.10

Rapidly Learning Beats in the Presence of Environmental and Robot Ego Noise

David Grunberg[1] and Youngmoo Kim[1],
[1]Department of Electrical & Computer Engineering, Drexel University

- We enabled a robot to learn musical beats given only 5 seconds of audio
- Stacked spectrograms compactly represent time-varying spectral characteristics of the signal
- Probabilistic Latent Component Analysis (PLCA) is used to extract the beat component

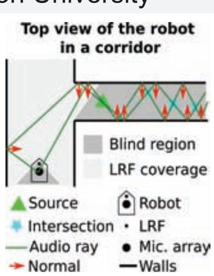


09:47–09:50	TuA3.11

Audio Ray Tracing for Position Estimation of Entities in Blind Regions

Jani Even[1], Yoichi Morales[1], Srikanth Kallakuri[2] Carlos Ishi[1] and Norihiro Hagita[1]
[1]ATR-IRC [2]Carnegie Mellon University

- Detection of a noisy entity in the blind region of the line of sigh sensors (LRFs).
- Use the acoustic reflections that “leak” from the blind region.
- Trace back audio rays to the sound origin in the blind region using estimated normals to surfaces from a point cloud generated 3D map.

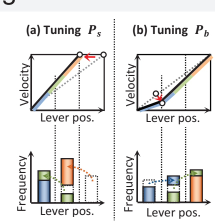


09:50–09:53	TuA3.12

An Adaptive Basic I/O Gain Tuning Method Based on Leveling Control Input Histogram for Human-Machine Systems

Mitsuhiro Kamezaki, Hiroyasu Iwata, and Shigeki Sugano
Research Inst. for Sci. and Eng. Waseda Univ.

- A method to tune a basic input-output gain (BIOG) is proposed.
- The tuning system is based on comprehensive features from the histogram of control lever input.
- The proposed system improves time efficiency while increasing subjective usability.



Tuning mechanism

Search, Rescue, and Audition / Field Robotics

Chair *Satoshi Tadokoro, Tohoku University*
Co-Chair

09:53–09:56 TuA3.13

Development and Field Test of Teleoperated Mobile Robots for Active Volcano Observation

K.Nagatani[1], K.Akiyama[1], G.Yamauchi[1], K.Yoshida[1], Y.Hada[2], S.Yuta[3], T.Izu[4], R.Mackay[5]
[1]Tohoku Univ. [2]Kogakuin Univ. [3]Shibaura Inst of Tech. [4]enRoute Co., Ltd. [5]Japan Drones Co., Ltd.

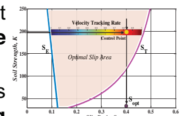
- Volcanic observation system that includes MUAV and UGV.
- A sky-crane mechanism is used to deploy UGV from MUAV.
- Field test was conducted at Mt. Asama in September 2013.

09:56–09:59 TuA3.14

Intelligent Slip-Optimization Control with Traction-Energy Trade-off for Wheeled Robots on Rough Terrain

Jayoung kim[1] and Jihong Lee[1],
[1]Chungnam National University

- On rough terrain, there are important characteristics on **soil types** and **surface shapes**
- Robots should be able to control the wheels for **maximizing traction** and **minimizing energy consumption**, while **tracking a desired velocity**.
- **Intelligent Slip-Optimization Control** is proposed to meet the performance of **traction-energy trade-off** on rough terrains



- Slip-Optimization -

- ISOC flow chart -

09:59–10:02 TuA3.15

Novel Robot Mechanism Capable of 3D Differential Driving Inside Pipelines

S.U. Yang[1], H.M. Kim[1], J.S. Suh[1], Y.S. Choi[1], H.M. Mun[1], C.M. Park[1], H. Moon[1] and H.R. Choi[1]
[1]Sungkyunkwan University, Korea

- Multi-axial differential gear mechanism
  - Power transmission of MRINSPECT VI
  - Extension of 3D differential gear
- Active wall pressing mechanism
- Brake mechanism for anti-slip
- Rescue mechanism for emergency
- Experiments

MRINSPECT VI

10:02–10:05 TuA3.16

Autonomous Robotic System for Bridge Deck Data Collection and Analysis

Hung La[1], Nenad Gucunski[2], Seong-Hoon Kee[3], Jingang Yi[4], Turgay Senlet[5], Luan Nguyen[6]
[1]University of Nevada, Reno, Nevada, USA
[2,4,5,6]Rutgers University, Piscataway, New Jersey, USA
[3]Dong-A University, Busan, Korea

- This paper presents an autonomous robotic system for bridge data collection and analysis.
- The robot is equipped with various non-destructive evaluation (NDE) sensors for simultaneous and fast data collection.
- Crack detection and mapping algorithm and NDE data analysis are presented.
- The presented robotic system has been successfully deployed to inspect numerous bridges in USA.

The deployment of the robotic bridge inspection system on the Washington Memorial bridge, Washington DC, USA in 2013.

10:05–10:08 TuA3.17

Road Surface Washing System for De-contaminating Radioactive Substances

Mitsuru Endo[1], Mai Endo[2] and Takao Kakizaki[2]
[1]College of Engineering, Nihon Univ.
[2]Graduated School of Engineering, Nihon Univ.

- Decontaminate radioactive sub-stances spread by the accident of Fukushima Nu-clear power plant
- Propose a washing mechanism and control algorithm
- Valid the decontaminating effective-ness by experiments

10:08–10:11 TuA3.18

A Framework for Predicting the Mission-Specific Performance of Autonomous Unmanned Systems

Phillip Durst[1], Wendell Gray[1], Agris Nikitenko[2], Joao Caetano[3], Mike Trentini[4], and Roger King[5]
[1]U.S. Army Engineer Research and Development Center [2]Riga Technical University [3]Portuguese Air Force [4]Defense Research and Development Canada [5]Mississippi State University

Search, Rescue, and Audition / Field Robotics

Chair *Satoshi Tadokoro, Tohoku University*

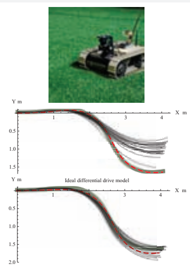
Co-Chair

10:11–10:14	TuA3.19

Experimental Analysis of Models for Trajectory Generation on Tracked Vehicles

Jonathan Fink and Ethan Stump
US Army Research Laboratory

- Consider and compare three kinematic motion models with extensive experiments
- Dynamic drivetrain model
- Applications to motion planning and feedback control systems for off-road terrain

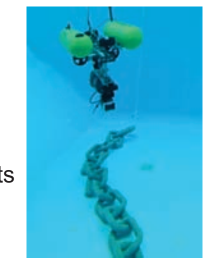


10:14–10:17	TuA3.20

Sonar-based Chain Following using an Autonomous Underwater Vehicle

N.Hurtós[1], N.Palomeras[1],A.Carrera[1],M.Carreras[1], C.P.Bechlioulis[2], G.C.Karras[2], S.H-a[2], K.K[2]
[1]University of Girona [2]N.T.U. of Athens

- Framework to perform chain following, combining perception, planning and control disciplines.
- Detection of links on challenging forward-looking sonar images.
- Detections are grouped in waypoints that the AUV follows while keeping the orientation to upcoming links.

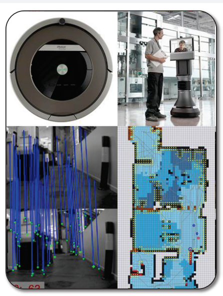


10:17–10:20	TuA3.21

Sponsor Talk: Vision-Based Navigation

Chris Jones
iRobot Corporation

- Leader in **Practical Robot Technologies and Products**
- Strategic focus on **Navigation and Visual Perception**
- Internships and Full-time **Positions Available** in Pasadena, CA and Bedford, MA (*http://irobot.com/careers; cjones@irobot.com*)



Medical Robots and Systems I / Rehabilitation Robotics I

Chair *Nikos Papanikolopoulos, University of Minnesota*
Co-Chair

10:50–11:10 TuB1.1

Keynote: Medical Robotics – Melding Clinical Need with Engineering Research

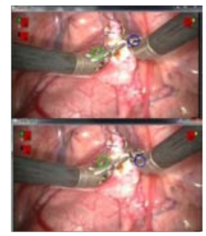
Pierre E. Dupont
Boston Children's Hospital, Harvard Med School

- Engineering academia and clinical medicine are very different worlds.
- To bridge the gap, I have moved my engineering lab to a hospital.
- In this talk, I will describe my group's experience and provide an overview of our research.

11:10–11:13 TuB1.2

A Fast, Low-Cost, Computer Vision Approach for Tracking Surgical Tools

R. Dockter[1], R. Sweet[2] and T. Kowalewski[1]
[1]University of Minnesota Mechanical Engineering
[2]University of Minnesota Medical School



- Robotic and Laparoscopic surgery needs low-cost skill measures derived from tool motion
- 3D video footage widely available
- We present: Computer Vision algorithm for near real time, 3D localization of surgical tool tips
- **26 FPS, 3.05 mm accuracy**

11:13–11:16 TuB1.3

A Dynamically Consistent Hierarchical Control Architecture for Robotic-Assisted Tele-Echography

Luís Santos[1], Rui Cortesão[1],
[1]Institute of Systems and Robotics, University of Coimbra, Portugal

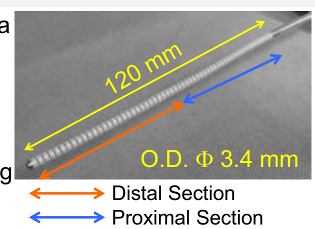
- **Explicit Cartesian force control arises as the primary task while orientation control is designed in the null space**
- Cartesian force control, driven by position errors, establishes interaction dynamics between probe and patient
- Probe orientation is controlled at joint level, where task space orientation errors are converted into joint velocity references

11:16–11:19 TuB1.4

Extended Kinematic Mapping of Tendon-Driven Continuum Robot for Neuroendoscopy

T. Kato[1,2], I. Okumura[3], H. Kose[3] , K. Takagi[3] and N. Hata[1] [1]Brigham and Women's Hospital
[2]Canon U.S.A., Inc. [3]Canon, Inc.

- Developed and validated a new tendon-driven continuum robot for neuroendoscopy
- Introduced an extended forward kinematic mapping with hysteresis operation

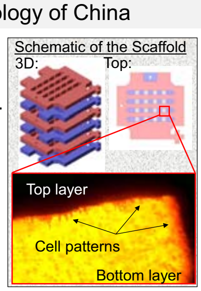


11:19–11:22 TuB1.5

Dielectrophoresis-based Automatic 3D Cell Manipulation and Patterning through a Micro-electrode Integrated Multi-layer Scaffold

H. K. Chu[1], Z. Huan[1,2], J. K. Mills[3], J. Yang[2], and D. Sun[1]
[1]City University of Hong Kong [3]University of Toronto
[2]University of Science and Technology of China

- A scaffold utilizing dielectrophoresis for cell manipulation and patterning was proposed.
- Electric fields generated from the multi-layer structure polarized the cells to facilitate 3D manipulation.
- 3D cellular patterns were formed which spanned all scaffold layers.

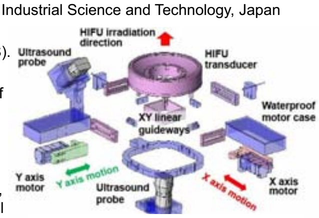


11:22–11:25 TuB1.6

A novel redundant motion control mechanism in accordance with medical diagnostic and therapeutic task functions for a NIUTS

Norihiro Koizumi, Dongjun Lee , Joonho Seo,
Takashi Azuma, and Mamoru Mitsuishi
School of Engineering, The University of Tokyo, Japan
Hiroyuki Tsukihara, Akira Nomiya, and Yukio Homma
School of Medicine, The University of Tokyo, Japan
Kiyoshi Yoshinaka
The National Institute of Advanced Industrial Science and Technology, Japan

- We have developed non-invasive ultrasound theragnostic system (NIUTS).
- In this report, we propose novel redundant motion control mechanism of HIFU focus, for therapeutics, that is independent of ultrasound probes for diagnostics.
- Proposed mechanism enables noise factors, which deteriorate image quality, to be reduced, thereby enhancing Focal Lesion Servo (FLS) performance.



Redundant motion control mechanism.

Medical Robots and Systems I / Rehabilitation Robotics I

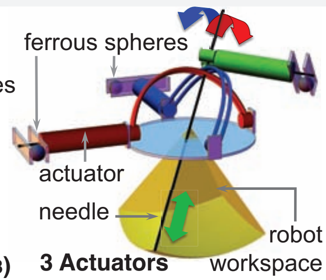
Chair *Nikos Papanikolopoulos, University of Minnesota*
Co-Chair

11:25–11:28 TuB1.7

Simultaneously Power & Control Many Actuators With a Clinical MRI Scanner

Aaron Becker, Ouajdi Felfoul, & Pierre E. Dupont
Boston Children's Hospital &
Harvard Medical School, USA

- Uses MRI to power & image multiple actuators
- Relies on inhomogeneities e.g. no parallel rotors
- Easily implemented position & velocity controllers—global asymptotic convergence
- **All code online (MATLAB)**

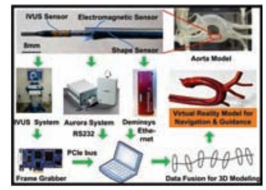


11:28–11:31 TuB1.8

Simultaneous Catheter and Environment Modeling for Trans-catheter Aortic Valve Implantation

Chaoyang Shi, Stamatia Giannarou,
Su-Lin Lee and Guang-Zhong Yang
The Hamlyn Centre, Imperial College London, UK

- 3D vessel reconstruction fusing IVUS images and EM measurement data;
- Catheter shape reconstruction based on FBG sensors;
- The method could facilitate intra-operative surgical guidance and minimize the use of contrast agent in TAVI procedures.

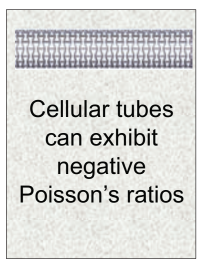


11:31–11:34 TuB1.9

Structurally-Redesigned Concentric-Tube Manipulators with Improved Stability

H. Azimian[1], P. Francis[2], T. Looi[1] and J. Drake[1]
[1]CIGITI, Hospital for Sick Children, Toronto
[2]University of Waterloo, Waterloo

- A new solution is proposed to reduce torsion in concentric-tube manipulators.
- Using composite structures with higher torsional-to-bending stiffness ratios is suggested.
- Results show up to 40% improvement in stability margin.

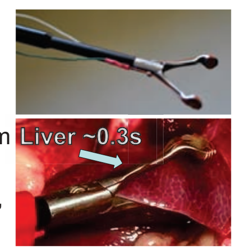


11:34–11:37 TuB1.10

Online Identification of Tissues *In Vivo* for Injury-Avoiding Surgical Robots

Astrini Sie[1], Michael Winek[1],
and Timothy M. Kowalewksi[1]
[1]University of Minnesota

- Presents a smart robotic surgical grasper capable of identifying abdominal soft tissues during the early stages of a grasp
- Employed an estimation algorithm based on extended Kalman filter
- Algorithm verified *in silico*, *in situ*, and *in vivo* on porcine models

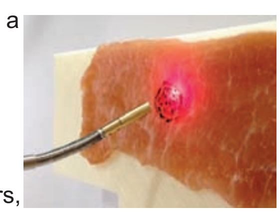


11:37–11:40 TuB1.11

Micro Laser Ablation System Integrated with Image Sensor for Minimally Invasive Surgery

Baiquan Su[1], Zhan Shi[1], Hongen Liao[1]
[1]Tsinghua University, Beijing, China

- A micro surgical system with a micro laser ablation module and an imaging sensor for minimally invasive surgery.
- The diameter and the length of the module are 3.5 millimeters and 15 millimeters, respectively.



11:40–11:43 TuB1.12

Preliminary Evaluation of a New Control Approach to Achieve Speed Adaptation in Robotic Transfemoral Prostheses

Tommaso Lenzi[12], Levi J Hargrove[12], and Jonathon W Sensinger[3]
[1]Rehabilitation Institute of Chicago [2]Northwestern University
[3]University of New Brunswick

- biologically accurate function at **varying walking speeds**
- *quasi-stiffness* modulation in stance phase
- *minimum jerk* trajectory in swing phase
- no need for subject-specific tuning

Medical Robots and Systems I / Rehabilitation Robotics I

Chair *Nikos Papanikolopoulos, University of Minnesota*
Co-Chair

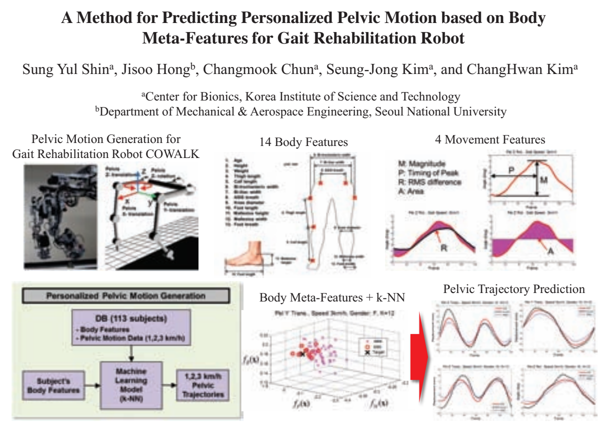
11:43–11:46 TuB1.13

Development of Elbow-Forearm Interlock Joint Mechanism Toward an Exoskeleton for Patients with Essential Tremor

Yuya Matsumoto[1], Motoyuki Amemiya[1], Daisuke Kaneishi[1], Yasutaka Nakashima[1], Masatoshi Seki[1,2], Takeshi Ando[1,3], Yo Kobayashi[1], Hiroshi Iijima[4], Masanori Nagaoka[5], Masakatsu G. Fujie[1]
[1]Waseda University [2]Kikuchiseisakusho Co., Ltd. [3]Panasonic [4]Yokohama Rehabilitation Centor [5]Juntendo University Graduate School

- Development of elbow-forearm interlock joint mechanism to avoid occurrence of compensatory movement without using an actuator
- The mechanism will be applied for an exoskeleton to suppress an involuntary oscillation of patients with tremor

11:46–11:49 TuB1.14

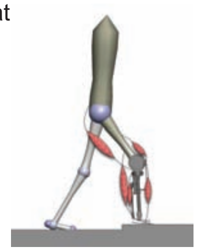


11:49–11:52 TuB1.15

Towards Local Reflexive Control of a Powered Transfemoral Prosthesis for Robust Amputee Push and Trip Recovery

Nitish Thatte[1], Hartmut Geyer[1]
[1]Carnegie Mellon University

- Amputees often suffer from falls that cause injuries and a fear of walking
- Neuromuscular models of walking produce robust and natural gaits
- Using neuromuscular reflexes to control prostheses may improve amputee walking robustness

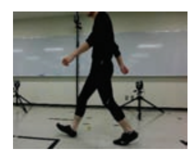


11:52–11:55 TuB1.16

Analysis of Inertial Motion in Swing Phase of Human Gait and Its Application to Motion Generation Method of Transfemoral Prosthesis

T. Wada[1], H. Sano[1], M. Sekimoto[2]
[1]Ritsumeikan University [2]University of Toyama

- A inertial motion index was proposed to evaluate closeness of given motion to inertial motion of multilink system
- Inertial motion was effectively used mid-swing of human gait
- A motion generation method of

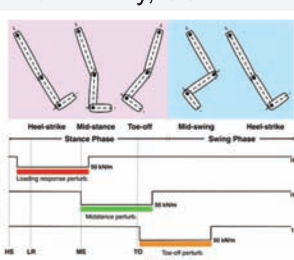


11:55–11:58 TuB1.17

Contralateral Leg Response to Unilateral Stiffness Changes using Novel Device

Jeffrey Skidmore[1], Andrew Barkan[1] and Panagiotis Artemiadis[1]
[1]Arizona State University, USA

- Unique research platform to investigate gait control mechanisms
- Investigation of sensory feedback on inter-limb coordination



11:58–12:01 TuB1.18

Mobile robotic gait rehabilitation system CORBYS

S. Slavnić[1], D. Ristić-Durrant[1], R. Tschakarow[2], T. Brendel[3], M. Tüttemann[3], A. Leu[1] and A. Gräser[1]
[1]IAT Bremen [2]Schunk GmbH [3]Otto-Bock

- System overview and first results on the orthosis actuation
- Novel push-pull control cable actuation system of the orthosis
- Actuation system identification
- Control of the orthosis
- Experimental results
- Conclusion and future work

CAD image of the CORBYS mobile gait rehabilitation system

Medical Robots and Systems I / Rehabilitation Robotics I

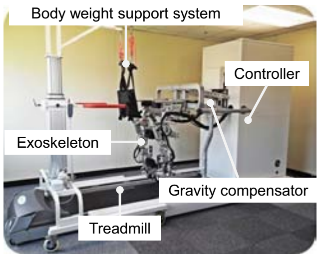
Chair *Nikos Papanikolopoulos, University of Minnesota*
Co-Chair

12:01–12:04 TuB1.19

Design and Control of an Exoskeleton System for Gait Rehabilitation Capable of Natural Pelvic Movement

C.-Y. Jung[1,2], J. Choi[2],
S. Park[1], J. M. Lee[2], C. Kim[2], and S.-J. Kim[2]
[1]Korea Univ. [2]KIST

- Exoskeleton system for gait rehabilitation of stroke survivors
- Pelvic motion is allowed for natural gait using 4 DOF
- Weight of exoskeleton is compensated by gravity compensator



12:04–12:07 TuB1.20

Integrated Control Method for Power-Assisted Rehabilitation

Jaemin Lee[1],Minkyu Kim[1],Sang-Rok Oh[1],Keehoon Kim[1]
[1]Interaction & Robotics Research Center
Korea Institute of Science and Technology, Seoul, Korea

- This research aims to offer the power – assisted rehabilitation for upper limb as guided by therapists.
- The proposed method is based on **the modified impedance controller**
- The desired position and assisting force are reproduced by **ellipsoid regression** of training data with the therapist

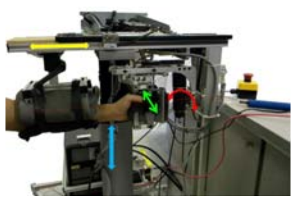
12:07–12:10 TuB1.21

reachMAN2: A compact rehabilitation robot to train reaching and manipulation

L.Z. Tong[1], J. Klein[2], S.A. Dual[1], C.L. Teo[1] and E. Burdet[2]
[1]National University of Singapore,
[2]Imperial College of Science, Technology and Medicine, London, UK

This paper describes the reachMAN2, a simple rehabilitation robot providing assistance in essential functions for activities of daily living: arm flexion/extension, forearm supination/pronation and hand opening/closing.

A special feature is the handle built over load cells and using an innovative cam mechanism enables natural hand opening/closing movements.



Human-Robot Interaction II / Robot Learning III

Chair *Jianwei Zhang, University of Hamburg*
Co-Chair

10:50–11:10	TuB2.1

Keynote: Robots and Gaming – Therapy for Children with Disabilities

Ayanna Howard
Georgia Institute of Technology

- Robots and gaming technologies that provide non-contact assistance to children for achieving their therapy goals will be discussed
- Quantitative assessment of the child's performance is also derived to provide feedback to the clinician
- These technologies have been deployed in various robot-child interaction scenarios

11:10–11:13	TuB2.2

A Gesture Recognition System for Mobile Robots That Learns Online

Alan J. Hamlet[1], Patrick Emami[1], and Carl D. Crane[1]
[1]University of Florida

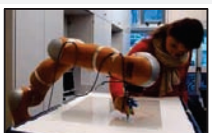
- **Novice** users can teach robot to recognize new **dynamic** gestures
- Requires **only one** training example
- **Learns** from experience, **improving** recognition accuracy over time
- Uses **R**obot **O**perating **S**ystem (**ROS**), **Kinect** sensor

11:13–11:16	TuB2.3

Cartesian Impedance Control of Redundant Manipulators for Human-Robot Co-Manipulation

F. Ficuciello, A. Romano, L. Villani, B. Siciliano
Università degli Studi di Napoli Federico II, Italy
Dip. Ing. Elettrica e Tecnologie dell'Informazione

- The problem of controlling a robot arm executing a cooperative task with a human is addressed.
- The end effector comply according to a Cartesian impedance law.
- Redundancy is used to ensure a decoupled inertia at the end effector for stability and performance.



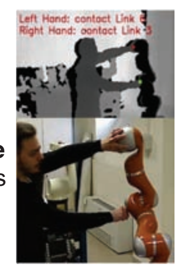
Snapshot of the co-manipulation task

11:16–11:19	TuB2.4

Estimation of Contact Forces using a Virtual Force Sensor

E. Magrini, F. Flacco, and A. De Luca
DIAG, Sapienza University of Rome, Italy

- Detect physical contacts and estimate the related joint torques by **residuals**
- Localize the contact point(s) on the robot by an external **depth sensor**
- Combine and obtain the **contact force vector(s)** without tactile or F/T sensors
- Validation of estimates and safe **HRI control** experiments on a KUKA LWR

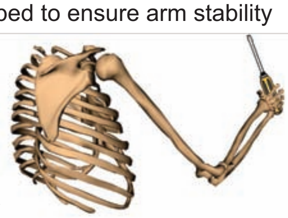


11:19–11:22	TuB2.5

Multi-Muscle FES Control of the Human Arm for Interaction Tasks

Yu-Wei Liao[1], Eric Schearer[1], Eric Perreault[1], Matt Tresch[1], and Kevin Lynch[1]
[1]Northwestern University

- An algorithm for feedforward control of the stiffness of a human arm model is developed to ensure arm stability
- Both effects of muscle co-contraction and postural adjustment are incorporated
- A "pushing with a stick" task is simulated to demonstrate the strength of our controller



11:22–11:25	TuB2.6

Pneumatic Tubular Body Fixture for Wearable Assistive Device

Yasuhisa Hasegawa[1], Takaaki Hasegawa[2], and Kiyoshi Eguchi[3], [1]Nagoya Univ. [2]Univ. of Tsukuba [3]Tsukuba Univ. Hospital

- Body holder, Active Cuff, of a wearable assistive device in simple wearing actions and comfort.
- Pneumatic actuator modules actively wrap and hold users' limb with less effort in a short time.
- Modeling of the actuators' deformations for holder design

Human-Robot Interaction II / Robot Learning III

Chair *Jianwei Zhang, University of Hamburg*
Co-Chair

11:25–11:28 TuB2.7

Implementation and experimental validation of DMP for object handover

Miguel Prada[1], Anthony Remazeilles[1], Ansgar Koene[2] and Satoshi Endo[2]
[1]Tecnalia [2]Univ. Of Birmingham

- Evaluation of a DMP-based controller for human-robot object exchange
- Experimental setup with a car mechanic inspired scenario
- Analysis of quantitative measurements and subjective user feedback

11:28–11:31 TuB2.8

Support Vector Machine Classification of Muscle Cocontraction to Improve pHRI

A. Moualeu[1], W. Gallagher[2] and J. Ueda[1]
[1]Georgia Institute of Technology [2]NASA

- The goal of our study is to improve performance in physical human-robot interaction.
- This requires endpoint stiffness estimation and accurate modeling of operator dynamics.
- This will ultimately allow us to properly tune impedance gains of a novel haptic controller.

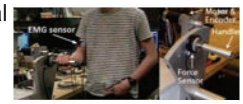


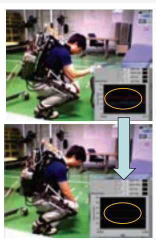
Figure. 1-DOF Haptic Device Experiment

11:31–11:34 TuB2.9

Oscillation Reduction Scheme for Wearable Robots Employing Linear Actuators and Sensors

Junghoon Choo[1], Junghoon Choo[1], Dong-Hyun Jeong[2] and Jong Hyeon Park[3]
[1,3]Hanyang University [2]DSME

- The moment arm of linear actuators is varied with joint angle, and sensed pressure is changed by the variation.
- An abrupt pressure change generates oscillations in a particular range of joint angle.
- For canceling the oscillation, three kinds of method are proposed.

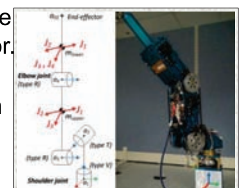


11:34–11:37 TuB2.10

Joint Configuration Strategy for Serial-chain Safe Manipulators

Seonghun Hong[1,2], Woosub Lee[2], Changhyun Cho[3], Sungchul Kang[2] and Hyeongcheol Lee[1]
[1]Hanyang Univ. [2]KIST [3]Chosun Univ.

- A collision can happen anywhere from the base to the end-effector.
- After several case studies were conducted, VTR:R configuration was selected as an appropriate joint configuration.
- We developed SS-Arm 3, for the proposed configuration strategy with safety components.



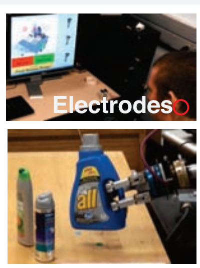
VTR:R Configuration and **SS-Arm 3**

11:37–11:40 TuB2.11

Single Muscle Site EMG Interface for Assistive Grasping

Jonathan Weisz[1], Alex Barszap[2], Sanjay Joshi[2], and Peter K. Allen[1]
[1]Columbia University [2]UC Davis

- Presents an assistive grasping system which integrates real-time grasp planning with novel sEMG device input device
- Recording from a single, site innervated from brainstem.
- UI designed to handle cluttered environments



11:40–11:43 TuB2.12

Using Haptics to Extract Object Shape from Rotational Manipulations

Claudius Strub[1,3], Florentin Wörgötter[1], Helge Ritter[2] and Yulia Sandamirskaya[3] [1]Georg-August-Universität Göttingen [2]Bielefeld University [3]Ruhr-Universität Bochum

- Rotating n-gons with a SDH-2
- Object pose and shape unknown
- Building an object shape representation during manipulation
- Requires to track the object orientation from tactile inputs and to correct for accumulating errors
- Solved with Dynamic Neural Fields

Human-Robot Interaction II / Robot Learning III

Chair *Jianwei Zhang, University of Hamburg*
Co-Chair

11:43–11:46 TuB2.13

Dynamic Attack Motion Prediction for Kendo Agent

Yasufumi Tanaka[1], Kazuhiro Kosuge[1]

- We propose a motion prediction method for Kendo Agent.
- Human motions are modeled usin Gaussian Mixture Models as nonlinear dynamical systems.
- Attack motion is predicted using the model and the euler' method.

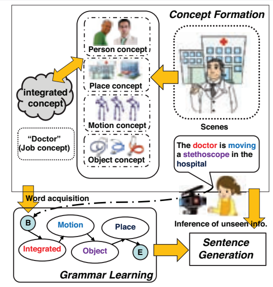
[1]Y. Tanaka and K. Kosuge, the Department of Bioengineering and Robotics, Graduate School of Engineering, Tohoku University

11:46–11:49 TuB2.14

Integration of Various Concepts and Grounding of Word Meanings Using Multi-layered Multimodal LDA for Sentence Generation

Muhammad Attamimi[1], Muhammad Fadlil[1], Kasumi Abe[1], Tomoaki Nakamura[1,2], Kotaro Funakoshi[2], and Takayuki Nagai[1],
[1]University of Electro-Communications [2]Honda Research Institute Japan

- A method to integrate various concepts considering the mutual interdependence among them in a hierarchical structure
- Grammar learning based on Markov model learned from order of concepts in teaching utterances is proposed to enable sentence generation
- Other abilities of proposed multi-layered multimodal LDA:
  - Inference among different kinds of concepts
  - Inference of unseen information
  - Grounding of word meanings in hierarchical structure of concepts

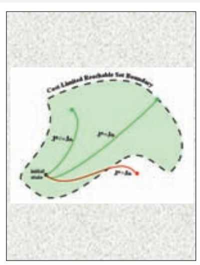


11:49–11:52 TuB2.15

A Machine Learning Approach for Real-Time Reachability Analysis

Ross Allen[1], Ashley Clark[1], Joseph Starek[1] and Marco Pavone[1]
[1]Stanford University

- A regression and a classification algorithm, trained with solutions to optimal control problems, can accurately predict reachability of novel reachability queries.
- These algorithms can solve a query in <10ms with >90% accuracy

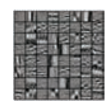


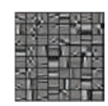
11:52–11:55 TuB2.16

Transfer of Sparse Coding Representations and Object Classifiers Across Heterogeneous Robots

Zsolt Kira[1],
[1]Georgia Tech Research Institute, Atlanta, GA 30318 USA

- We examine the problem of transfer learning in a heterogeneous robot team when sparse coding feature learning is used to classify objects.
- We propose a technique to align features learned across different robots and demonstrate transfer.
- We further show that codebook schemes significantly improve transfer.


Robot 1 features

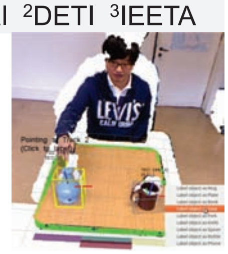

Robot 2 features

11:55–11:58 TuB2.17

A Perceptual Memory System for Grounding Semantic Representations in Intelligent Service Robots

M. Oliveira[1,3], G. H. Lim[1,3], L. Seabra Lopes[1,2,3], S. Kasaei[1,3], A. M. Tomé[1,2,3] and A. Chauhan[1,3]
[1]University of Aveiro, Portugal [2]DETI [3]IEETA

Based on an analysis of requirements for storing both semantic and perceptual data, a perceptual memory system was developed. The perceptual memory supports anchoring of object symbols as well as open-ended learning of object categories. http://youtu.be/jLJqY2fKTdI

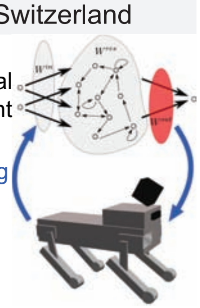


11:58–12:01 TuB2.18

Actor-Critic Design using Echo State Networks in a Quadruped Robot

Nico Schmidt, Matthias Baumgartner and Rolf Pfeifer
AI-Lab, University of Zurich, Switzerland

- Navigation of a simulated compliant quadruped robot is learnt from minimal prior knowledge through reinforcement learning (actor-critic design).
- The complex action-behavior mapping of the robot is captured by the dynamic reservoir of the echo state network that predicts future rewards and is used for action selection.



Human-Robot Interaction II / Robot Learning III

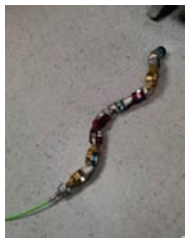
Chair *Jianwei Zhang, University of Hamburg*
Co-Chair

12:01–12:04 TuB2.19

Expensive Multiobjective Optimization for Robotics with Consideration of Heteroscedastic Noise

Ryo Ariizumi[1], Matthew Tesch[2], Howie Choset[2] and Fumitoshi Matsuno[1]
[1]Kyoto University [2]Carnegie Mellon University

- Expensive multiobjective optimization based on response surface method through noisy observations
- Use heteroscedastic Gaussian process regression to handle observation noise on robotic experiments
- The method is tested on numerical and real snake robot experiments

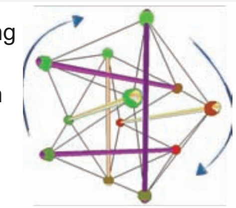


12:04–12:07 TuB2.20

Flop and Roll: Learning Robust Goal-Directed Locomotion for a Tensegrity Robot

A. Iscen[1,4], A. Agogino[2,4], V. SunSpiral[3,4] and K. Turner[1]
[1]Oregon State University [2]UARC [3]SGT Inc
[4]NASA Ames Research Center

- Learning based, compliant rolling locomotion algorithm
- Distributed and robust actuation
- Uses minimal sensory input
- Can handle different terrain conditions

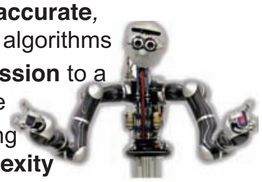


12:07–12:10 TuB2.21

Efficient Bayesian Local Model Learning for Control

Franziska Meier[1], Philipp Hennig[2] and Stefan Schaal[1,2]
[1]University of Southern California [2]Max-Planck-Institute for Intelligent Systems

- Model-based control requires **accurate**, **efficient** and **robust learning** algorithms
- We transform **Bayesian regression** to a **localized inference** procedure
- This results in a **robust** learning procedure that has **low complexity**
- **Evaluation on two robotic platforms demonstrates accurate learning**



Marine Robotics / Space Robotics

Chair *John Leonard, MIT*
Co-Chair

10:50–11:10 TuB3.1

Keynote: Human-guided video data collection in marine environments

Gregory Dudek
McGill University

- Issues in autonomous underwater data collection, a retrospective.
- Issues for robots working at the behest of a human operator, collecting data for their use.
- Combination of interactive command execution, navigation and vision-based data summarization

11:10–11:13 TuB3.2

Predicting the Speed of a Wave Glider ASV from Wave Model Data

P. Ngo[1], J. Das[2], J. Ogle[3], J. Thomas[4], W. Anderson[4] and R.N. Smith[3]
[1]QUT, [2]USC, [3]FLC, [4]LRI

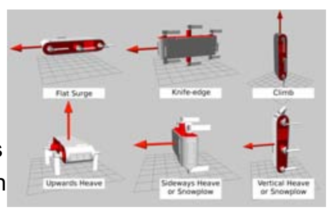
- Apply Gaussian process models to WAVEWATCH III model data to predict the velocity of a Wave Glider
- Train GP models with on-board data.
- Compare multiple regression models across different spatiotemporal scales to data collected during field trials.

11:13–11:16 TuB3.3

3D Trajectory Synthesis and Control for a Legged Swimming Robot

David Meger[1], Florian Shkurti[1], David Cortés Poza[1], Phipippe Giguère[2] and Gregory Dudek[1]
[1]McGill University [2]Université Laval

- Dynamic 3D legged swimming motions
- Feedback control with *in situ* parameter learning
- Trajectory synthesis HRI intuitive for scuba divers
- Validated via open ocean ship-wreck inspection

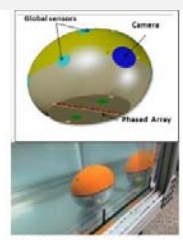


11:16–11:19 TuB3.4

Compact, Tetherless ROV for In-Contact Inspection of Underwater Structures

S Bhattacharyya[1], HH Asada[2],
[1,2] Massachusetts Institute of Technology

- EVIE: An ellipsoidal tetherless appendage free underwater vehicle for in contact inspection of submerged surfaces.
- Preliminary design with angled jets and analysis of the hybrid system.
- Demonstration of closed loop control on a horizontal underwater plane.



Conceptual EVIE (above) and Experimental Demonstration(below)

11:19–11:22 TuB3.5

3D Reconstruction of Bridge Structures above the Waterline with an USV

J. Han, J. Park and J. Kim
Division of Ocean Systems Engineering, KAIST, Korea

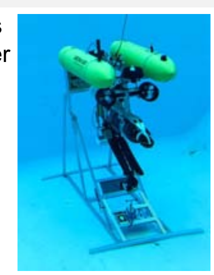
- GPS signals are severely deteriorated near or underneath bridge structures.
- A parameterized SLAM is introduced which estimates geometric parameters of detected bridge piers to achieve improved SLAM performance.
- 3D reconstruction of bridge structures is implemented by sensor fusion.

11:22–11:25 TuB3.6

I-AUV Docking and Intervention in a Subsea Panel

N. Palomeras[1], A. Peñalver[2], M. Massot-Campos[3], G.V[1], P.N[3], J.J.F[2], P.R[1], P.J.S[2], G.O[3], A.P[1]
[1]Universitat de Girona [2]Universitat Jaume I [3]Universitat Illes Balears

- The paper presents an autonomous intervention on a friendly underwater panel with a light-weight I-AUV.
- Autonomous intervention steps are: docking, valve turning, and hot stab plugging/unplugging.
- The mission has been successfully tested on a water tank with the Girona 500 I-AUV.



Marine Robotics / Space Robotics

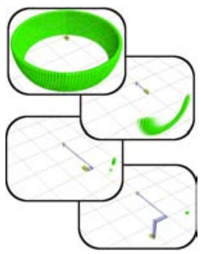
Chair *John Leonard, MIT*
Co-Chair

11:25–11:28 TuB3.7

Active Range-Only Beacon Localization for AUV Homing

Guillem Vallicrosa[1], Pere Ridao[1], David Ribas[1] and Albert Palomer[1]
[1]Universitat de Girona

- Sum of Gaussian (SOG) filter for Range-Only beacon localization.
- Active Localization by taking the movement leading to the smaller uncertainty after SOG filter update.
- Tested in a harbor environment with Girona500 AUV and an underwater panel with a beacon.

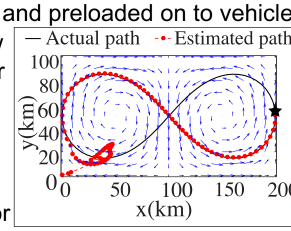


11:28–11:31 TuB3.8

Autonomous Vehicle Localization in a Vector Field: Underwater Vehicle Implementation

Zhuoyuan Song[1] and Kamran Mohseni[1]
[1]University of Florida

- A background vector field based localization method is discussed and implemented in an underwater scenario
- Background flow velocity maps with time stamps are predicted by ocean models and preloaded on to vehicles
- Vehicles measure local flow velocities and estimate their locations by comparing the measurements with map prediction using particle filters, which results in convergent localization error



11:31–11:34 TuB3.9

Underway Path-planning for an USV Performing Cooperative Navigation

Jonathan Hudson[1], Mae L. Seto[2]
[1]Dalhousie University [2]Defence R&D Canada

- USV used as a communications and navigations aid (CNA) for UUVs
- objective to reduce UUVs' positioning error through optimal path-planning for USV CNA
- USV path-planning adapts to changes in planned UUV paths
- implementation in MOOS-IvP

IVER2 UUVs used for in-water validation

11:34–11:37 TuB3.10

Experimental Validation of Robotic Manifold Tracking in Gyre-Like Flows

Matthew Michini and M. Ani Hsieh
SAS Lab, Mechanical Engineering & Mechanics, Drexel University, USA
Eric Forgoston
Department of Mathematical Sciences, Montclair State University, USA
Ira B. Schwartz
Naval Research Lab, USA

- Experimental validation of a collaborative control strategy for distributed tracking of coherent structures in ocean-like flows
- Novel multi-robot experimental test-bed capable of creating controllable ocean-like flows
- Experimental results for time-independent and time-dependent flow fields using a fleet of micro-autonomous surface vehicles (mASVs) show the feasibility and robustness of the approach.

Three mASVs in the Multi-Robot (MR) Tank with PIV/PTV tracer particles

11:37–11:40 TuB3.11

Trajectory Planning with Adaptive Control Primitives for Autonomous Surface Vehicles Operating in Congested Civilian Traffic

Brual C. Shah, Petr Švec, and Satyandra K. Gupta
Maryland Robotics Center, College Park, USA
Ivan R. Bertaska, Wilhelm Klinger, Armando J. Sinisterra, Karl von Ellenrieder, and Manhar Dhanak
Ocean & Mechanical Engineering, Florida Atlantic University, USA

- Developed 5D lattice-based trajectory planner for unmanned surface vehicle (USV) that reasons about reciprocal behaviors of civilian boats in congested traffic
- Planner incorporates contingency maneuvers into trajectory to be used in case any of civilian vessels breaches COLREGs
- Its computational efficiency is increased by dynamically time scaling motion primitives based on scene congestion

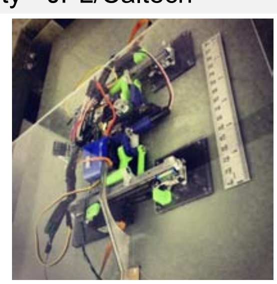
A scenario with an USV and civilian vessels moving to their respective destinations in a harbor region

11:40–11:43 TuB3.12

Inchworm Style Gecko Adhesive Climbing Robot

Simon Kalouche[12], Nicholas Wiltsie[2], Hai-jun Su[2] and Aaron Parness[2]
[1]Ohio State University [2]JPL/Caltech

- Two oppositional gecko adhesive pads provide omni-directional anchoring for climbing in any orientation
- Inchworm gait is realized with a rack and pinion mechanism
- Turning and plane changes are also possible.



Marine Robotics / Space Robotics

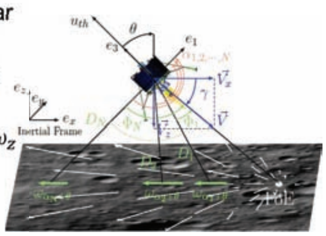
Chair *John Leonard, MIT*
Co-Chair

11:43–11:46 TuB3.13

Backup State Observer Based on Optic Flow Applied to Lunar Landing

G. Sabiron[1,2], L. Burlion[2], G. Jonniaux[3], E. Kervendal[3], E. Bornschlegl[4], T. Raharijaona[1], and F. Ruffier[1]
[1]Aix-Marseille University, CNRS, Institute of Movement Science, Biorobotics Dept., UMR7287, 13288, Marseille, France, [2]ONERA, The French Aerospace Lab, [3]Airbus Defence and Space, [4]European Space Agency

- **IMU-less** solution for lunar landing
- Only 3 non-gimbaled bio-inspired OF sensors
- Estimation of θ, ω_x and ω_z
- **LPV observer** based on an LPV model

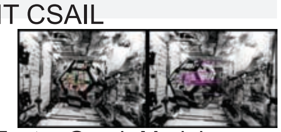


11:46–11:49 TuB3.14

Experimental Evaluation of On-board, Visual Mapping of an Object Spinning in Micro-Gravity aboard the International Space Station

Brent Tweddle[1], Timothy Setterfield[1], Alvar Saenz-Otero[1], David Miller[1], and John Leonard[2]
[1]MIT SSL [2]MIT CSAIL

- SLAM of an object spinning about its intermediate axis in microgravity
- Incorporates Dynamics into Factor Graph Model
- First ever run of SLAM algorithm onboard a computer in space (to the best of our knowledge)

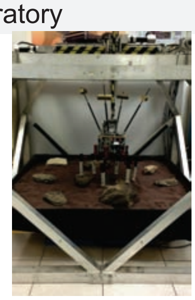


11:49–11:52 TuB3.15

Small Body Surface Mobility with a Limbed Robot

Daniel Helmick[1], Bertrand Douillard[1], and Max Bajracharya[1]
[1]Jet Propulsion Laboratory

- **Goal:** Develop, demonstrate, and evaluate small body (asteroids and comets) mobility with a limbed robot
- **Results:** Have demonstrated in a micro-gravity gantry various mobility behaviors with a prototype limbed robot including: landing, blind walking, hopping, and path following

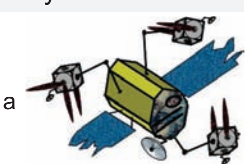


11:52–11:55 TuB3.16

On Controller Parametric Sensitivity of Passive Object Handling in Space by Robotic Servicers

Georgios Rekleitis[1], Evangelos Papadopoulos[1],
[1]National Technical University of Athens

- Passive object manipulation by orbital servicers in zero gravity
- Parametric sensitivity analysis of a model-based control, in terms of parametric uncertainties
- Linearization methodology used to provide a scheme for a-priori ensuring controller robust behavior
- Verification by simulations of realistic 3D scenarios

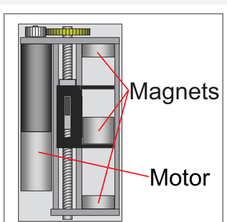


11:55–11:58 TuB3.17

Design of a Hopping Mechanism using Permanent Magnets for Small-scale Exploration Rovers

Masamitsu Kurisu
Tokyo Denki University

- Design of a hopping mechanism using permanent magnets for small-scale exploration rovers is presented.
- An example of the design procedure for deriving the potential ability of the mechanism is introduced.



Hopping mechanism

11:58–12:01 TuB3.18

Soft Landing of Capsule by Casting Manipulator System

Hitoshi Arisumi[1], Masatsugu Otsuki[2], and Shinichiro Nishida[3] [1]AIST [2]JAXA [3]Tottori Univ.

- Control method of capsule's flight by mutual tension of wires is proposed
- Motion planner, launcher, & energy dissipation device were developed
- Landing impact of the capsule was decreased by 97.8% in experiments
- Capsule floated for 0.4s and its soft landing was successfully realized

Marine Robotics / Space Robotics

Chair *John Leonard, MIT*
Co-Chair

12:01–12:04 TuB3.19

Particle Filter based 3D Position Tracking for Terrain Rovers using Laser Point Clouds

Peshala G. Jayasekara[1], Genya Ishigami[2] and Takashi Kubota[3]
[1]AIST [2]Keio University [3]ISAS, JAXA

- A state variable extension (SVE) method is proposed to establish a connection between (z, roll, pitch) and (x, y, yaw) state variables, given the knowledge of the terrain in the form of laser point clouds.
- SVE is employed in a particle filter to estimate the full 3D pose of a rover with rocker suspension.

12:04–12:07 TuB3.20

A Real-time Recognition Based Drilling Strategy for Lunar Exploration

Quanqi Quan and Junyue Tang
Harbin Institute of Technology, China

- Proposed a concept of LRD (lunar regolith drillability);
- Adopted pattern recognition method of SVM to recognize the LRD online;
- Verified real-time recognition based drilling strategy which can adapt to complicated drilling media well.

Dynamics and Control / Manipulation and Grasping IV

Chair *Jonas Buchli, ETH Zurich*
Co-Chair

13:30–13:50 TuC1.1

Keynote: Highly dynamic, energy-aware, biomimetic robots

Stefano Stramigioli
University of Twente

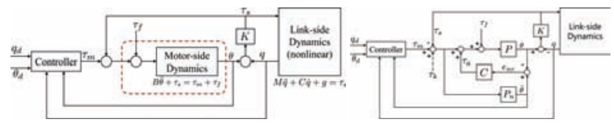
- Reproducing highly dynamic behaviour happening in nature can only be achieved by energy-aware modelling and control
- This keynote will present some activities, ideas, theory and arguments on the subject
- Biomimetic robots presented are a peregrine falcon and a cheetah

13:50–13:53 TuC1.2

Robust Control of Flexible Joint Robots Based On Motor-side Dynamics Reshaping using Disturbance Observer (DOB)

Min Jun Kim[1] and Wan Kyun Chung[1]
[1]POSTECH

- Use flexible joint model(motor dynamics+link dynamics)
- Apply DOB only on the motor-side dynamics
- Studies the stability issue of DOB-based structure
- Estimated signal is fed back into controller

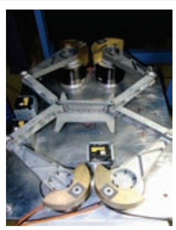


13:53–13:56 TuC1.3

A Novel RISE-Based Adaptive Feedforward Controller for RA-PKMs

Moussab Bennehar, Ahmed Chemori and François Pierrot
LIRMM, Univ. Montpellier 2 - CNRS, France

- A RISE-based adaptive controller for RA-PKMS is developed.
- An adaptive feedforward term is added to RISE control scheme.
- A projection operator is applied to reduce internal forces.
- Experimental results show the improved control performances.



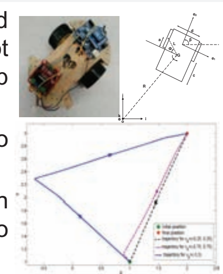
Dual-V RA-PKM

13:56–13:59 TuC1.4

Constrained Directions as a Path Planning Algorithm for Mobile Robots

Rana Soltani-Zarrin, Suhada Jayasuriya,
Drexel University

- Dynamic modeling of a 2wheeled differential drive mobile robot subject to slipping with a novel slip characterizing model
- More realistic results compared to existing models in literature
- Path finding algorithm based on constrained directions subject to actuator limitations

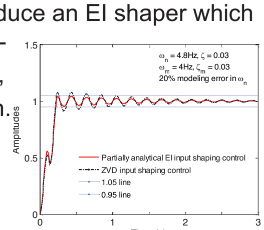


13:59–14:02 TuC1.5

Partially Analytical Extra-Insensitive Shaper for a Lightly Damped Flexible Arm

Chul-Goo Kang[1] and Manh-Tuan Ha[1]
[1]Konkuk University, Korea

- In order to suppress residual vibration for a lightly damped flexible arm, we introduce an EI shaper which is represented by a partially closed form with one parameter, instead of a numerical solution.
- The validity of the partially analytical EI shaper is shown by simulations and experiments.

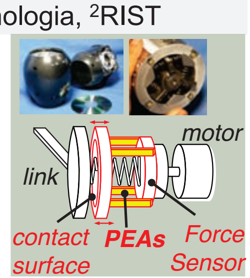


14:02–14:05 TuC1.6

Terminal Sliding-Mode Based Force Tracking Control of Piezoelectric Actuators for Variable Physical Damping

Jinoh Lee[1], Maolin Jin[2], Nikolaos G. Tsagarakis[1] and Darwin G. Caldwell[1]
[1]Istituto Italiano di Tecnologia, [2]RIST

- A robust force tracking controller for Piezoelectric actuator (PEA)
- Terminal SMC incorporating with an efficient model-free dynamics compensation for hysteresis and creep effects.
- Application on physical variable damping system driven by PEA.



Dynamics and Control / Manipulation and Grasping IV

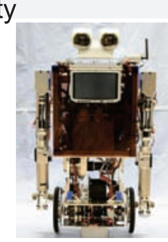
Chair *Jonas Buchli, ETH Zurich*
Co-Chair

14:05–14:08 TuC1.7

Development of a Single Controller for the Compensation of Several Types of Disturbances During Task

Luis Canete[1], Takayuki Takahashi[1],
[1]Fukushima University

- Presenting the Inverted PENdulum Type Assistant Robot (I-PENTAR)
- Development of “a single controller for multiple tasks” method
- Improved disturbance compensation method

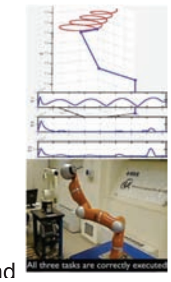


14:08–14:11 TuC1.8

A Reverse Priority Approach to Multi-Task Control of Redundant Robots

F. Flacco and A. De Luca
DIAG, Sapienza University of Rome, Italy

- Inverse differential kinematics for multiple tasks **free** of algorithmic singularities
- Contributions by high priority tasks added **after** those of lower priority (**reverse**)
- Rank loss in prioritized task Jacobians does not affect the original **hierarchy**
- Validation with numerical simulations and



14:11–14:14 TuC1.9

Dynamic modeling of continuum robots using the Euler-Lagrange formalism

Valentin Falkenhahn[1], T. Mahl[1], A. Hildebrandt[2], R. Neumann[2] and Oliver Sawodny[1]
[1]University of Stuttgart [2]Festo AG & Co. KG

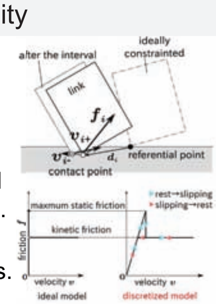
- Aim: Model of continuum robots with multiple sections for model-based MIMO controller design
- Kinetic model based on kinematic model (constant curvature)
- Results validated with simulations and experiments

14:14–14:17 TuC1.10

Fast and Reasonable Contact Force Computation in Forward Dynamics Based on Momentum-Level Penetration Compensation

Naoki Wakisaka[1], Tomomichi Sugihara[1],
[1]Osaka University

- We proposed a novel $O(n)$ forward dynamics computation method.
- The numerical stability is improved by regularization technique.
- The penetrations are compensated at the momentum-level by low cost.
- A novel model of friction force transition at the discretized process.



14:17–14:20 TuC1.11

Recursive Dynamics and Feedback Linearizing Control of Serial-Chain Manipulators

Matthew Travers and Howie Choset

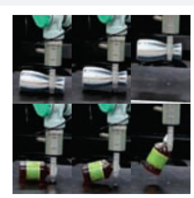
- We derive closed form feedback linearizing controllers for N-link serial chain manipulators
- The analytical expressions make it possible to accurately control these complex-coupled systems, even in the presence of significant joint elasticity

14:20–14:23 TuC1.12

Grasp Planning for Constricted Parts of Objects Approximated with Quadric Surfaces

T. Tsuji[1], S. Uto[1], K. Harada[2], R. Kurazume[1], T. Hasegawa[3] and K. Morooka[1]
[1]Kyushu University [2]AIST [3]Kumamoto-NCT

- We develop a grasp planner which allows a robot to grasp the constricted parts of objects.
- We propose a method for grasp stability evaluation based on the stress distribution applied to an object by the fingers.



Dynamics and Control / Manipulation and Grasping IV

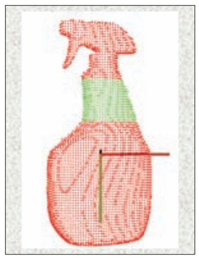
Chair *Jonas Buchli, ETH Zurich*
Co-Chair

14:23–14:26 TuC1.13

Fast grasping of unknown objects using force balance optimization

Qujiang Lei, Martijn wisse
Delft University of Technology

- A novel grasping algorithm is presented for unknown object grasping. Force balance calculation on XOY and XOZ plane makes sure the grasping very reliable and stable. The robot can quickly work out the grasping position and orientation with one point cloud or two point clouds.



14:26–14:29 TuC1.14

Robotic Nonprehensile Catching: Initial Experiment

Masahito Yashima[1] and Tasuku Yamawaki[1]

[1]National Defense Academy of Japan

- Initial efforts to achieve robotic nonprehensile catching
- The importance of nonprehensile catching in a robotic catching task is shown
- Control strategies for nonprehensile catching are proposed
- Demonstration through experiments

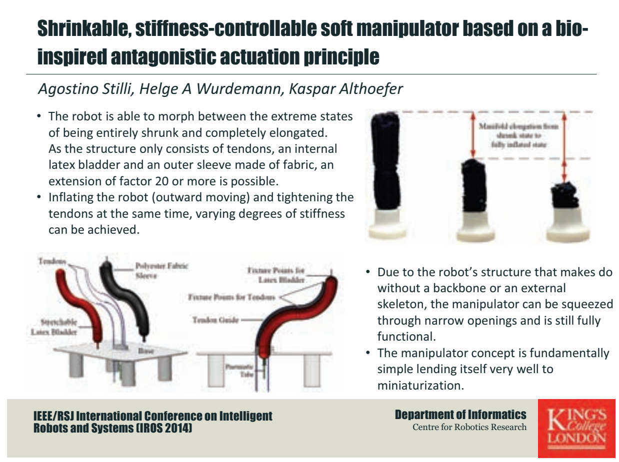
14:29–14:32 TuC1.15

Changing Pre-Grasp Strategies With Increasing Object Location Uncertainty

Boris Illing[1], Tamim Asfour[1] and Nancy S. Pollard[2]
[1]Karlsruhe Institute of Technology
[2]Carnegie Mellon University

- Presenting a set of human pre-grasp strategies commonly used when dealing with various amounts of object location uncertainty
- Mostly used: direct grasp (low uncertainty) and tapping (high)
- Both strategies compared with a Shadow Dexterous Hand

14:32–14:35 TuC1.16

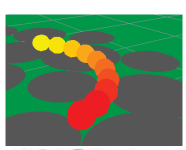


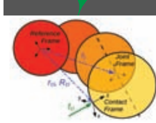
14:35–14:38 TuC1.17

Guided Locomotion in 3D for Snake Robots Based on Force Optimization

Hugo Ponte, Matt Travers, and Howie Choset
Carnegie Mellon University

We apply contact force optimization, in combination with gain scheduling, to perturb existing gait controllers (on a simulated snake robot) to perform better in rugged three-dimensional environments.





14:38–14:41 TuC1.18

Push Resistance in In-hand Manipulation

Junhu He, Jianwei Zhang
University of Hamburg (TAMS)

- The object and fingers are considered as a black box;
- Thumb is controlled to push slightly along different directions;
- The contact force feedback is collected to estimate the robot object interaction state.

Dynamics and Control / Manipulation and Grasping IV

Chair *Jonas Buchli, ETH Zurich*
Co-Chair

14:41–14:44	TuC1.19

Online Interactive Perception of Articulated Objects with Multi-Level Recursive Estimation Based on Task-Specific Priors

Roberto Martín Martín and Oliver Brock
Robotics and Biology Lab, Technische Universität Berlin

- Perceptual skill for the online perception of degrees of freedom
- Perceives type and parameters (orientation, position) of joints
- Estimates uncertainty of perceived dofs
- Tracks rigid bodies and joint values
- Useful to control and monitor robot manipulation and detect failures

14:47–14:50	TuC1.21

Sponsor Talk: Components for Mobile Manipulation: Light-Weight Arms and Robotic Hands

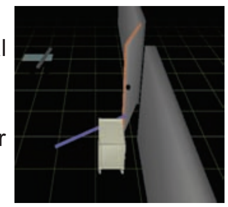
Christopher Parlitz
SCHUNK

- Modular approach and integrated components for robot applications
- Open control architecture
- Low power consumption
- **Products for today's research and industrial service robot solutions**

14:44–14:47	TuC1.20

Using Environment Objects as Tools: Unconventional Door Opening

Martin Levihn and Mike Stilman
Georgia Institute of Technology



- Robots should be able to utilize environment objects as tools
- We present the concept of physical constraint propagation
- Demonstrate application to the problem of opening a jammed door
- Algorithm finds lever for prying the door or configurations for ramming it with a cart

Humanoids and Bipeds II / Domestic and Interactive Robots

Chair *C. S. George Lee, Purdue University*
Co-Chair

13:30–13:50 TuC2.1

Keynote: Human-Robot Interaction Socially Assistive Robotics

Brian Scassellati
Yale University

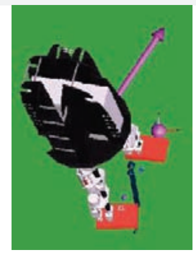
- Robots tutors take on a variety of roles: teacher, student, and peer
- We show results for these roles in:
  - Nutrition Education
  - Teaching ESL
  - Bullying Prevention
  - Social Skills Training

13:50–13:53 TuC2.2

Perturbation Recovery of Biped Walking by Updating the Footstep

Chenglong Fu
Tsinghua University

- This paper presented a strategy of updating the footstep for humanoid walking to recover balance from a large perturbation.
- The footstep calculator consists of three stages: perturbation detection, rapid adaption, and capturabililty inspection.

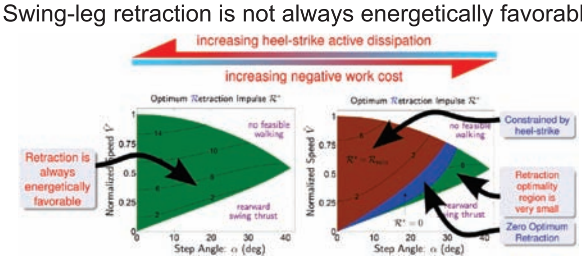


13:53–13:56 TuC2.3

Swing-Leg Retraction Efficiency in Bipedal Walking

S. J. Hasaneini[1,2], Chris J.B. Macnab[2], John .E.A. Bertram[2] and Henry Leung[2]
[1]Cornell University [2]University of Calgary

Swing-leg retraction is not always energetically favorable

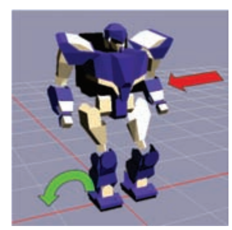


13:56–13:59 TuC2.4

Falling Prevention of Humanoid Robots by Switching Standing Balance and Hopping Motion Based on MOA Set

Ko Yamamoto[1]
[1]University of Tokyo

- The Maximal Output Admissible (MOA) set is extended to a hopping motion.
- Based on the MOA set, we can adaptively switch the two types of controllers.
- The falling prevention control is validated with simulations.



13:59–14:02 TuC2.5

Preliminary Walking Experiments with Underactuated 3D Bipedal Robot MARLO

B. G. Buss[1], A. Ramezani[1], K. Akbari Hamed[1], B. A. Griffin[1], K. S. Galloway[2] and J. W. Grizzle[1]
[1]University of Michigan, [2]U.S. Naval Academy

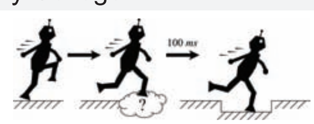
- MARLO has 13 DOF (single-support) and 6 actuators. Feet are passive.
- Control based on virtual constraints.
- Experiments initiated from free standing position.
- Lateral stabilization inspired by SIMBICON enabled 3D walking indoors and outdoors.

14:02–14:05 TuC2.6

Running into a Trap: Numerical Design of Task-Optimal Preflex Behaviors

J. Van Why[1], C. Hubicki[1], M. Jones[1], M. Daley[2] and J. Hurst[1] [1]Oregon State University [2]Royal Veterinary College

- Preflexes are pre-reflex behaviors for disturbance rejection in the presence of feedback delays



- We introduce a method for designing energy-optimal preflexes via trajectory optimization for efficient legged locomotion on unpredictable terrain

Humanoids and Bipeds II / Domestic and Interactive Robots

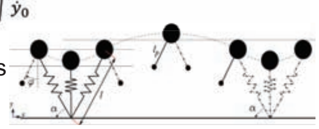
Chair *C. S. George Lee, Purdue University*
Co-Chair

14:05–14:08 TuC2.7

SLIP with swing leg augmentation as a model for running

Aida Mohammadinejad, Maziar A. Sharbafi and Andre Seyfarth
Lauflabor locomotion lab, TU Darmstadt

- **Model:** SLIP + pendulum for swing leg movement
- **Control approach**: pendulum length adjustment at takeoff (to) with $l_p = l_{p0}\sqrt{\frac{\dot{y}_{to}}{\dot{y}_0}}$
- **Achievements:**
  - Stability and robustness
  - Similarity to humans running pattern



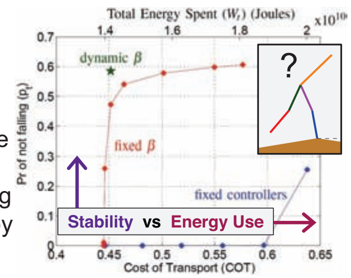
SLIP + pendulum like swinging

14:08–14:11 TuC2.8

Quantifying the Trade-Offs Between Stability versus Energy Use for Underactuated Biped Walking

Cenk Oguz Saglam, Katie Byl
University of California, Santa Barbara

- We measure stability by average steps-to-failure (MFPT)
- We quantify energy consumption by Cost of Transport (COT)
- By switching between multiple controllers, we increase stability by 129% while decreasing energy consumption by 29%.

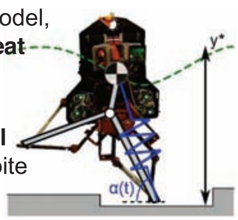


14:11–14:14 TuC2.9

Highly Robust Running of Articulated Bipeds in Unobserved Terrain

Albert Wu[1], Hartmut Geyer[1]
[1]Carnegie Mellon University

- We embed the **robust behavior** of an **abstract gait model** in the **control** of a higher order robot model.
- In the spring-mass running gait model, leg placement gives **near-deadbeat** rejection of large, **unobserved** changes in **ground height.**
- Simulation shows that the **bipedal robot inherits this stability** despite modeling error and sensor noise.

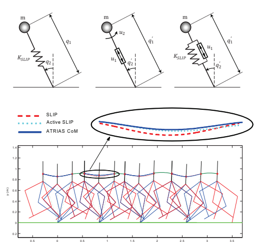


14:14–14:17 TuC2.10

From Template to Anchor: A Novel Control Strategy for Spring-Mass Running of Bipedal Robots

Behnam Dadashzadeh[1], Hamid Reza Vejdani[2], and Jonathan Hurst[2]
[1]School of Engineering-Emerging Technologies, University of Tabriz,
[2]Dynamic Robotics Laboratory, Oregon State University

- Full dynamic model of a multibody real biped robot.
- The active SLIP model tracks the SLIP model.
- The multibody model tracks the toe force profile of the active SLIP model.
- Stable and Steady Running.



14:17–14:20 TuC2.11

An Estimation Model for Footstep Modifications of Biped Robots

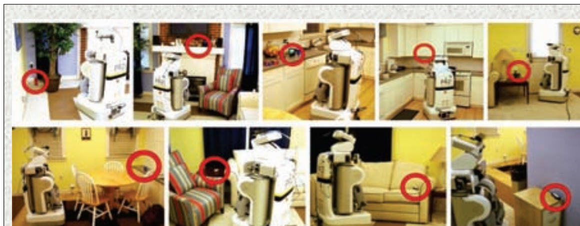
Robert Wittmann[1], Arne-Christoph Hildebrandt[1], Alexander Ewald[1] and Thomas Buschmann[1]
[1]Technische Universität München

- **Three mass estimation model** with **two unactuated DoFs**
- Stabilization unit and compliant unilateral contacts are included
- Calculation of footstep modifications with the prediction results
- **Real-time application** and experimental results

14:20–14:23 TuC2.12

Finding and Navigating to Household Objects with UHF RFID Tags by Optimizing RF Signal Strength

Travis Deyle, Matthew S. Reynolds, & Charles C. Kemp



PR2 robot's final configurations after navigating to tagged objects in the Georgia Tech Aware Home

Humanoids and Bipeds II / Domestic and Interactive Robots

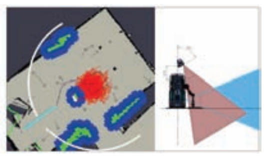
Chair *C. S. George Lee, Purdue University*
Co-Chair

14:23–14:26 TuC2.13

RGB-D Sensor Setup for Multiple Tasks of Home Robots and Experimental Results

P. de la Puente[1], M. Bajones[1], P. Einramhof[1], D. Wolf[1], D. Fischinger[1] and M. Vincze[1]
[1]Technical University of Vienna

- Two RGB-D sensors to cover conflicting needs
- Adaptation of ROS navigation for the proposed setup
  - Data preprocessing
  - Parameter tuning
  - Solving blind area problems
- Rooms and places
- SMACH-based behaviour

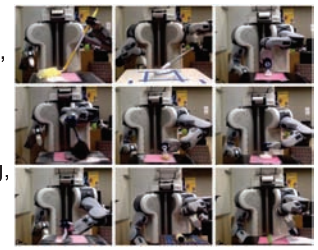


14:26–14:29 TuC2.14

Enhanced Robotic Cleaning with a Low-cost Tool Attachment

Zhe Xu and Maya Cakmak
Computer Science & Engineering Department
University of Washington

- Designed a universal attachment, called **Griple**, that makes human tools more robot-friendly.
- Demonstrated significant improvements in grasping, applying, and placing 10 different cleaning tools.



14:29–14:32 TuC2.15

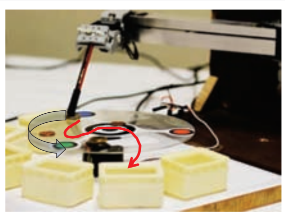
CHARM: A Platform for Algorithmic Robotics Education & Research

Surya P. N. Singh, Hanna Kurniawati, Kianoosh S. Naveh, Joshua Song & Tyson Zastrow
Uni. Queensland – Robotics Design Lab

- Fast Money: Autonomously sort moving coins to bins
- Profitable: a diverse mezzanine robotics project
- Low-Cost: Based on simple, widely obtainable parts

∴ Engineering + Computation

➔ **Algorithmic Robotics Education**

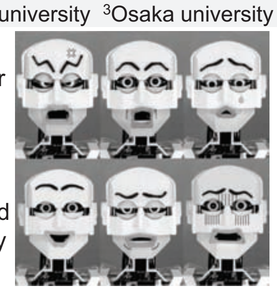


14:32–14:35 TuC2.16

Development of a Comic Mark Based Expressive Robotic Head Adapted to Japanese Cultural Background

Tatsuhiro Kishi[1,2], Hajime Futaki[2], Gabriele Trovato[2], Nobutsuna Endo[3], Matthieu Destephe[2], Sarah Cosentino[2], Kenji Hashimoto[2] and Atsuo Takanishi[2]
[1]JSPS research fellow [2]Waseda university [3]Osaka university

- Flexible LED display and mechanisms are designed for displaying the cartoon marks on the robotic head
- Experimental evaluation shows comic marks increased the emotion expression ability of the robotic head

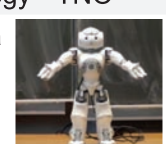


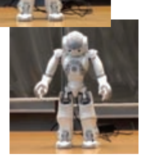
14:35–14:38 TuC2.17

Effects of Bodily Mood Expression of a Robotic Teacher on Students

Junchao Xu[1], Joost Broekens[1], Koen Hindriks[1] and Mark A. Neerincx[1,2]
[1]Delft University of Technology [2]TNO

- A robot gave a 30 minutes lecture in a university class setting.
- Robot mood was expressed by 41 modulated coverbal gestures.
- Students' own valence/arousal and ratings of the lecturing quality and the gesture quality were significantly higher in the positive mood condition.





14:38–14:41 TuC2.18

Real-Time Recognition of Pointing Gestures for Robot to Robot Interaction

Polychronis Kondaxakis[1], Joni Pajarinen[1], and Ville Kyrki[1]
[1]Intelligent Robotics Group, Aalto University

- The detection is based on **RGB-D** and a **NAO** robot is used as the pointing agent in the experiments.
- Algorithms implemented under **ROS**
- Developed system operates efficiently in **Real-Time**
- Results indicate a **73%** success rate out of **330** pointing gesture attempts

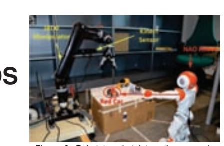


Figure 8. Robot to robot interaction scenario where NAO points at red wooden car and Kinova's JACO arm grasps and relocates the object.

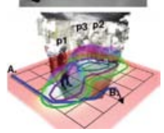
Humanoids and Bipeds II / Domestic and Interactive Robots

Chair *C. S. George Lee, Purdue University*
Co-Chair

14:41–14:44 TuC2.19

Adaptive Spacing in Human-Robot Interactions

P. Papadakis[1], P. Rives[1] and A. Spalanzani[2]
[1]INRIA, Sophia Antipolis, France
[2]Univ. Grenoble, LIG, France, INRIA



- **Goal**: Spatially situated Human-Robot interaction.
- **Contribution**: Generative model of atomic/global social spacing, accounting for uncertainty and perception capacity.
- **Experiments**: Socially-compliant navigation in populated scenes.

14:44–14:47 TuC2.20

Determining the Affective Body Language of Older Adults during Socially Assistive HRI

Derek McColl and Goldie Nejat
Autonomous Systems and Biomechatronics Laboratory,
Department of Mechanical and Industrial Engineering,
University of Toronto, Canada

- Our work focuses on developing a socially assistive robot designed to engage older adults in the important meal-eating activity.
- A novel automated affect recognition and classification system using body language features and learning-based classifiers is developed to allow the robot to interpret affective body language during one-on-one assistive interactions.
- Results from meal-time experiments with older adults showed that the system was able to classify natural body language displays at rates up to 93.6% for arousal and 77.9% for valence.

The socially assistive robot Brian 2.1 and an elderly user during the meal-eating activity.

14:47–14:50 TuC2.21

Sponsor Talk: The Eyes: A History of Baxter's Personification

Kyle Maroney
Rethink Robotics

- Origin
- The Power of Personification
  - Indicate State
  - Convey Intent
  - Provide Comfort
- Rethink Robotics Brand

Localization and Mapping III / Visual Servoing and Tracking

Chair *José Neira, Universidad de Zaragoza*
Co-Chair

13:30–13:50	TuC3.1

Keynote: The SLAM Problem - A Fifteen Year Journey …..

Gamini Dissanayake
University of Technology, Sydney

The SLAM problem has revealed many surprises since the first "solutions" emerged in the late 90's. This talk will chronicle the author's journey in looking for solutions to SLAM through extended Kalman filters, information filters, non-linear optimisers and most recently linear least-squares.

13:50–13:53	TuC3.2

Direction-Driven Navigation Using Cognitive Map for Mobile Robots

Vui Ann Shim[1], Bo Tian[1], Miaolong Yuan[1], Huajin Tang[1,2] and Haizhou Li[1] [1]Institute for Infocomm Research, Singapore [2]Sichuan University, China

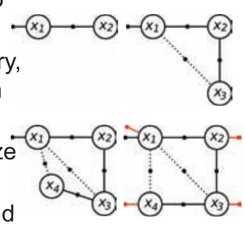
- To propose a direction-driven navigation system. A grid-based direction planner (as global planner) is devised to extract direction instructions
- To propose a local planner with asymmetrical multi-layered module
- To implement simultaneous localization and mapping (SLAM) and navigation of a mobile robot in an indoor environment

13:53–13:56	TuC3.3

iSPCG: Incremental SPCG for Online SLAM with Many Loop-Closures

Yong-Dian Jian and Frank Dellaert
Georgia Institute of Technology

- Use iSAM to solve a subgraph to obtain an approx. solution
- If iSAM's solution is unsatisfactory, use SPCG to solve the full graph to obtain the optimal solution
- Use SPCG's solution to regularize iSAM in the next steps
- iSPCG is efficient, consistent, and can deliver the optimal solution

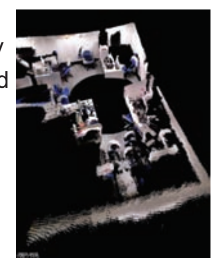


13:56–13:59	TuC3.4

Real Time RGB-D Registration and Mapping in Texture-less Environments

Khalid Yousif[1], Alireza Bab-Hadiashar[1] and Reza Hoseinnezhad[1]
[1]RMIT University, Australia

- Real time 3D SLAM for texture-less scenes using depth information only
- Developed a novel sampling method using Ranked Order Statistics
- Extracts points carrying the most useful information for registration
- Reduces computational time while achieving high accuracy

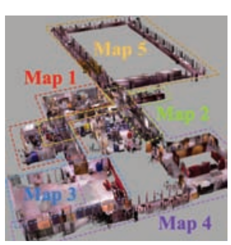


13:59–14:02	TuC3.5

Online Global Loop Closure Detection for Multi-Session Graph-Based SLAM

Mathieu Labbé and François Michaud
Université de Sherbrooke

- Maps are merged by detecting loop closures between sessions.
- Memory management approach (Working Memory, Long-term Memory) is used to respect real-time constraints independently of the size of the environment.
- RGB-D mapping.

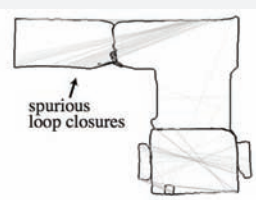


14:02–14:05	TuC3.6

Selecting Good Measurements via l_1 Relaxation: a Convex Approach for Robust Estimation over Graphs

Luca Carlone[1], Andrea Censi[2], Frank Dellaert[1]
[1]Georgia Institute of Technology, [2]Massachusetts Institute of Technology

- Outliers are not observable if one does not assume a generative model
- We frame outlier rejection as selection of the maximal set of **coherent** measurements
- We focus on pose graph optimization: measurement selection can be formulated as a **linear program**, which entails fast computation and scalability.



Localization and Mapping III / Visual Servoing and Tracking

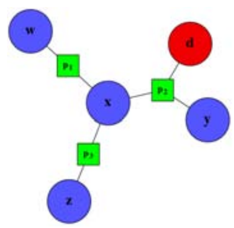
Chair *José Neira, Universidad de Zaragoza*
Co-Chair

14:05–14:08	TuC3.7

Hybrid Inference Optimization for Robust Pose Graph Estimation

Aleksandr Segal[1] and Ian Reid[2],
[1]University of Oxford [2]University of Adelaide

- New optimization algorithm for pose graph estimation
- Approximate Discrete-Continuous Inference replaces Least-Squares solver in Gauss-Newton algorithm
- Can infer outlier loop closures significantly better than competing robust techniques

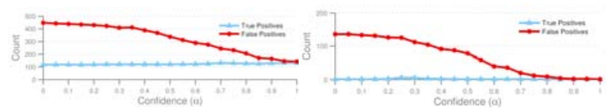


14:08–14:11	TuC3.8

Robust Graph SLAM: A Comparative Analysis

Y. Latif[1], C. Cadena[2], and J. Neira[1]
[1]University of Zaragoza [2]University of Adelaide

- Dataset for Robust SLAM evaluation based on KITTI dataset, a total of 7 x 21 sequences
- Comparative analysis of Robust Methods and their effect on the underlying Graph-SLAM representation

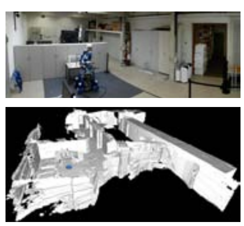


14:11–14:14	TuC3.9

Graph SLAM with Signed Distance Function Maps on a Humanoid Robot

René Wagner[1], Udo Frese[2] and Berthold Bäuml[1]
[1]German Aerospace Center (DLR) [2]University of Bremen

- Dense truncated signed distance function (TSDF) mapping/ICP (KinectFusion) integrated with sparse graph SLAM
- SLAM optimizer moves local TSDF sub-maps attached to reference nodes for global map deformation
- High quality large-scale maps due to improved sensor model



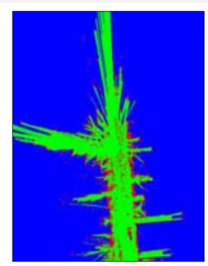
14:14–14:17	TuC3.10

Credibilist Simultaneous Localization and Mapping with a LIDAR

G. Trehard[1], Z. Alsayed[1],
E. Pollard[1], B. Bradai[2] and F. Nashashibi[1]
[1]INRIA [2]Valeo

A new SAM solution based on the Transferable Belief Model (TBM) framework is proposed in this article.

The paper aims at proving that the use of this new theoretical context opens a lot of perspectives for the SLAM community



14:17–14:20	TuC3.11

Novel Insights into the Impact of Graph Structure on SLAM

Kasra Khosoussi, Shoudong Huang
Gamini Dissanayake
CAS, University of Tech. Sydney

Graph Connectivity ⟺ Achievable Accuracy

- Number of Spanning Trees
- Algebraic Connectivity
- Average Degree

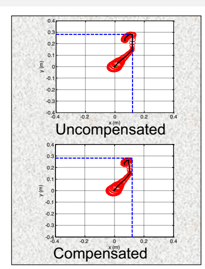
- Applications: Graph Pruning, Active SLAM
- Applicable to Estimation Problems in Sensor Networks

14:20–14:23	TuC3.12

Robust Model Predictive Control for Visual Servoing

Akbar Assa, Farrokh Janabi-Sharifi
Department of Mechanical and Industrial Engineering
Ryerson University

- A model predictive controller is exploited for trajectory generation considering the system constraints.
- The uncertainties of the system are estimated and compensated.
- An online controller is employed to control the robot towards the goal using the generated trajectories.



Localization and Mapping III / Visual Servoing and Tracking

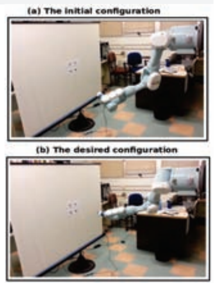
Chair *José Neira, Universidad de Zaragoza*
Co-Chair

14:23–14:26 TuC3.13

Prescribed Performance Image Based Visual Servoing under Field of View Constraints

Shahab Heshmati-alamdari, Charalampos P. Bechlioulis, Minas V. Liarokapis and Kostas J. Kyriakopoulos
National Technical University of Athens

- A novel IBVS scheme that imposes prescribed transient and steady state response on the image feature coordinate errors.
- Providing an error transformation that converts the original constrained problem of IBVS into an equivalent unconstrained one.
- Satisfying the Visibility constraints.
- Very low computational complexity which makes implementation on fast embedded control platforms straightforward.



14:26–14:29 TuC3.14

Monocular Template-based Vehicle Tracking for Autonomous Convoy Driving

Carsten Fries and Hans-Joachim Wuensche
University of the Bundeswehr Munich

- **Main goal:** Vision-based autonomous convoy driving
- **Paper-specific goal:** Monocular vehicle tracking
  - 3D template models
  - Cascade classifiers
    - Haar, LBP, HOG
  - Unscented Kalman filter
  - Dynamic region growing

14:29–14:32 TuC3.15

Real-time Object Pose Recognition and Tracking with an Imprecisely Calibrated Moving RGB-D Camera

Karl Pauwels[1], Vladimir Ivan[2], Eduardo Ros[1] and Sethu Vijayakumar[2]
[1]Univ. of Granada, Spain [2]Univ. of Edinburgh, UK

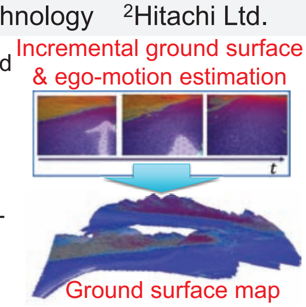
- 40 Hz pose updates with >100 objects
- multi-object and manipulator pose with implicit occlusion handling

14:32–14:35 TuC3.16

Robust Ground Surface Map Generation Using Vehicle-Mounted Stereo Camera

Kouma Motooka[1], Shigeki Sugimoto[1], Masatoshi Okutomi[1] and Takeshi Shima[2]
[1]Tokyo Institute of Technology [2]Hitachi Ltd.

- A **direct** approach to ground surface map generation.
- Combinational use of feature- and area-based methods for **robustness**.
- **Friendly** to off-road mobile-robot applications: e.g. traversable area detection.

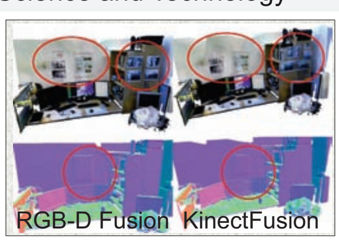


14:35–14:38 TuC3.17

RGB-D Fusion: Real-time Robust Tracking and Dense Mapping with RGB-D Data Fusion

Seong-Oh Lee, Hwasup Lim, Hyoung-Gon Kim and Sang Chul Ahn
Korea Institue of Science and Technology

- We present RGB-D Fusion which robustly tracks and reconstructs dense textured surfaces of scenes by integrating both color and depth images.

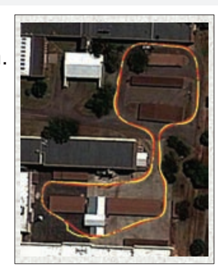


14:38–14:41 TuC3.18

Bearings-only Path Following with a Vision-based Potential Field

Deon Sabatta[1,2] and Roland Siegwart[2]
[1]CSIR, South Africa [2]ETH Zurich, Switzerland

- We present a vision-based teach-and-replay path following algorithm.
- The algorithm uses feature bearings to construct a potential field which is then minimised by a controller.
- The algorithm is demonstrated on a 400m outdoor urban path.



Localization and Mapping III / Visual Servoing and Tracking

Chair *José Neira, Universidad de Zaragoza*
Co-Chair

14:41–14:44	TuC3.19

Event-based, 6-DOF Pose Tracking for High-Speed Maneuvers

Elias Mueggler, Basil Huber
and Davide Scaramuzza
University of Zurich

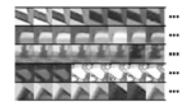
- Event-based tracking during high-speed maneuvers such as quadrotor flips
- Rotational speeds of 1200°/s

14:44–14:47	TuC3.20

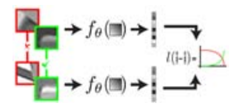
Learning Visual Feature Descriptors for Dynamic Lighting Conditions

Nicholas Carlevaris-Bianco and Ryan M. Eustice
University of Michigan

- Method to learn visual feature descriptors that are robust to changes in lighting
- Improves performance compared to SIFT and SURF on challenging long-term dataset



Feature Tracks



Descriptor Learning

14:47–14:50	TuC3.21

Detection of Small Moving Objects Using a Moving Camera

Moein Shakeri[1], Hong Zhang[1],
[1]University of Alberta, Edmonton, Canada

- Steps:

(1) Motion compensation by two kinds of registration methods on Wavelet components in two levels, (2) GMM algorithm with a combination of a component-based technique and pixel based learning framework, and (3) Particle filter to optimize the performance.

Actuators / Kinematics and Mechanism Design II

Chair *Venkat Krovi, University at Buffalo (SUNY Buffalo)*
Co-Chair

15:00–15:20	TuD1.1

Keynote: Robots for Interaction with Humans and Unknown Environments

Alin Albu-Schäffer
DLR, Institute of Robotics and Mechatronics

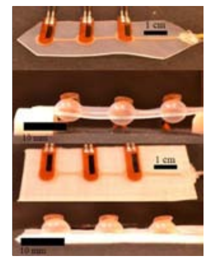
- The talk will discuss how robot design evolves to enable safe and robust interaction with humans and how robotics and biomechanics can benefit from each other.

15:20–15:23	TuD1.2

Soft Pneumatic Actuator Skin with Embedded Sensors

Chansu Suh[1], Jordi Condal Margarit[2],
Yun Seong Song[1] and Jamie Paik[1]
[1]École Polytechnique Fedérale de Lausanne

The Soft Pneumatic Actuator skin (SPA-skin) is an ultra-thin (< 1 mm) distributed actuator. As various actuation points can have embedded sensors, the SPA-skin can work as both input and output hardware for diverse wearable robotics application including human machine interfacing, vibro-tactile feedback device and distributed soft surface sensor.

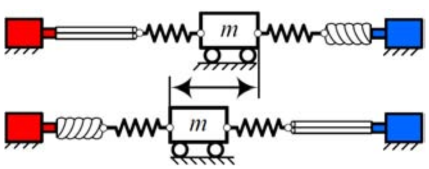


15:23–15:26	TuD1.3

Towards Variable Stiffness Control of Antagonistic Twisted String Actuators

Dmitry Popov, Igor Gaponov,
and Jee-Hwan Ryu
Korea University of Technology and Education

- A new type of variable stiffness actuator powered by twisted string is introduced.
- Simultaneous position/tension control law is proposed.



15:26–15:29	TuD1.4

A Multiplex Pneumatic Actuator Drive Method Based on Acoustic Communication in Air Supply Line

Koichi Suzumori[1], Naoto Osaki[2], Jumpei Misumi[2],
Akina Yamamoto[2] and Takefumi Kanda[2]
[1]Tokyo Institute of Technology, [2]Okayama University

- A new control method for pneumatic system is proposed, which removes electrical control lines in pneumatic mechatronics.
- Acoustic communication and power supply device for each local module are developed.
- The prototype works very well.

15:29–15:32	TuD1.5

A Low-Friction Passive Fluid Transmission and Fluid-Tendon Soft Actuator

John P. Whitney[1], Matthew F. Glisson[1],
Eric L. Brockmeyer[1], and Jessica K. Hodgins[1]
[1]Disney Research, Pittsburgh, PA, USA

- Passive hydrostatic transmission: antagonist pairs of leak-free, low-stiction rolling diaphragm cylinders, air or water working fluid
- Water-filled: stiff, completely backdrivable, high force bandwidth, zero backlash, haptic qualities
- Soft-actuator design demonstrated

15:32–15:35	TuD1.6

Intermittent self-closing mechanism for a MACCEPA-based SPEA

Glenn Mathijssen, R. Furnémont, B. Brackx, R. Van Ham, D. Lefeber, and B. Vanderborght
Vrije Universiteit Brussel, Belgium

- Self closing guides provide intermittent motion to recruit parallel springs in succession.
- Motor torque and energy consumption lowered due to variable load cancellation.
- Bi-directional output torque and variable stiffness.

Actuators / Kinematics and Mechanism Design II

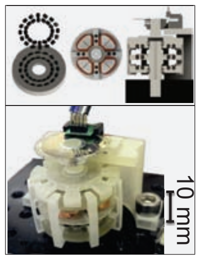
Chair *Venkat Krovi, University at Buffalo (SUNY Buffalo)*
Co-Chair

15:35–15:38	TuD1.7

Resonant Parallel Elastic Actuator for Biorobotic Applications

Angelo Sudano[1], Nevio Luigi Tagliamonte[1],
Dino Accoto[1] and Eugenio Guglielmelli[1]
[1]Università Campus Bio-Medico di Roma

- In several biorobotic applications it is necessary to efficiently produce oscillatory motions
- We developed a compact axial flux miniature motor integrating a parallel magnetic spring
- The motor can oscillate at 8.5 Hz, with an amplitude of 40°, absorbing 860 mW.

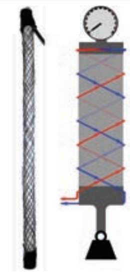


15:38–15:41	TuD1.8

Smart Braid: Air Muscles that Measure Force and Displacement

Wyatt Felt[1], C David Remy[1],
[1]University of Michigan

- By making the mesh of an Air Muscle out of conductive fibers, we can detect the contraction and force output.
- The inductance increases with the changing alignment of the fibers
- The resistance increases with the strain from the force and pressure



15:41–15:44	TuD1.9

Variable Stiffness Fabrics with Embedded Shape Memory Materials for Wearable Applications

Thomas P. Chenal[1,2], Jennifer C. Case[1],
Jamie Paik[2] and Rebecca K. Kramer[1]
[1]Purdue University [2]EPFL

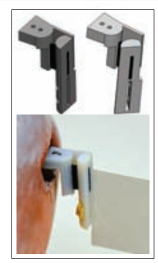
- New, fast and simple way of producing thermally activated variable stiffness fibers/fabrics.
- One order of magnitude change in bending stiffness within less than 15 seconds.

15:44–15:47	TuD1.10

A Flexible Passive Joint for Robotic Fish Pectoral Fins

Sanaz Bazaz Behbahani[1] and Xiaobo Tan[1]
[1]Michigan State University

- Novel design of a **flexible joint** that enables the pectoral fin to sweep back passively to minimize the drag
- Dynamic modeling of the robotic fish propelled by the novel flexible joint
- Comparison of the performance of the robotic fish between the novel flexible joint and traditional rigid joint

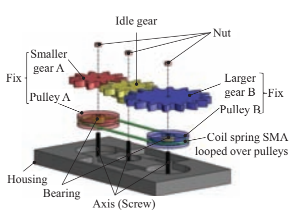


15:47–15:50	TuD1.11

Formulation and optimization of pulley-gear-type SMA heat engine toward microfluidic MEMS motor

H. Aono[1], R. Imamura[1], O. Fuchiwaki[1], Y. Yamanashi[1],
K. F Böhringer[2]
1 Dept. of Mechanical Engine., Yokohama National University (YNU)
2 Dept. of Electrical Engine., University of Washington (UW).

- First paper to solve the optimal solution for a pulley-gear-type heat engines with SMA coil spring
- We also discuss the miniaturization of the heat engine to actuate the Bio MEMS and the micro TAS devices as fluidic MEMS actuators.



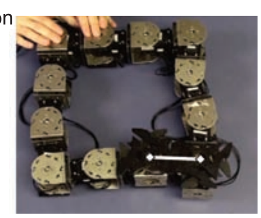
Assembling drawing of the pulley-gear-type heat engine driven by SMA coil spring

15:50–15:53	TuD1.12

Design, Principles, and Testing of a Latching Modular Robot Connector

Nick Eckenstein, Mark Yim
University of Pennsylvania

- New 2D Latching Connector Design for high error tolerance reconfiguration of modular robots
- Design parameters of interest examined
- Force characteristics tested and analyzed
- Reconfiguration of multiple types performed with modular robots



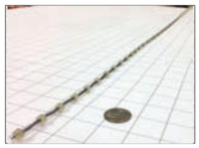
Actuators / Kinematics and Mechanism Design II

Chair *Venkat Krovi, University at Buffalo (SUNY Buffalo)*
Co-Chair

15:53–15:56 TuD1.13

Long and Slim Continuum Robotic Cable

Manas Tonapi[1], Isuru Godage[1] and Ian Walker[1] [1]Clemson University

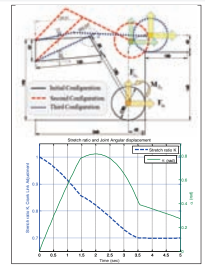


- Novel design for constructing multi-section continuum robots
- Thin (less than 1 cm diameter) and relatively long length (more than 100 cm)
- Compact actuation assembly
- New 2D forward kinematic model and its validation

15:56–15:59 TuD1.14

Kinetostatic Optimization for an Adjustable Four-Bar Based Articulated Leg-Wheel Subsystem

Aliakbar Alamdari, Javad Sovizi, Seung-kook Jun and Venkat Krovi
State University of New York at Buffalo



- Articulated leg-wheel design based on adjustable four-bar mechanism.
- Kinematic optimization to match desired wheel-axle motion profile.
- Subsequent static optimization of spring assist to reduce actuation.
- Evaluation of multiple alternate active-adjustment configurations.

15:59–16:02 TuD1.15

A Single DOF arm for transition of climbing robots between perpendicular planes

Carlos Viegas[1], Mahmoud Tavakoli[1],
[1]Institute for Systems and Robotics, University of Coimbra, Portugal

- An innovative transmission mechanism driving simultaneously two joints with a single actuator
- An electromagnet adhesion unit adaptable to both flat and curved structures.

16:02–16:05 TuD1.16

Design of Variable Release Torque-based Compliant Spring-clutch

Jushin Seok[1], Sungchul Kang[2] and Woosub Lee[2]
[1]University of Science and Technology
[2]Korea Institute of Science and Technology

- VCSC is a safe joint of robot.
- VCSC has a release mechanism.
- VCSC has a constant release torque without gravity compensator.
- VCSC can estimate an external torque by using distance sensor.
- VCSC is designed for small and light robot like a mannequin.

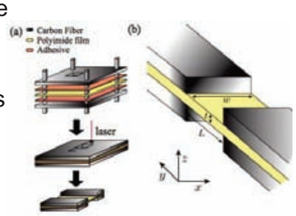
Prototype of VCSC

16:05–16:08 TuD1.17

Principles of Microscale Flexure Hinge Design for Enhanced Endurance

Ronit Malka[2], Alexis Lussier Desbiens[1], Yufeng Chen[2], and Robert J. Wood[2]
[1]Université de Sherbrooke, [2]Harvard University

- Laminated flexure hinges are increasingly popular in microrobotics.
- This paper evaluates various techniques to increase their lifespan.
- The Robobee wing hinge lifespan was increased from 70,000 to 2,000,000+cycles

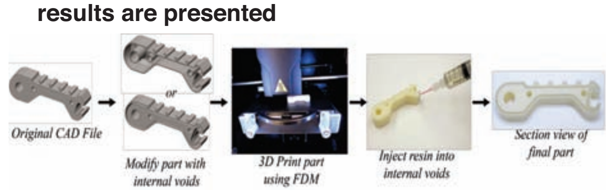


16:08–16:11 TuD1.18

Strengthening of 3D Printed Robotic Parts via Fill Compositing

Joseph T. Belter & Aaron M. Dollar
Yale University

- **3D printed part strength was increased by up to 45% compared to standard ABS FDM Printing**
- **Simple process of fill compositing and testing results are presented**



Actuators / Kinematics and Mechanism Design II

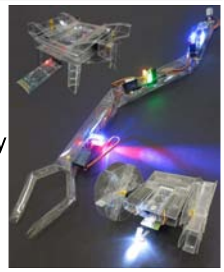
Chair *Venkat Krovi, University at Buffalo (SUNY Buffalo)*
Co-Chair

16:11–16:14	TuD1.19

Cogeneration of Mechanical, Electrical, and Software Designs for Printable Robots

Ankur Mehta[1], Joseph DelPreto[1], Benjamin Shaya[1] and Daniela Rus[1]
[1]Massachusetts Institute of Technology

- Allow novices to quickly generate robots from structural descriptions
- Modularize electronics and mechanical structures to create an integrated electromechanical library
- Hierarchically compose blocks
- Automatically generate layout, software, and user interface



16:14–16:17	TuD1.20

Design of a robotic finger using series gear chain mechanisms

Yuuki Mishima[1], Ryuta Ozawa[1],
[1]Ritsumeikan University

- An underactuated finger is designed by using special gear chains.
- These chains enables the finger to realize coupling motions and adaptive curling.
- The mechanisms are useful in decreasing the size and weight and in simplifying the assembly.

16:17–16:20	TuD1.21

Sponsor Talk: The Next Research Revolution with KUKA's Robotic Reference Platforms

Corey T. Ryan
KUKA Robotics Corp

- KUKA's technology is changing the focus of some research
- New technologies and different product development plans can add functionality and capabilities suited to different research strategies

Reasoning and AI Planning / Path and Task Planning

Chair *Sam Ade Jacobs, ABB Inc*
Co-Chair

15:00–15:20 TuD2.1

Keynote: Symbiotic Mobile Robot Autonomy in Human Environments

Manuela Veloso
Carnegie Mellon University

- Robust **Episodic Non-Markov Localization** in varying indoor spaces *(with Joydeep Biswas)*
- Multirobot task scheduling with **transfers** *(with Brian Coltin)*
- **Learning** from human interaction and the web *(with Vittorio Perera)*
- Autonomous **data** acquisition and mapping *(with Richard Wang)*

15:20–15:23 TuD2.2

Prior-Assisted Propagation Of Spatial Information for Object Search

Malte Lorbach[1], Sebastian Höfer[1], Oliver Brock[1]
[1]Technische Universität Berlin

- Improve object search efficiency by reasoning about possible locations
- We suggest five priors that capture structure of the physical world
- A probabilistic inference model propagates prior knowledge across locations and generates consistent beliefs over object locations
- Experiments in a simulated environment demonstrate improved search efficiency

15:23–15:26 TuD2.3

Combining Top-down Spatial Reasoning and Bottom-up Object Class Recognition for Scene Understanding

L. Kunze[1], C. Burbridge[1], M. Alberti[2], A. Tippur[2], J. Folkesson[2], P. Jensfelt[2], N. Hawes[1]
[1]University of Birmingham, UK [2]KTH Royal Institute of Technology, SW

- Understanding scenes based on perception only is a difficult task
- Spatial background knowledge can provide additional information
- We combine a 3D object class recognition system with learned, spatial models of object relations
- Experiments show that our approach can improve the task performance

15:26–15:29 TuD2.4

Learning Relational Affordance Models for Two-Arm Robots

Bogdan Moldovan[1], Luc De Raedt[1]
[1]KU Leuven, Belgium

- Extend relational affordance model to continuous domain
- Develop pipeline for table-top two-arm manipulation
- Build two-arm model from single-arm babbling data, symmetry assumptions, and background rules
- Two-arm action prediction task

Two-arm actions for object placement

15:29–15:32 TuD2.5

Cognitive Factories with Multiple Teams of Heterogeneous Robots: Hybrid Reasoning for Optimal Feasible Global Plans

Zeynep G. Saribatur, Esra Erdem and Volkan Patoglu
Sabanci University, Istanbul, Turkey

- Each team can compute task plans with minimum total action cost, and makespan. Heterogeneity of robots and feasibility checks are considered during planning.
- An optimal feasible global plan is computed with a semi-distributed approach: (i) A neutral mediator finds an optimal coordination of the teams, (ii) all teams compute their own optimal local feasible plans in parallel, (iii) local plans are decoupled into an optimal feasible global plan.

15:32–15:35 TuD2.6

Incorporating Kinodynamic Constraints to Automated Design of Simple Machines

Can Erdogan Mike Stilman
Georgia Institute of Technology

- Manipulation of multi-body objects for mechanical lever
- Robot joint and torque limits
- Levernberg-Marquardt optimization using factor graph representation
- **Results:** Lever-fulcrum systems that overturn 100 kg loads and push 240 kg obstacles

Reasoning and AI Planning / Path and Task Planning

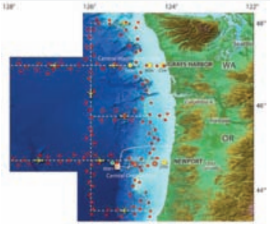
Chair *Sam Ade Jacobs, ABB Inc*
Co-Chair

15:35–15:38 TuD2.7

Unifying Multi-Goal Path Planning for Autonomous Data Collection

Jan Faigl[1], Geoffrey A. Hollinger[2]
[1]Czech Technical University, Czech Republic
[2]Oregon State University, United States

- Prize-Collecting Traveling Salesman Problem with Neighborhoods (PC-TSPN)
- Novel self-organizing map based optimization algorithm
- Improved solution quality
- Lower computational requirements



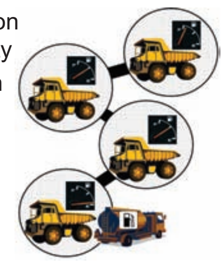
Evaluation scenario based on Ocean Observatories Initiative Endurance Array

15:38–15:41 TuD2.8

Stochastic Collection and Replenishment (SCAR) Optimisation for Persistent Autonomy

Andrew W Palmer[1], Andrew J Hill[1], and Steven J Scheding[1]
[1]Australian Centre for Field Robotics, USyd, AUS

- Combinatorial schedule optimisation of a refuelling robot with uncertainty
- Ratio objective function better than existing methods
- Minimises risk of running empty
- Examples include mining vehicles and water/fuel trucks, aerial refuelling, surveillance, etc.

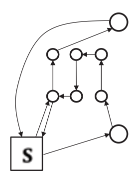


15:41–15:44 TuD2.9

Coverage Planning with Finite Resources

Grant P Strimel[1], Manuela M Veloso[1],
[1]Carnegie Mellon University

- Introduce a new sweeping planning algorithm **BC Sweep**
- Builds on boustrophedon cellular decomposition coverage
- Accounts for fixed fuel/battery capacity of the robot and service station recharges
- Provably complete and illustrate method with real maps



15:44–15:47 TuD2.10

Coordination in Human-Robot Teams Using Mental Modeling and Plan Recognition

Kartik Talamadupula[1], G. Briggs[2], T. Chakraborti[1], M. Scheutz[2] and S. Kambhampati[1]
[1]Arizona State University [2]Tufts University

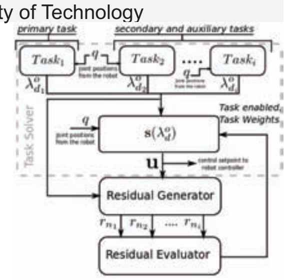
- **Coordination** is essential in **human-robot teaming**
- **Beliefs** can be used to infer an agent's intentions
- Intentions can be used along with a domain model to **predict the plan** and **goals** of an agent
- **Information extracted** from the predicted plan is used to **coordinate the robot's actions with human** agents
- **Plan recognition** used to fold in action **observations**
- **Implemented** and **evaluated** on a **PR2 robot**

15:47–15:50 TuD2.11

A Framework for Formal Specification of Robotic Constraint-based Tasks and their Concurrent Execution with Online *QoS* Monitoring

E. Scioni[1,2], G. Borghesan[1], H. Bruyninckx[1,3] and M. Bonfè[2]
[1]University of Leuven [2]University of Ferrara
[3]Eindhoven University of Technology

- Formulation of Quality of Service (QoS) as online criteria to monitor and evaluate a constraint-based task execution
- Task classification to aid the coordination model synthesis (FSM).
- Concurrent tasks execution while QoS is preserved.
- Experiments using KUKA youBot mobile platform on pick&place application



15:50–15:53 TuD2.12

Synthesizing Manipulation Sequences for Under-Specified Tasks using Unrolled MRFs

Jaeyong Sung, Bart Selman, Ashutosh Saxena
Cornell University

- Inferring the sequence of steps where the goals are under-specified and have to be inferred from the context.
- An attribute-based representation of the environment for task planning.
- A graph-based representation of a dynamic plan by unrolling the loop into a MRF.

Reasoning and AI Planning / Path and Task Planning

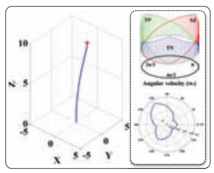
Chair *Sam Ade Jacobs, ABB Inc*
Co-Chair

15:53–15:56	TuD2.13

A Probability-based Path Planning Method Using Fuzzy Logic

Jaeyeon Lee
Electrical engineering, University of Texas at Dallas, USA.
Wooram Park
Mechanical engineering, University of Texas at Dallas, USA.

- The path-of-probability(POP) method has been successfully used for robot path plannning.
- One drawback of POP is discrete search for each intermediate path.
- The fuzzy logic converts the discrete search to a continuous one.
- We verified the performance of the POP combined with fuzzy logic.



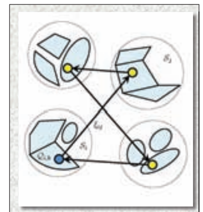
A path planning method using POP and fuzzy logic

15:56–15:59	TuD2.14

Multi-Goal Path Planning based on the Generalized TSP with Neighborhoods

Kevin Vicencio[1], Brian Davis[1], and Iacopo Gentilini[1]
[1]Embry-Riddle Aeronautical University

- Multi-goal path planning problems with non-connected or clustered target domains.
- Novel disjunctive formulation for the Generalized TSP with Neighborhoods (GTSPN).
- Solution procedure via genetic algorithm and crossover operators.



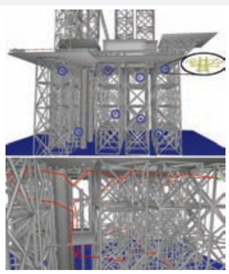
GTSPN Instance

15:59–16:02	TuD2.15

A Multi-Tree Extension of the Transition-based RRT

Didier Devaurs, Thierry Siméon and Juan Cortés
LAAS-CNRS and Univ de Toulouse, France

- Multi-T-RRT: multiple-tree variant of the Transition-based RRT
- Anytime behavior: useful cycles
- Solve ordering-and-pathfinding problems in continuous cost spaces (visit a set of waypoints)
- Ex.: industrial inspection with an aerial robot in a large workspace

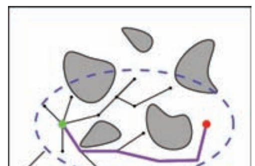


16:02–16:05	TuD2.16

*Informed RRT**: Optimal Sampling-based Path Planning Focused via Direct Sampling of an Admissible Ellipsoidal Heuristic

Jonathan D. Gammell[1], Siddhartha S. Srinivasa[2] and Timothy D. Barfoot[1]
[1]University of Toronto [2]Carnegie Mellon University

- RRT* asymptotically finds the optimal paths from the start to every state in the problem domain.
- For shortest-path problems, the states that can improve a solution form an ellipse.
- We present a method to directly sample these ellipses, improving performance across a wide-range of problems and state dimensions.



Adding samples from the ellipse is required to improve the solution.

16:05–16:08	TuD2.17

Integrating multiple soft constraints for planning practical paths

Jing Yang, Patrick Dymond, Michael Jenkin
York University

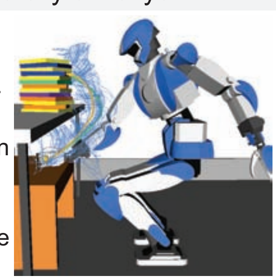
- Optimization of sampling-based planners is complex due to the large range of potential optimizers.
- An auction-based scheme is developed that allows potential optimizers to compete.
- Approach is validated on high DOF tentacle robots.

16:08–16:11	TuD2.18

Sampling-based Trajectory Imitation in Constrained Environments using Laplacian-RRT*

Thomas Nierhoff[1], Sandra Hirche[1] and Yoshihiko Nakamura[2]
[1]TU Munich [2]University of Tokyo

- Goal: Find similar trajectories while avoiding obstacles
- Approach: Incremental RRT*-based method with a novel metric for velocity/acceleration differences
- Result: Successful evaluation on HRP-4 for a pick-and-place scenario



Reasoning and AI Planning / Path and Task Planning

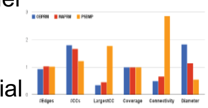
Chair *Sam Ade Jacobs, ABB Inc*
Co-Chair

16:11–16:14	TuD2.19

The Anatomy of a Distributed Motion Planning Roadmap

Sam Ade Jacobs[1] and Nancy Amato[2]
[1]ABB [2]Texas A&M University

- Parallel and distributed systems are ubiquitous (including robots)
- Parallel and distributed motion planning algorithms are needed
- We present a comparative study of roadmaps from sequential and parallel planners
- Results show that heterogeneous evironments are appropriate for spatial subdivision parallel processing

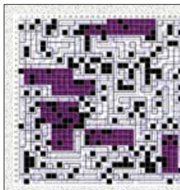


16:14–16:17	TuD2.20

Safest Path Adversarial Coverage

R. Yehoshua, N. Agmon, G. A. Kaminka
Computer Science Dept., Bar Ilan University

- Robot must visit every point in a target area that contains threats
- Goal: find a coverage path that maximizes robot's survivability
- Real-world applications: demining, hazardous fields exploration
- Suggested two heuristic algorithms for finding a safest coverage path



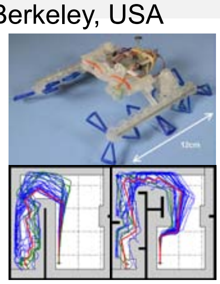
Coverage paths in an adversarial environment

16:17–16:20	TuD2.21

Planning with the STAR(s)

K. Karydis[1], D. Zarrouk[2], I. Poulakakis[1], R. Fearing[3] and H. Tanner[1]
[1]Univ. of Delaware, USA; [2]Ben Gurion Univ., Israel; [3]Univ. of California, Berkeley, USA

- Enabling motion planning methods to the novel robot STAR
- Experimental validation of unicycle models for the STAR
- Characterization of the open-loop performance of the robot executing pre-computed motion plans



Sensing I / Sensing for Human Environments

Chair *Dezhen Song, Texas A&M University*
Co-Chair

15:00–15:20 TuD3.1

Keynote: Life In a World of Ubiquitous Sensing

Greg Hager
Johns Hopkins University

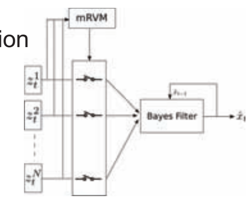
Sensing technology is becoming smaller, more granular, more capable and nearly pervasive. Where will this take us? What are the implications for robotics? Will this lead to new opportunities to aid the aged, the sick or disabled, as well as all of the rest of us? Can we benefit from data but preserve privacy?

15:20–15:23 TuD3.2

Augmenting Bayes filters with the Relevance Vector Machine for time-varying context-dependent observation distribution

Alexandre Ravet[1], Simon Lacroix[1], and Gautier Hattenberger[2]
[1]LAAS-CNRS [2]ENAC

- Explicitly introduce context influence in Bayes filters
- 'Intelligent' measurement selection + observation noise prediction
- Contrasts with typical state-dependent models

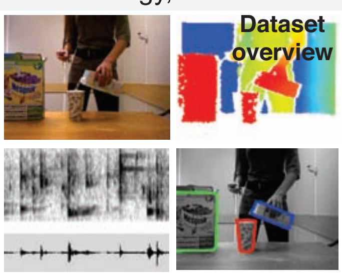


15:23–15:26 TuD3.3

Audio Visual Classification and Detection of Human Manipulation Actions

Alessandro Pieropan, Giampiero Salvi, Karl Pauwels and Hedvig Kjellström
Royal Institute Of Technology, Sweden

- Classifying human actions using multiple sensor modalities outperforms single source classification
- New publicly available evaluation dataset



15:26–15:29 TuD3.4

Object Shape Categorization in RGBD Images using Hierarchical Graph Constellation Models based on Unsupervisedly Learned Shape Parts described by a Set of Shape Specificity Levels

C. A. Mueller, K. Pathak and A. Birk
Jacobs University Bremen, Germany

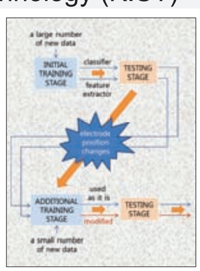
- Shape parts are classified to a set of symbols on different specificity levels based on their surface-structural appearance
- Hierarchical graphical models are generated which reflect the constellation of classified parts for different shape categories
- Experiments show an enhanced classification compared to a flat approach

15:29–15:32 TuD3.5

sEMG-based Decoding of Human Intentions robust to the Change of Electrode Position changes

Myoung Soo Park[1],
[1]Korea Inst. of Science and Technology (KIST)

- Performance of an sEMG decoder is dependent on electrode positions when it is trained, so the changes may make the decoder useless one.
- A new supervised feature extraction based on the ICA is proposed, using which the old decoder performs well only after matching old/new feature from electrode position changes.

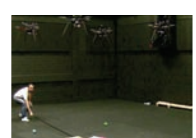


15:32–15:35 TuD3.6

Multi-Target Visual Tracking with Aerial Robots

Pratap Tokekar[1], Volkan Isler[1] and Antonio Franchi[2]
[1]University of Minnesota, U.S.A
[2]LAAS-CNRS, France

- Scenario: Aerial robots tasked with tracking mobile ground targets.
- Problem 1: Track *all* targets while maintaining an upper bound on the deviation from the optimal tracking quality. Shown to be infeasible.
- Problem 2: Maximize the number of tracks with a given bound on quality. We present a 2 approximation.



Simulations and Experiments with a team of quadrotor UAVs

Session TuD3 | Red Lacquer Room | Tuesday, September 16, 2014, 15:00–16:20

Sensing I / Sensing for Human Environments

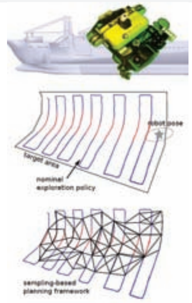
Chair *Dezhen Song, Texas A&M University*
Co-Chair

15:35–15:38 | TuD3.7

Opportunistic Sampling-based Planning for Active Visual SLAM

S. Chaves[1], A. Kim[2], and R. Eustice[1]
[1]University of Michigan, [2]ETRI S. Korea

- Gaussian process for saliency prediction and probabilistic modeling of loop-closure utility
- Sampling-based planning with information filtering for path search and evaluation
- Opportunistic optimization process for selecting loop-closure revisit actions during SLAM



15:38–15:41 | TuD3.8

Ear-based Exploration on Hybrid Metric/Topological Maps

Qiwen Zhang [1], David Whitney [1], Florian Shkurti [1], and Ioannis Rekleitis[1]
[1]School of Computer Science, McGill University

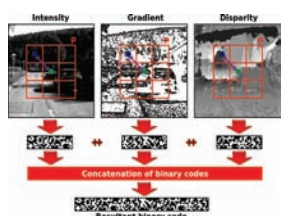
- Ear-based exploration facilitates loop-closures
- **GVG** is used to navigate through the environment and to identify distinct places for localization
- Localizing only at meetpoints ensures computational efficiency
- Code available online

15:41–15:44 | TuD3.9

Fast and Effective Visual Place Recognition using Binary Codes and Disparity Information

R. Arroyo[1], P. F. Alcantarilla[2], L. M. Bergasa[1], J. J. Yebes[1] and S. Bronte[1]
[1]University of Alcalá [2]Toshiba Research Europe

- Novel visual loop closure detection method (ABLE-S) using D-LDB descriptor.
- Tested on the challenging KITTI Odometry dataset.
- Precision superior in 25% to FAB-MAP, 23% to WI-SURF and 16% to BRIEF-Gist.

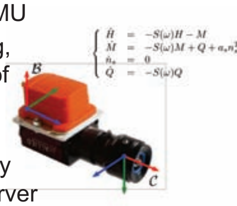


15:44–15:47 | TuD3.10

A linear approach to visuo-inertial fusion for homography filtering and estimation

Alexandre Eudes[1], Pascal Morin[1]
[1]ISIR, UPMC/CNRS UMR 7222, France

- Context: Real-time planar visual tracking from one camera and IMU
- Objectives: Homography filtering, estimation of velocity, direction of gravity, normal and scale factor
- Main results: Linear formulation, uniform observability and stability analysis, luenberger linear observer



15:47–15:50 | TuD3.11

Fusion of Optical Flow and Inertial Meas. for Robust Egomotion Estimation

Bloesch, Omari, Fankhauser, Sommer, Gehring, Hwangbo, Hoepflinger, Hutter, Siegwart
Autonomous Systems Lab, ETH Zürich

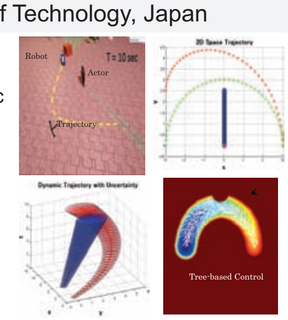
- Visual-inertial state estimation with optical flow
- Focus on velocity and inclination angle estimation
- Only frame-to-frame tracking and no landmark estimation
- Unscented Kalman filtering

15:50–15:53 | TuD3.12

Cameraman Robot: Dynamic Trajectory Tracking with Final Time Constraint using State-time Space Stochastic Approach

Igi Ardiyanto and Jun Miura
Toyohashi University of Technology, Japan

- We present an algorithm for a cameraman robot as the dynamic trajectory tracking problem.
- The task is to follow a trajectory for taking the video of an actor.
- Our approach generates tree-based robot control considering obstacles, trajectory cost, and actor's visibility in a 3D time-space.



Sensing I / Sensing for Human Environments

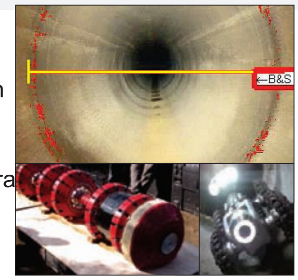
Chair *Dezhen Song, Texas A&M University*
Co-Chair

15:53–15:56 TuD3.13

Automatic Detection and Verification of Pipeline Construction Features with Multi-modal data

T. Vidal-Calleja[1], J. Valls Miro[1], F. Martin[2], D. Lingnau[3] and D. Russell[3]
[1]UTS:CAS [2]Carlos III Univ. [3]Russell NDE Inc.

- A framework to locate pipeline's Construction Features (CF) for inspection with NDT sensors
- Independent CF detection with NDT sensor and camera
- Verification based on both modalities

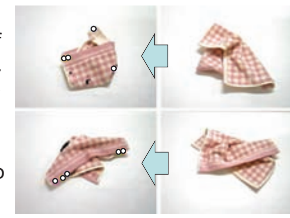


15:56–15:59 TuD3.14

Grasping Point Selection on an Item of Crumpled Clothing Based on Relational Shape Description

Kimitoshi Yamazaki, Shinshu University, Japan

- We propose a method to select two grasp points from an item of clothing that is randomly placed.
- The method is not influenced by any variety of appearance such as color or texture.
- The method makes it possible to simplify the manipulation procedure for picking up and spreading a wrinkled cloth



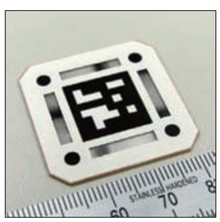
Input data & selected grasp points — Sought similar shape from learning data

15:59–16:02 TuD3.15

A Solution to Pose Ambiguity of Visual Markers Using Moiré Patterns

Hideyuki Tanaka[1], Yasushi Sumi[1] and Yoshio Matsumoto[1]
[1]AIST, Japan

- Novel visual marker "LentiMark" which uses lenticular lenses
- World's first small planar marker solving pose ambiguity problem
- Design and performance of the marker are described
- LentiMark brings great benefits to many applications



16:02–16:05 TuD3.16

On Leader Following and Classification

Procopio Stein[1], Anne Spalanzani[12], Vitor Santos[3] and Christian Laugier[1]
[1]INRIA [2]Univ. Grenoble Alpes [3]Univ. Aveiro

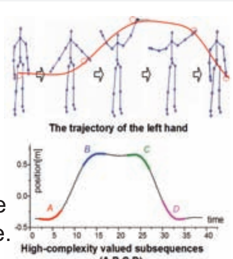
- Leader following can enhance robot navigation in dynamic environments.
- But who should the robot follows?
- This works uses machine learning to classify leaders and to study their characteristic features

16:05–16:08 TuD3.17

Complexity–based Motion Features and Their Applications to Action Recognition by Hierarchical Spatio–temporal Naïve Bayes Classifier

Woo Young Kwon [1] and Il Hong Suh[1],
[1]Hanyang University, Korea

- This paper presents complexity–based motion feature and hierarchical spatio–temporal naïve Bayes classifier.
- A certain part of the trajectory is more important than other parts.
- The amount of importance can be computed by complexity measure.

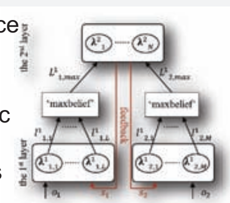


16:08–16:11 TuD3.18

Enhancement of Layered HMM by Brain-inspired Feedback Mechanism

Sang Hyoung Lee, Min Gu Kim, and Il Hong Suh
Hanyang University, Seoul, Korea

- To further enhance the performance of a LHMM, we propose a brain-inspired feedback mechanism.
- For this achievement, the semantic information (i.e., labels of data) is used to improve the performances by the feedback mechanism.
- This LHMM is validated using several cooking activities of a human.



[Feedback Process of LHMM]

Sensing I / Sensing for Human Environments

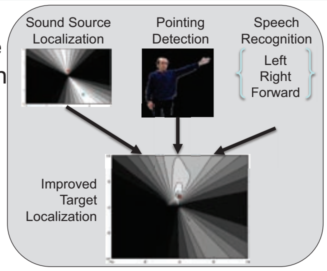
Chair *Dezhen Song, Texas A&M University*
Co-Chair

16:11–16:14 TuD3.19

Guiding Computational Perception through a Shared Auditory Space

Eric Martinson, Ganesh Yalla
Toyota InfoTechnology Center, USA

- Combining human and robot audition to improve sound source localization
- Demonstrated improvement with multiple sources
- Useful for Blind users makes queries about the environment

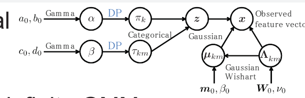


16:14–16:17 TuD3.20

Classification and Identification of Robot Sensing Data based on Nested Infinite GMMs

Yoko Sasaki[1], Naotaka Hatao[1],
Shogo Tsurusaki[2] and Satoshi Kagami[1]
[1]AIST [2]Tokyo University of Science

- demonstrates experimental proofs of the classification and identification of robot sensing data using nested infinite GMMs.
- Test three different data: human trajectories, 3D objects and audio events
- The results show the model naturally describes the needed numbers of Gaussians and classes for varied sensor data from the observed vectors



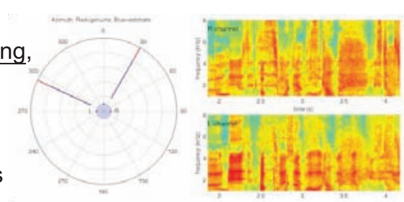
16:17–16:20 TuD3.21

Localization of Multiple Sources from a Binaural Head in a Noisy Environment

Alban Portello[1,2], Gabriel Bustamante[1,2],
Patrick Danès[1,2] and Alexis Mifsud[2]
[1]Univ Toulouse 3 UPS [2]LAAS-CNRS France

Maximum Likelihood Estimator of multiple sources azimuths under W-Disjointness Orthogonality

- EM algorithm,
- to handle scattering,
  - left & right HRTFs
  - environment noise statistics



Constrained and Underactuated Robots / Legged Robots I

Chair *Martin Buehler, Vecna Technologies*
Co-Chair

16:50–17:10 TuE1.1

Keynote: Robot Motion Optimization

Frank C. Park
Seoul National University

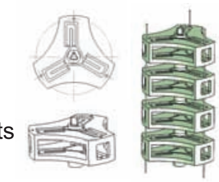
The state-of-the-art in dynamics-based robot motion optimization, and more generally the use of optimal control techniques in robotics, is reviewed. Dimension reduction techniques, and recent work on statistical learning-based approaches to optimal robot motion generation, are also described.

17:10–17:13 TuE1.2

A Novel Continuum-Style Robot with Multilayer Compliant Modules

Peng Qi, Chen Qiu, Hongbin Liu, Jian S. Dai, Lakmal Seneviratne, Kaspar Althoefer
King's College London

- Novel design of continuum-style robot decoupling contraction and bending motion is presented.
- Large linear bending motion and avoidance of friction between joints achieved.
- Screw theory based analytical method to study the compliance characteristics applied.



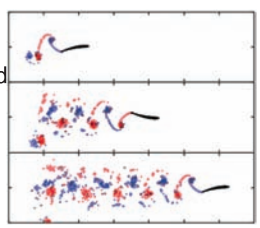
Double-layer module & Robot assembly.

17:13–17:16 TuE1.3

A Fish-like Locomotion Model in an Ideal Fluid with Lateral-line-inspired Background Flow Estimation

Yiming Xu[1] and Kamran Mohseni[2]
[1]MAE, University of Florida [2]MAE, ECE, Institute for Networked Autonomous Systems, University of Florida

- Locomotion model of deforming fish-like swimmer
- Lateral-line-inspired background flow estimation
- Internal force for quantitative control effort and efficiency analysis

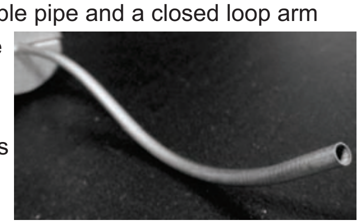


17:16–17:19 TuE1.4

MR Compatible Continuum Robot Based on Closed Elastica with Bending and Twisting

Atsushi Yamada[1], Shigeyuki Naka[1], Shigehiro Morikawa[1] and Tohru Tani[1]
[1]Shiga University of Medica Science

- A novel continuum robot
- Combination of a flexible pipe and a closed loop arm
- Prototype features are
  *MR compatible
  *3mm outer radius
  *0.2 mm wall thickness

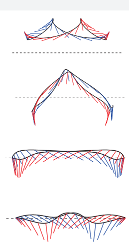


17:19–17:22 TuE1.5

Trajectory Optimization of Flapping Wings Modeled as A Three Degree-of-Freedoms Oscillation System

Yi Qin[1], Bo Cheng[1], Xinyan Deng[1]
[1]Purdue University

- The wing is modeled as a rigid body with three degree-of-freedoms.
- One actuator and one torsional spring at the stroke angle act as the power muscles.
- Two torsional springs at the rotation angle and the deviation angle mimic the control muscles.



17:22–17:25 TuE1.6

The Use of Unicycle Robot Control Strategies for Skid-Steer Robots Through the ICR Kinematic Mapping

Jesse Pentzer[1], Sean Brennan[1], and Karl Reichard[1]
[1]The Pennsylvania State University

- Trajectory control strategies for unicycle robots are well developed.
- The ICR kinematic mapping from skid-steer to unicycle movements can leverage these strategies.
- The adapted unicycle robot trajectory controller has been tested on two skid-steer robotic platforms.

Constrained and Underactuated Robots / Legged Robots I

Chair *Martin Buehler, Vecna Technologies*
Co-Chair

17:25–17:28 TuE1.7

Open-Source, Affordable, Modular, Light-Weight, Underactuated Robot Hands

A. Zisimatos[1], M. Liarokapis[1],
C. Mavrogiannis[2] and K. Kyriakopoulos[1]
[1]National Technical University of Athens, Greece
[2]Cornell University, USA

- A new open source design for the development of affordable, modular, lightweight, compliant, under-actuated robot hands.
- Robot hands can be developed using off-the-shelf materials.
- Robot hands efficiently grasp a plethora of everyday life objects.

17:28–17:31 TuE1.8

Modeling of Wheeled Mobile Robots as Differential-Algebraic Systems

Alonzo Kelly, Neal Seegmiller,
Carnegie Mellon University

- Detailed, useful, complete formulation of WMR dynamics and kinematics as a differential algebraic system.
- Experiments show formulation is both more accurate and more efficient than traditional approaches.
- Introduces the concept of “constrained” kinematics where Lagrange multipliers are used to enforce kinematic constraints on WMRs.

17:31–17:34 TuE1.9

Practical Identification and Flatness based Control of a Terrestrial Quadrotor

Sylvain Thorel[1], Brigitte d’Andréa-Novel[1],
[1]MINES Paristech, PSL-Research University,
Centre for robotics

Context: Indoor exploration with a terrestrial quadrotor capable of flying and sliding on the ground to save energy

Terrestrial mode :

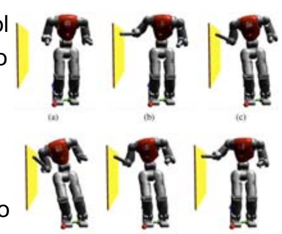
- 2D xy plane trajectory tracking based on a flatness approach
- Identification and experimental results of the control law

17:34–17:37 TuE1.10

Partial Force Control of Constrained Floating-Base Robots

A. Del Prete[1], N. Mansard[1], F. Nori[2],
G. Metta[2] and L. Natale[2]
[1]LAAS/CNRS, Toulouse, France [2]IIT, Genoa, Italy

- Multi-task motion/force control
- Exploit structure of problem to derive analytical sparse solution of constraints
- Reduce computational complexity
- ~19x speed-up with respect to classical formulation



17:37–17:40 TuE1.11

Balancing Control Algorithm for a 3D Under-actuated Robot

Morteza Azad[1] and Roy Featherstone[2]
[1]University of Birmingham, UK
[2]Istituto Italiano di Tecnologia, Italy

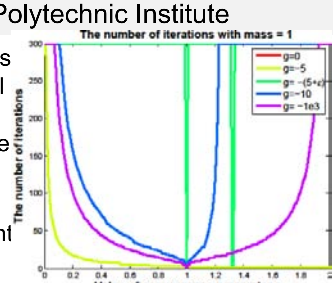
- A novel decomposition of 3D balancing into:
  - balancing in the plane, and
  - keeping the plane vertical
- A novel robot mechanism that decouples the dynamics of 3D balancing
- Balancing while following a commanded trajectory

17:40–17:43 TuE1.12

On the Convergence of Fixed-point Iteration in Solving Complementarity Problems Arising in Robot Locomotion and Manipulation

Ying Lu[1], Jeff Trinkle[1]
[1]Rensselaer Polytechnic Institute

- Model-based approaches to the planning or control of robot locomotion or manipulation requires the solution of CPs
- We studied the factors that affect how fixed-point iteration method converges



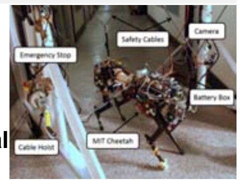
Constrained and Underactuated Robots / Legged Robots I

Chair *Martin Buehler, Vecna Technologies*
Co-Chair

17:43–17:46 TuE1.13

Quadruped Bounding Control with Variable Duty Cycle via Vertical Impulse Scaling

Hae-Won Park[1], Meng Yee (Michael) Chuah[1], and Sangbae Kim[1]
[1]Massachusetts Institute of Technology

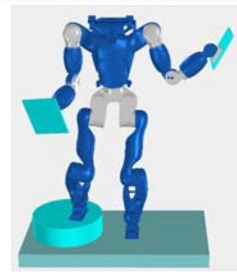


- **Dynamic quadruped bounding gait** with variable duty cycle is obtained experimentally on **MIT Cheetah 2**.
- The algorithm **prescribes vertical impulse** by generating scaled ground reaction forces at each step to achieve the desired stance and total stride duration.

17:46–17:49 TuE1.14

Balance Control for Humanoid Robots in Multi-Contact Scenarios based on MPC

Bernd Henze, Christian Ott and Maximo A. Roa
German Aerospace Center (DLR)

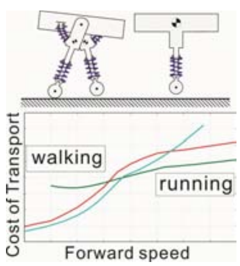


- Force based balancing with an arbitrary number of end effectors in contact
- Prediction allows a reaction to future reference signals
- Control of COM position and hip orientation
- Task prioritization by weightings

17:49–17:52 TuE1.15

Optimal Gaits and Motion for Legged Robots

Weitao Xi, C. David Remy
University of Michigan

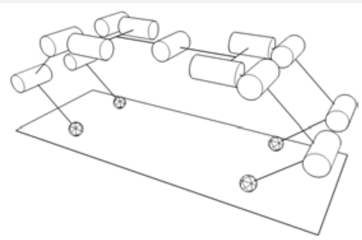


- Explored a trajectory optimization method for unspecified contact sequences as a tool to identify optimal gaits and motions
- Improved the existing algorithm
- The proposed method discovered walking and running gaits at different speed automatically

17:52–17:55 TuE1.16

Quadratic Programming-Based Inverse Dynamics Control for Legged Robots with Sticking and Slipping Frictional Contacts

Samuel Zapolsky[1], Evan Drumwright[2]
[1,2]George Washington University



Human-Robot Interaction III / Grasp Learning

Chair *Nicholas Wettels, NASA-JPL*
Co-Chair

16:50–17:10 TuE2.1

Keynote: Perception-Action-Learning and Associative Skill Memories

Stefan Schaal
MPI Intelligent Systems & Univ. of S. California

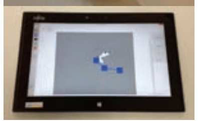
- Robotics needs more research on perception-action-learning loops:
  - Interactive perception
  - Automatic creation of behavior graphs for complex skills
  - Prediction, recovery, switching based on sensory information
  - Machine learning techniques

17:10–17:13 TuE2.2

Remote Control System for Multiple Mobile Robots using Touch Panel Interface and Autonomous Mobility

Yuya Ochiai[1], Kentaro Takemura[2], Atsutoshi Ikeda[1], Jun Takamatsu[1] and Tsukasa Ogasawara[1]
[1]Nara Inst. of Science and Technology, [2]Tokai University

- Propose the remote control system that uses touch panel interface
- Achieves autonomy of mobile robots by using SLAM, motion planning, and object tracking.
- Reduce the user's concentration against each robots and total time to complete navigation



17:13–17:16 TuE2.3

Ridesharing with Passenger Transfers

Brian Coltin and Manuela Veloso
Carnegie Mellon University

- In ridesharing, passengers request rides from non-professional drivers.
- We introduce three algorithms to schedule rides, with passenger **transfers.**
- We compare and evaluate the algorithms on maps with real-world data.

17:16–17:19 TuE2.4

Modeling of Human Velocity Habituation for a Robotic Wheelchair

Morales Y., Abdur-Rahim J.A., Even J., Kondo T., Ogawa T., Hagita N., and Ishii S.

- Model for **Human Habituation** while riding a robotic wheelchair in terms of preferred velocity
- Preferred velocity is selected based on user experience
- Evaluation with skin conductance and questionnaires show preference for habituation velocity control over fixed velocity control

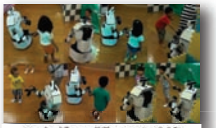
17:19–17:22 TuE2.5

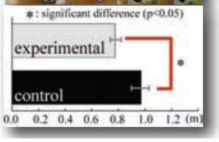
Physical Embodied Communication between Robots and Children:

An Approach for Relationship Building by Holding Hands

Chie Hieida[1], Kasumi Abe[1], Muhammad Attamimi[1], Takayuki Shimotomai[2], Takayuki Nagai[1] and Takashi Omori[2]
[1] The University of Electro-Communications,
[2] Tamagawa University

- Our hypothesis is "physical embodied communication between robots and children" **improves the relationship** between them
- An experiment was carried out using **37** 5-6 year-old children
- The children in the experimental (holding hands) group were **closer to the robot** than those in the control (non holding hands) group as in the graph





17:22–17:25 TuE2.6

Using social cues to estimate possible destinations when driving a wheelchair

Arturo Escobedo[1], Anne Spalanzani[2], and Christian Laugier[1]
[1]INRIA Rhone-Alpes [2]Univ. Grenoble Alpes, Lab. LIG, Grenoble, France. Inria

- A method to estimate the user intended destination to alleviate the user involvement when driving a robotic wheelchair is presented.
- Meeting points to join a group of people and frequent goals are considered.
- Personal and interaction spaces are respected by the navigation system.

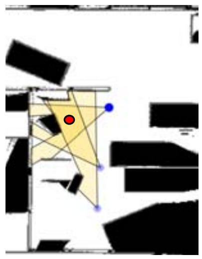
Human-Robot Interaction III / Grasp Learning

Chair *Nicholas Wettels, NASA-JPL*
Co-Chair

17:25–17:28 TuE2.7

A Novel User-Guided Interface for Robot Search

Shahar Kosti, David Sarne and Gal A. Kaminka
Bar Ilan-University, Israel

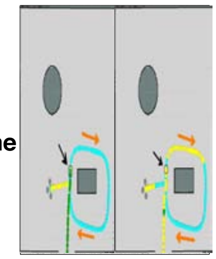


- An asynchronous interface for human operators of robotic search.
- The interface presents the operator with highly-relevant images, based on selected **POI**s (Point Of Interest).
- We show improved performance over the state-of-the-art system-guided approach.

17:28–17:31 TuE2.8

Contextual Task-Aware Shared Autonomy for Assistive Mobile Robot Teleoperation

Ming Gao, Jan Oberlaender,
Thomas Schamm and J. Marius Zoellner
Forschungszentrum Informatik

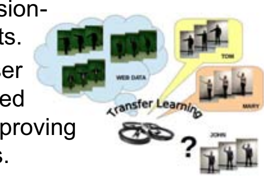


- Robot provides assistance by recognizing the on-going **task**
- **Task features** are defined to describe the context information
- A **unified framework** using **machine learning** method is proposed
- **Simulation results** verify the effect of the proposed approach

17:31–17:34 TuE2.9

Personalizing Vision-based Gestural Interfaces for HRI with UAVs: a Transfer Learning Approach

G. Costante[1], E. Bellocchio[1], P. Valigi[1], E. Ricci[1,2]
[1]University of Perugia,[2]Fondazione Bruno Kessler



- We address the problem of vision-mediated HRI with flying robots.
- Our system recognizes the user identity to invoke a personalized gesture recognition model, improving accuracy over generic models.
- A novel transfer learning algorithm for creating user-specific classifiers is proposed, which exploits data from other users or downloaded from the web.

17:34–17:37 TuE2.10

Multimodal Real-Time Contingency Detection for HRI

Vivian Chu[1], Kalesha Bullard[1],
Andrea L. Thomaz[1]
[1]Georgia Institute of Technology

- Implemented real-time controller to detect initial human engagement
- Based on human cognition: solved as a contingency detection problem
- Trained three Support Vector Machines; Evaluated with two separate experiments

Best F_1 score, with participants: 0.72

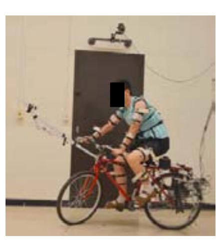

Curi performing “Wave” signal

17:37–17:40 TuE2.11

Pose Estimation in Physical Human-Machine Interactions with Application to Bicycle Riding

Yizhai Zhang[1], Kuo Chen[2], Jingang Yi[2], and Liu Liu[1]
[1]Northwestern Polytechnical University, P. R. China
[2]Rutgers University, USA

- Propose a whole-body pose estimation scheme for rider-bicycle system
- Physical constraints are used to reduce the number of sensors
- Extensive experiments demonstrate the robust and drift-free performance

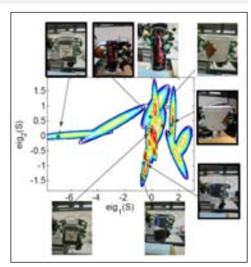


17:40–17:43 TuE2.12

Learning of Grasp Adaptation through Experience and Tactile Sensing

Miao Li[1], Yasemin Bekiroglu[2],
Danica Kragic[2] and Aude Billard[1]
[1]LASA, EPFL [2]CVAP, KTH

- A grasp stability estimator is learnt based on an object-level impedance controller.
- Once a grasp is predicted to be unstable by the stability estimator, a grasp adaptation strategy is triggered according to the experience and tactile sensing.



Human-Robot Interaction III / Grasp Learning

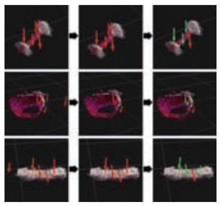
Chair *Nicholas Wettels, NASA-JPL*
Co-Chair

17:43–17:46 TuE2.13

Construction of an Object Manipulation Database from Grasp Demonstrations

David Kent[1], Sonia Chernova[1]
[1]Worcester Polytechnic Institute

- Crowdsourcing-based grasp demonstration system
- Grasp success rates learned from outlier filtering and online epsilon-greedy grasp training algorithm
- Compared usefulness of non-expert and expert demonstrated grasps



17:46–17:49 TuE2.14

Evaluating Efficacy of Grasp Metrics for Utilization in a Gaussian Process-Based Grasp Predictor

Alex Goins[1], Ryan Carpenter[1], Weng-Keen Wong[1] and Ravi Balasubramanian[1]
[1]Oregon State University

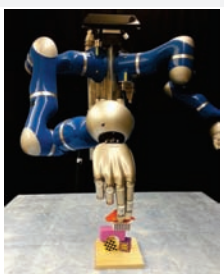
- We collect a large grasp data set (522 grasps) and evaluate twelve grasp metrics and compare their ability to classify grasp performance using physical shake test data. After evaluating the grasp metrics, we use a machine learning technique to combine the metrics to create a new grasp predictor which is able to out perform the individual metrics and provide an absolute measure of grasp quality.

17:49–17:52 TuE2.15

Predicting Object Interactions From Contact Distributions

Oliver Kroemer[1], Jan Peters [1,2],
[1] IAS, TU Darmstadt [2] MPI Intelligent Systems

- Interactions between objects depend on contact distributions
- Define a kernel function for computing similarity between contact distributions
- Use kernel methods to predict interactions from contacts
- Successfully evaluated on both grasping and block stacking tasks

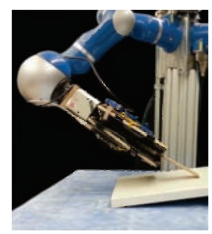


17:52–17:55 TuE2.16

Learning Robot Tactile Sensing for Object Manipulation

Yevgen Chebotar[1], Oliver Kroemer[1], and Jan Peters[1,2]
[1]IAS, TU Darmstadt [2]MPI Intelligent Systems

- Tactile feedback is needed for more robust manipulation
- Evaluate three methods for in-hand localization with tactile information
- Learn tactile manipulation from demonstration and self-improvement
- Efficient learning is possible using dimensionality reduction



Unmanned Aerial Systems I / Localization and Pose Estimation

Chair *Christopher M. Clark, Harvey Mudd College*
Co-Chair

16:50–17:10 TuE3.1

Keynote: Aerial Robot Swarms

Vijay Kumar
University of Pennsylvania

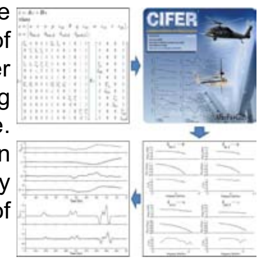
This talk will introduce aerial robotics, the opportunities in the field. and the key challenges in control, perception and planning for developing swarms of autonomous micro aerial vehicles.

17:10–17:13 TuE3.2

Frequency-Domain Dynamics Model Identification of Miniature Quadcopters

Guowei Cai, Guowei Cai, Hind Al Mehairi, Hanan Al-Hosani, Jorge Dias, and Lakmal Seneviratne
Khalifa University

This work presents a complete system identification process of identifying miniature quadcopter flight dynamics model using CIFER identification programme. Various validations have been conducted to proof the efficiency of the method and the fidelity of the identified model.



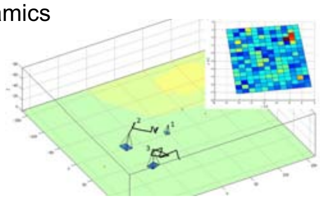
17:13–17:16 TuE3.3

Simulating Quadrotor UAVs in Outdoor Scenarios

Andrew Symington, Renzo De Nardi, Simon Julier, and Stephen Hailes
University College London

Matlab Toolbox

- General quadrotor dynamics
- Advanced GPS model
- Military wind models
- Noisy sensors
  - Barometric pressure
  - AHRS



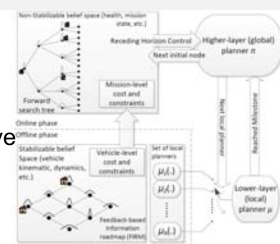
github.com/UCL-CompLACS/qrsim

17:16–17:19 TuE3.4

Health Aware Stochastic Planning For Persistent Package Delivery Missions using Quadrotors

Ali-akbar Agha-mohammadi [1], N. Kemal Ure [1], Jonathan P. How [1] and John Vian[2]
[1]MIT [2] Boeing Research and Technology

- Extending the health-aware planning (HAP) problem to partially-observable domains
- Proposing a proactive-reactive method for the problem of package delivery under uncertainty and health degradation



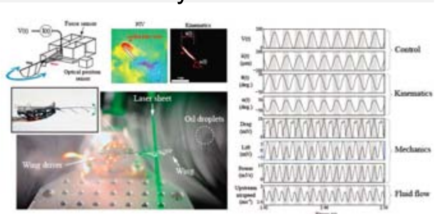
Method architecture

17:19–17:22 TuE3.5

High-throughput study of flapping wing aerodynamics for biological and robotic applications

Nick Gravish[1], Yufeng Chen[1], Stacey Combes[2] and Robert J. Wood1
[1]SEAS, Harvard University [2]OEB, Harvard University

Here we present a high-throughput measurement system for study and optimization of micri-aerial vehicle aerodynamics

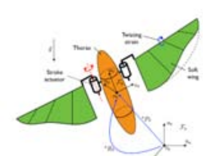


17:22–17:25 TuE3.6

Computational morphology for a soft micro air vehicle in hovering flight

Christine Chevallereau, Vincent Lebastard, Frédéric Boyer
IRCCyN, CNRS, Ecole des Mines de Nantes

- Bio-inspired MAV with actuated flapping motion of soft wings with passive twisting
- Depending on stiffness, and geometric characteristic, hovering flight can be naturally stable or not.
- Mathematical tools and methodologies are proposed to find an appropriate design and reduce the computational cost of control.



Unmanned Aerial Systems I / Localization and Pose Estimation

Chair *Christopher M. Clark, Harvey Mudd College*
Co-Chair

17:25–17:28 TuE3.7

Towards Valve Turning using a Dual-Arm Aerial Manipulator

Christopher Korpela[1], Matko Orsag[2], and Paul Oh[1]
[1]Drexel University [2]University of Zagreb

- Aerial manipulator endowed with dual 2-DOF arms and grippers
- Ellipsoid detection and compliance control facilitate task completion
- Coupling between arms and valve is evaluated to ensure system stability
- Flight tests and validation using a test rig confirm dynamic model

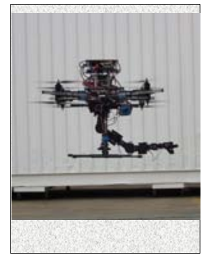

Valve turning flight test

17:28–17:31 TuE3.8

Control of a Multirotor Outdoor Aerial Manipulator

G. Heredia, A.E. Jimenez-Cano, I. Sanchez, D. Llorente, V. Vega, J. Braga, J.A. Acosta and A. Ollero, GRVC-University of Seville

- Design and control of a multirotor-based aerial manipulator developed for outdoor operation.
- Backstepping-based controller for multirotor that uses the coupled full dynamic model.
- Experimental results compared to baseline PID controller.

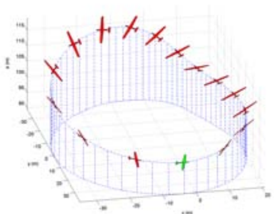


17:31–17:34 TuE3.9

Reinforcement Learning for Autonomous Dynamic Soaring in Shear Winds

Corey Montella, and John Spletzer
Lehigh University

- Reinforcement learning (RL) for a dynamic soaring task (DS) is demonstrated in simulation.
- Teaching controller demonstrates correct (DS) strategies.
- RL controller improves on performance by almost 50%

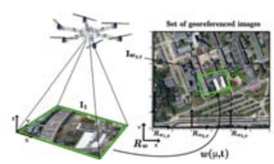


17:34–17:37 TuE3.10

Vision-based Absolute Localization for Unmanned Aerial Vehicles

A. Yol[1], B. Delabarre[1], A. Dame, J.-E. Dartois and E. Marchand[1]
[1]Inria/Irisa Rennes, Lagadic Team

- Direct **Pose Estimation**
- **Vision-based** approach using image registration relying on the **Mutual Information**.
- Drift effects avoided by using **georeferenced** images.



Absolute localization of the UAV

17:37–17:40 TuE3.11

Variable impedance control for aerial interaction

Abeje Y. Mersha,[1] Stefano Stramigioli,[2] and Raffaella Carloni[2]
[1]Saxion University of Applied Science
[2]University of Twente

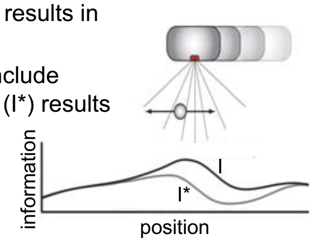
- Versatile control architecture for free-flight and interaction
- Unified variable impedance and time-varying interaction force controller
- Performance demonstrated by experiments

17:40–17:43 TuE3.12

Improving object tracking through distributed exploration of an information map

Izaak Neveln[1], Lauren Miller[1], Malcolm MacIver[1] and Todd Murphey[1]
[1]Northwestern University

- Maximizing Information (I) results in poor tracking
- Modifying Information to include sensor history information (I*) results in distributed trajectories
- Distributed trajectories give better estimates of object position with more certainty in 1D



Unmanned Aerial Systems I / Localization and Pose Estimation

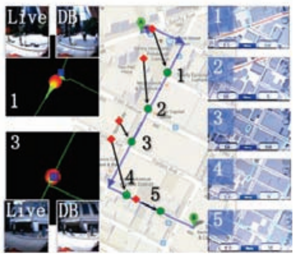
Chair *Christopher M. Clark, Harvey Mudd College*
Co-Chair

17:43–17:46 TuE3.13

Topometric Localization on a Road Network

Danfei Xu[1], Hernán Badino[1],
and Daniel Huber[1]
[1]Carnegie Mellon University Robotics Institute

- This paper presents an algorithm for localizing a vehicle on an arbitrary GPS-denied road network using vision, road curvature estimates, or a combination of both.

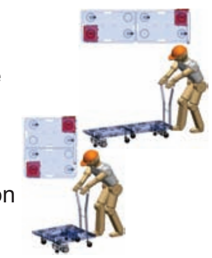


17:46–17:49 TuE3.14

Pose Estimation of Servo-Brake-Controlled Caster Units Arbitrarily Located on a Mobile Base

Masao Saida[1], Yasuhisa Hirata[1]
and Kazuhiro Kosuge[1]
[1]Tohoku University, Japan

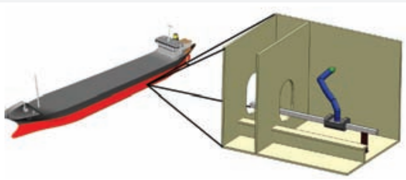
- Estimation of the geometrical relationships between caster units
- Recursive Estimation using only the velocity information of each caster unit by the Extended Kalman filter
- A simple pattern that enables users to provide sufficiently rich information for relationship estimates



17:49–17:52 TuE3.15

Rail-Guided Robotic End-Effector Position-Error Due to Rail Compliance and Ship Motion

D.J. Borgerink[a,b], J. Stegenga[b],
D.M. Brouwer[a], H.J. Wörtche[b] and S. Stramigioli[a]
[a]University of Twente [b]INCAS[3]



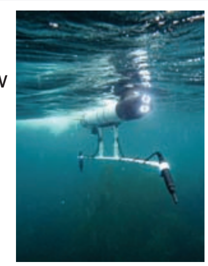
- Inspection robot for ballast water tanks in ships
- Influence of rail compliance on the end-effector position
- Alternative design strategy is recommended

17:52–17:55 TuE3.16

A Multi-AUV State Estimator for 3D Localization of Tagged Fish

Y. Lin[1], H. Kastein[1],
T. Peterson[1], C. White[2], C. G. Lowe[2] , C. Clark[1]
Harvey Mudd College[1], CSU Long Beach[2]

A 3D state-estimator part of a multi-AUV shark tracking system is presented. Experimental results show significant tracking performance compared to previous works. The system has also been successfully used to track a tagged leopard shark over a span of 4 days.



Wednesday September 17

Medical Robots and Systems II / Rehabilitation Robotics II

Chair *Russell H. Taylor, The Johns Hopkins University*
Co-Chair

09:00–09:20	WeA1.1

Keynote: Towards Intelligent Robotic Surgical Assistants

M. Cenk Cavusoglu
Case Western Reserve University

This talk will introduce the current state of our research towards development of intelligent robotic surgical assistants. I will present our latest results on robotic sensing, active perception, planning, and manipulation algorithms towards autonomous execution of low-level surgical tasks.

09:20–09:23	WeA1.2

Task-space motion planning of MRI-actuated catheters for catheter ablation of atrial fibrillation

Tipakorn Greigarn[1], Cenk Çavuşoğlu[1],
[1]Case Western Reserve University

- An MRI-actuated catheter is steered by applying currents to the coils attached to the catheter under MRI magnetic field.
- Main difficulty is kinematic redundancy and underactuation
- Control trajectory is calculated in the task space to avoid the problems

09:23–09:26	WeA1.3

Using Lie algebra for shape estimation of medical snake robots

Rangaprasad Arun Srivatsan[1],
Matthew Travers[1] and Howie Choset[1]
[1]Carnegie Mellon University

Using Lie algebra in the state vector of an extended Kalman filter, the shape of a highly articulated robot is estimated.

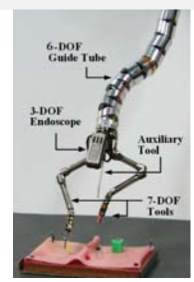
This approach provides a more accurate estimation of the shape compared to approaches using conventional parameterization of SE(3).

09:26–09:29	WeA1.4

Modeling and Control of Robotic Surgical Platform for Single-Port Access Surgery

Jusuk Lee[1], J. Kim[1], K. Lee[2], S. Hyung[1],
Y. Kim[3], W. Kwon[1], K. Roh[1], and J. Choi[1]
[1] Samsung Electronics, [2] KIST, [3] KOREATECH

- The surgical robot consists of a 6-DOF guide tube, two 7-DOF tools, a 3-DOF stereo camera, and a 5-DOF slave arm.
- We propose a Cartesian-level controller to position and orient the guide tube.
- We compensate for the backlash in the tool joints for accurate motion.

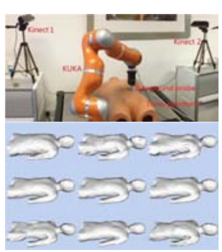


09:29–09:32	WeA1.5

Semi-Autonomous Navigation for Robot Assisted Tele-Echography using Generalized Shape Models and Co-Registered RGB-D cameras

Lin Zhang[1], Su-Lin Lee[1],
Guang-Zhong Yang[1] and George P. Mylonas[1]
[1]Imperial College London

- Proposed a navigation system with a master-slave setup for robot-assisted remote ultrasound examination using a deformable shape model of patient
- A patient specific customized model is generated and updated based on patient's motion
- Experiments show the effectiveness of the shape model and system



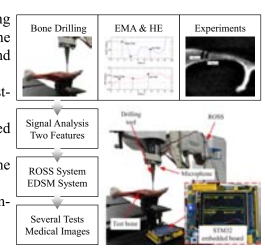
09:32–09:35	WeA1.6

State Recognition of Bone Drilling With Audio Signal in Robotic Orthopedics Surgery System

Yu Sun, Haiyang Jin, Ying Hu*, Peng Zhang, Jianwei Zhang

Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences, ShenZhen,China

(1) For analyzing the audio signal in the bone drilling process, the power spectral density caculated in the FFT method is used to determine an effective band with less noise.
(2) Two features, EMA and HE, are proposed for illustrating the drilling process.
(3) A drilling state recognition algorithm is developed to monitor the drilling process.
(4) A embedded state monitor is developed for real-time recognition.
(5) A robotic orthopedics surgery system is used to conduct an experiment to demonstrate the algorithm.



Medical Robots and Systems II / Rehabilitation Robotics II

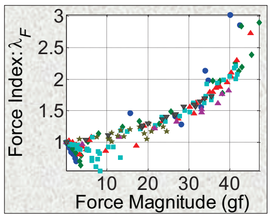
Chair *Russell H. Taylor, The Johns Hopkins University*
Co-Chair

09:35–09:38 WeA1.7

Estimating Contact Force for Steerable Ablation Catheters based on Shape Analysis

Mahta Khoshnam[1,2], Rajni V. Patel[1,2],
[1]Canadian Surgical Technologies and Advanced Robotics (CSTAR), [2] Western University, Canada

- Feasible to estimating tip/tissue contact force from catheter shape.
- Defining an index to denote the range of contact forces.
- The index correctly detects force ranges in 80% of cases.



09:38–09:41 WeA1.8

Shape Prediction for a Nonconstant Curvature Snake-like Manipulator

R Murphy[1,2], Y Otake[1], R Taylor[1] and M Armand[1,2]
[1]Johns Hopkins University
[2]Johns Hopkins University Applied Physics Lab

- Developed two-stage algorithm to predict the kinematic configuration of a snake-like manipulator from string length
- Compared to experimental data, results demonstrate successful prediction for tip position and manipulator shape

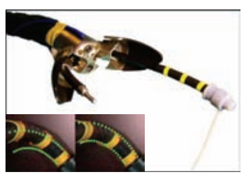
Example predicted configuration (green)

09:41–09:44 WeA1.9

Comparison of Methods for Estimating the Position of Actuated Instruments in Flexible Endoscopic Surgery

P. Cabras, D. Goyard,
F. Nageotte, P. Zanne, C. Doignon
ICUBE – University of Strasbourg, CNRS

- Robotic Endoscopic Surgery with flexible instruments.
- Measuring the position of instruments using the embedded endoscopic camera.
- *Model-based approach with tolerance on geometrical model.*
- *Learning-based approach.*

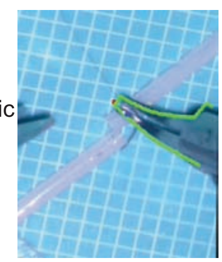


09:44–09:47 WeA1.10

Robust Forceps Tracking Using Online Calibration of Hand-Eye Coordination for Microsurgical Robotic System

Shinichi Tanaka[1], Young Min Baek[1], Kanako Harada[1], Naohiko Sugita[1], Akio Morita[2], Shigeo Sora[3], Hirofumi Nakatomi[4], Nobuhito Saito[4] and Mamoru Mitsuishi[1]
1. The University of Tokyo, Department of Mechanical Engineering
2. Nippon Medical School Hospital
3. Tokyo Metropolitan Police Hospital
4. The University of Tokyo, Department of Neurosurgery

- Forceps tracking method for microsurgical robotic system is proposed.
- The kinematic data and microscopic image are used for the tracking.
- The hand-eye coordination is updated online to handle the repositioning of the microscope.

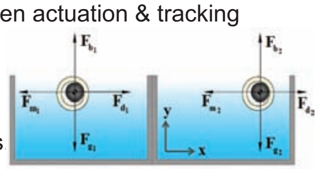


09:47–09:50 WeA1.11

MRI-powered Closed-loop Control for Multiple Magnetic Capsules

Alina Eqtami, Ouajdi Felfoul
and Pierre E. Dupont
Boston Children's Hospital, Harvard Medical School

- Use of **Clinical MRI** for powering and tracking.
- Goal: Closed-loop control of a group of millimeter scale magnetic capsules.
- **Optimal switching** between actuation & tracking as these are interleaved.
- Consideration of all the practical issues: delays constraints & disturbances

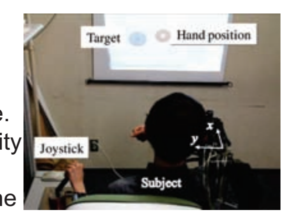


09:50–09:53 WeA1.12

Development and Evaluation of an Operation Interface for Physical Therapy Devices based on Rehab Database

Toshiaki Tsuji, Chinami Momiki, and Sho Sakaino
Saitama University, Japan

For joystick operation interfaces, the operator can freely control the device by recognizing the direction and magnitude of the applied force. An appropriate degree of rigidity for the joystick is needed to enable operations involving fine and large motions.



Medical Robots and Systems II / Rehabilitation Robotics II

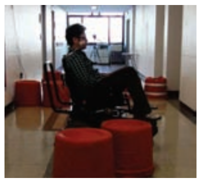
Chair *Russell H. Taylor, The Johns Hopkins University*
Co-Chair

09:53–09:56 WeA1.13

EMG-based Continuous Control Method for Electric Wheelchair

Giho Jang and Youngjin Choi
Hanyang University, South Korea

- Conventional methods have provided intermittent commands.
- Facial muscles are utilized as inputs to replace the conventional joystick interface.
- The effectiveness of the proposed control scheme is verified through several experiments.



09:56–09:59 WeA1.14

NTUH-II Robot Arm with Dynamic Torque Gain Adjustment Method for Frozen Shoulder Rehabilitation

C.-H. Lin[1], W.-M. Lien[1], W.-W. Wang[1], S.-H. Chen[1], C.-H. Lo[1], S.-Y. Lin[1], L.-C. Fu[1], *Fellow, IEEE* and J.-S. Lai[2]
[1]National Taiwan University(NTU) [2]NTU Hospital

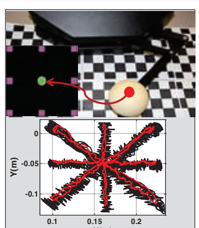
- A new 8 degrees of freedom (DOFs) rehabilitation robot arm named NTUH-II has been developed.
- A dynamic gain adjustment method based on stiffness model for frozen shoulder rehabilitation is proposed.

09:59–10:02 WeA1.15

Involuntary Movement during Haptics-enabled Robotic Rehabilitation

S. Farokh Atashzar[1], A. Saxena[1],M.Shahbazi[1] and Rajni V. Patel[1]
[1]Western University (UWO), Canada

- Safety of patient-robot interaction in the presence of pathological tremors for haptics-enabled rehabilitation.
- Control architecture to provide a modulated force field that can damp out hand tremor and assist/coordinate voluntary actions.



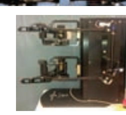
Test bed & Results

10:02–10:05 WeA1.16

A Framework for Supervised Robotics-Assisted Mirror Rehabilitation Therapy

Mahya Shahbazi[1,2], S.F. Atashzar[1,2],R.V. Patel[1,2]
[1]Canadian Surgical Technologies and Advanced Robotics (CSTAR), [2]Western University, Canada

- Novel robotics-assisted framework for bilateral mirror-image therapy: to facilitate brain neuro-plasticity in post-stroke patients.
- Customized dual-user teleoperation architecture incorporated with Guidance Virtual Fixtures (GVFs).
- Closed-loop stability using the small-gain theorem.

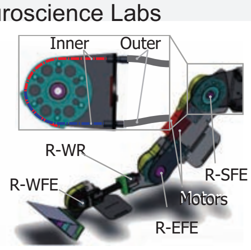


10:05–10:08 WeA1.17

Development of an Upper Limb Exoskeleton Powered via Pneumatic Electric Hybrid Actuators with Bowden Cable

Tomoyuki Noda[1], Tatsuya Teramae[1], Barkan Ugurlu[1], and Jun Morimoto[1]
[1]ATR Computational Neuroscience Labs

- Powered by a hybrid way (PAMs with Bowden Cable + a small electromagnetic motor)
- Implementable multi-DOF generates precise large torque with agility and backdrivability
- Prototyped light weight right arm exoskeleton (5kg)

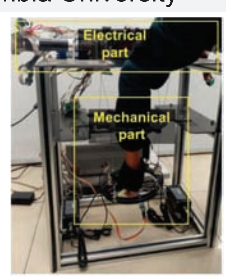


10:08–10:11 WeA1.18

A Novel Customized Cable-Driven Robot for 3-DOF Wrist and Forearm

Xiang Cui[1], Weihai Chen[1], Sunil K. Agrawal[2] and Jianhua Wang[1]
[1]Beihang University [2]Columbia University

- Features of the system: Cable-driven, cost-effective, low-weight, and easy-to-reconfigure
- System design
- Workspace analysis of a crossed-cable-driven structure
- Fast-convergent Parameter identification algorithm



Medical Robots and Systems II / Rehabilitation Robotics II

Chair *Russell H. Taylor, The Johns Hopkins University*
Co-Chair

10:11–10:14 WeA1.19

Identifying Inverse Human Arm Dynamics Using a Robotic Testbed

E. Schearer[1], Y. Liao[1], E. Perreault[1], M. Tresch[1], W. Memberg[2], R. Kirsch[2], and K. Lynch[1]
[1]Northwestern U. [2]Case Western Reserve U.

- We want to use functional electrical stimulation to control a human arm paralyzed by spinal cord injury.
- Robot moves hand along smooth reaching trajectories and measures force required to move hand.
- Gaussian process regression predicts mapping from shoulder and elbow positions and velocities to torque.

10:14–10:17 WeA1.20

A Risk Assessment Infrastructure for Powered Wheelchair Motion Commands without Full Sensor Coverage

P. TalebiFard, J. Sattar, I. M. Mitchell
The University of British Columbia

- Risk assessment for collaborative control of a powered wheelchair
- Estimate collision risk using a dynamic egocentric occupancy map and a neural network model of joystick control of PWC
- Demonstrate under two scenarios using single RGB-D sensor on an actual PWC

10:17–10:20 WeA1.21

LINarm: a Low-cost Variable Stiffness Device for Upper-limb Rehabilitation

Matteo Malosio[1,2], Marco Caimmi[1,2], Giovanni Legnani[2] and Lorenzo Molinari Tosatti[1]
[1]CNR-ITIA, Italy [2]UNIBS, Italy

- Device to perform linear rehabilitation exercises of the human arm
- Variable stiffness actuator
- Force estimation
- Low-cost design
- Control aspects
- 3D-printable

Motion and Path Planning III / Planning, Failure Detection and Recovery

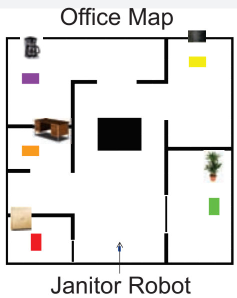
Chair *Torsten Kroeger, Google, Inc.*
Co-Chair

09:00–09:20 WeA2.1

Keynote: Planning for Complex High-Level Missions

Lydia E. Kavraki
Rice University

- The goal is to produce low-level motion plans that satisfy a high-level specification or mission.
- How can the mission be specified?
- How can the motion plans be generated for a general hybrid system?

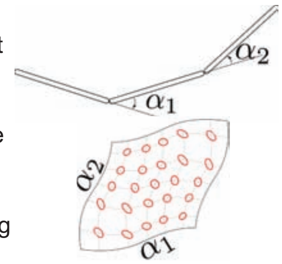


09:20–09:23 WeA2.2

Nonlinear Dimensionality Reduction for Kinematic Cartography

Tony Dear[1], Ross Hatton[2], and Howie Choset[1]
[1]Carnegie Mellon University
[2]Oregon State University

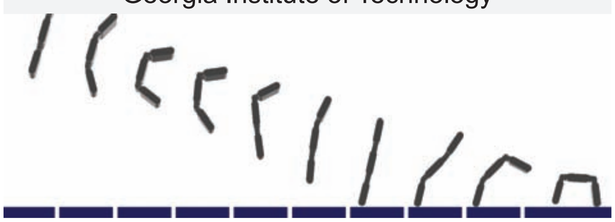
- Non-Euclidean metrics for motion planning often distort a robot's shape manifold.
- Goal: "Relax" the distortions so that trajectory lengths are better visually represented.
- Isomap finds the manifold's best projection for preserving point-to-point distances.



09:23–09:26 WeA2.3

Orienting in Mid-Air … to Achieve a Rolling Landing for Reducing Impact …

Jeffrey Bingham, Jeongseok Lee, Ravi Haksar, Jun Ueda and Karen Liu
Georgia Institute of Technology

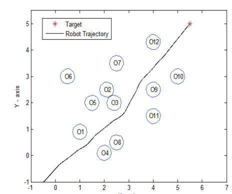


09:26–09:29 WeA2.4

Motion planning for non-holonomic mobile robots using the i-PID controller and potential field

Yingchong MA[1], Gang Zheng[1,2], Wilfrid Perruquetti[1,2] and Zhaopeng Qiu[1]
[1]Ecole Centrale de Lille [2]INRIA-Lille Nord Europe

- Using i-PID controller to track the desired velociy
- New potential field function improves the performance of obstacle avoidance and can produce smooth forces

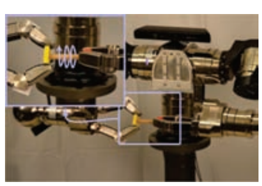


09:29–09:32 WeA2.5

Spherical Parabolic Blends for Robot Workspace Trajectories

Neil Dantam and Mike Stilman
Georgia Institute of Technology

- Multiple Workspace Waypoints
- Smooth, Nonstop Motion
- Constant-Axis Segments
- Blending of Spherical Linear Interpolation


Screw Alignment and Insertion

09:32–09:35 WeA2.6

Trajectory Planning for Car-Like Robots in Unknown, Unstructured Environments

Dennis Fassbender[1], André Mueller[1], and Hans-Joachim Wuensche[1]
[1]University of the Bundeswehr Munich

- **Goal**: Navigation under adverse conditions, e.g. off-road, poor GPS
- Figure: GPS road data in cyan, generated trajectory in green
- Costs determined by path's shape and terrain it crosses (e.g. slopes)
- **1st place** at euRathlon 2013 (Autonomous Navigation scenario)

Motion and Path Planning III / Planning, Failure Detection and Recovery

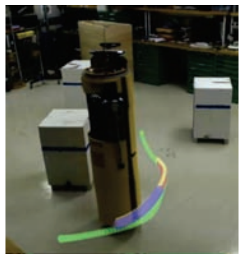
Chair *Torsten Kroeger, Google, Inc.*
Co-Chair

09:35–09:38 WeA2.7

Fast, Dynamic Trajectory Planning for a Dynamically Stable Mobile Robot

Michael Shomin and Ralph Hollis
Carnegie Mellon University

- Ballbot: a balancing, person sized mobile robot
- Presented is a method for generating dynamically feasible trajectories amongst obstacles in milliseconds
- Tractable and experimentally verifiedPictured: the ballbot executing a trajectory through clutter at .7 m/s

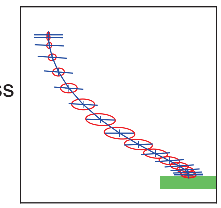


09:38–09:41 WeA2.8

Risk-aware Trajectory Generation with Application to Safe Quadrotor Landing

Jörg Müller and Gaurav S. Sukhatme
University of Southern California

- **State uncertainty** and closed-loop control cause **deviations** form the desired trajectory
- **Optimize** trajectory wrt. smoothness and **risk of collision or failure**
- Trade off risk against duration
- Encode constraints in efficient polynomial trajectory representation

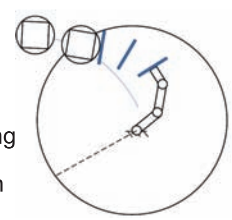


09:41–09:44 WeA2.9

Hierarchical Robustness Approach for Nonprehensile Catching of Rigid Objects

Alexander Pekarovskiy[1], Ferdinand Stockmann[1], Masafumi Okada[2] and Martin Buss[1]
[1]TUM, LSR [2]TITECH, MEP

- Nonprehensile catching of arbitrarily shaped rigid objects
- Multi-level approach and action sequence for robust task planning
- Catching strategies classification



09:44–09:47 WeA2.10

Parameterized Controller Generation for Multiple Mode Behavior

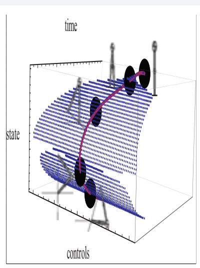
- Generating joint trajectories using inverse kinematics, allowing a snake robot to maintain constant head orientation while climbing poles
- Using FFT based modal decomposition method to derive analytical equations, which concisely represent joint trajectories for head alignment
- Visual tracking based on the parameterized equation

09:47–09:50 WeA2.11

Extending Equilibria to Periodic Orbits for Walkers using Continuation Methods

Nelson Rosa Jr.[1] and Kevin M. Lynch[1],
[1]Northwestern University

- A **simple** method for **generating walking gaits**.
- Generates passive and powered gaits.
- Method applies to multi-degree-of-freedom bipeds.
- Geometric interpretation of gaits as points on a manifold.

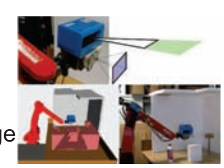


09:50–09:53 WeA2.12

Global Registration of Mid-Range 3D Observations and Short Range Next Best Views

Jacopo Aleotti, Dario Lodi Rizzini[1], Riccardo Monica[1] and Stefano Caselli[1]
[1]University of Parma, Italy

- Exploration of unknown objects by sensor fusion of 3D range data using two eye-in-hand sensors
- First sensor operates at mid-range
- Second sensor provides short-range data from next best view planning
- Global registration of all object observations



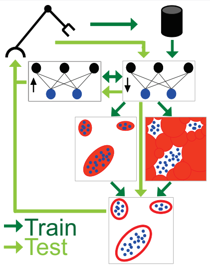
Motion and Path Planning III / Planning, Failure Detection and Recovery

Chair *Torsten Kroeger, Google, Inc.*
Co-Chair

09:53–09:56 WeA2.13

Model-free robot anomaly detection

Rachel Hornung[1], H. Urbanek[1], J. Klodmann[1], C. Osendorfer[2] and P. van der Smagt[2,3]
[1]DLR [2]TUM [3]Fortiss



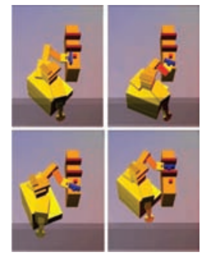
- Learns anomalies from valid data
- Generalizes to unseen data
- Handles high-dimensional data
- Can be adjusted to new setups
- Applicable for online use

09:56–09:59 WeA2.14

A constraint-based method for solving sequential manipulation planning problems

Tomas Lozano-Perez and Leslie Pack Kaelbling
MIT

- Presents and approach to integrated task and motion planning.
- Task planner produces plan skeleton with variables for geometric parameters.
- Geometric parameters are chosen by solving a constraint-satisfaction problem (CSP).



09:59–10:02 WeA2.15

Attack Resilient State Estimation for Autonomous Robotic Systems

Nicola Bezzo, J. Weimer, M. Pajic, O. Sokolsky, G. J. Pappas, and I. Lee
University of Pennsylvania

- Development of a **Recursive Adaptive Estimator** based on the Linear Quadratic Regulator to *shield* against malicious attacks on sensors.

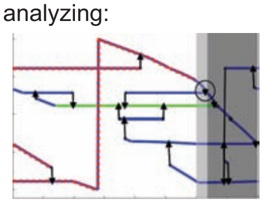
- Validation via extensive **simulations** and **experiments** on two ground vehicles running **cruise control**.

10:02–10:05 WeA2.16

A Metric for Self-Rightability and Its Relationship to Simple Morphologies

Chad C. Kessens[1], Craig T. Lennon[1], and Jason Collins[2]
[1]US Army Research Lab [2]Engility Corp.

- Metric enables comparison across disparate designs
- Demonstrated metric utility for analyzing:
  - Range of motion
  - Relative mass
  - Mass location
  - Relative limb length
  - Body aspect ratio
- Validated in physical hardware

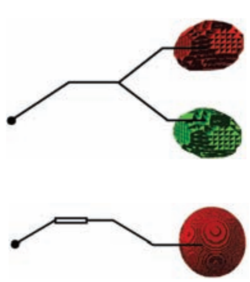


10:05–10:08 WeA2.17

Sampling-Based Motion Planning with Reachable Volumes : Application to Manipulators and Closed Chain Systems

Troy McMahon, Shawna Thomas and Nancy M. Amato
Parasol Lab, Dept of Computer Science and Engineering, Texas A&M University, USA

- Reachable volumes are a geometric representation of the regions the joints of a robot can reach. They can be used to generate constraint satisfying samples for problems including complicated linkage robots (e.g. closed chains and graspers).
- We show that reachable volumes have an O(1) complexity in unconstrained systems and in many constrained systems. We also show that reachable volume can be computed in linear time and that reachable volume samples can be generated in linear time in problems without constraints.
- We evaluate the reachable volume sampler over a wide variety of systems including linkages, closed chains and tree-like robots with as many as 262 dof. Our results show that reachable volume sampling produces better connected roadmaps and requires less computation time than existing methods.

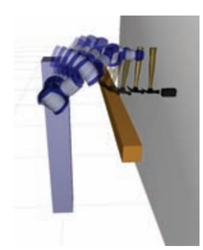


10:08–10:11 WeA2.18

Probabilistically Complete Kinodynamic Planning for Robot Manipulators with Acceleration Limits

Tobias Kunz, Mike Stilman
Georgia Tech

- Joint acceleration limits instead of full robot dynamics
- RRT with steering method
- Multiple orders of magnitude faster than a standard kinodynamic RRT



Motion and Path Planning III / Planning, Failure Detection and Recovery

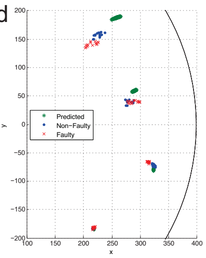
Chair *Torsten Kroeger, Google, Inc.*
Co-Chair

10:11–10:14 WeA2.19

Run-time Detection of Faults in Autonomous Mobile Robots Based on the Comparison of Simulated and Real Robot Behaviour

Alan G. Millard[1], Jon Timmis[1] and Alan F.T. Winfield[2]
[1]University of York [2]University of the West of England

- Non-faulty robot behaviour predicted via simulation of controller code
- Observed behaviour ≠ expected behaviour → Faulty robot
- Periodically reinitialise simulation to prevent drift due to reality gap
- Trade-off between minimising drift and detecting faulty behaviour

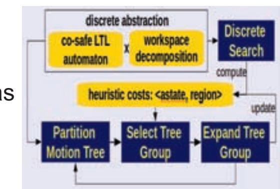


10:14–10:17 WeA2.20

Sampling-Based Tree Search with Discrete Abstractions for Motion Planning with Dynamics and Temporal Logic

James McMahon[1,2], Erion Plaku[1],
[1]Catholic University of America
[2]US Naval Research Laboratory

- Plan collision-free, low-cost, and dynamically-feasible trajectories that satisfy tasks given as co-safe LTL formulas
- Incorporate physics-based engines for accurate simulations of rigid-body dynamics



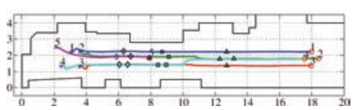
10:17–10:20 WeA2.21

Distributed fault detection and recovery for networked robots

Filippo Arrichiello
Università degli Studi di Cassino e del Lazio Meridionale, Cassino, Italy
Alessandro Marino
Università degli Studi di Salerno, Salerno, Italy
Francesco Pierri
Università degli Studi della Basilicata, Potenza, Italy

- A decentralized fault tolerant strategy for networked robotic systems is devised
- Each robot implements a decentralized observer-controller schema to estimate the overall system state and to compute the motion input
- At the same time, an FDI module is designed to detect and isolate faulty vehicles, to compensate recoverable faults or to rearrange the mission in presence of unrecoverable faults
- Numerical simulations and experiments with 5 robots are provided to show the effectiveness of the approach


The experimental setup


Vehicle paths

Networked Robots / Swarm Robotics

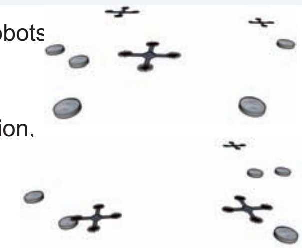
Chair *Richard Vaughan, Simon Fraser University*
Co-Chair

09:00–09:20 WeA3.1

Keynote: Networked Robots

Daniela Rus
CSAIL, MIT

- Challenges in networked robots
- New capabilities at the intersection of communication, perception, and control
- Coverage

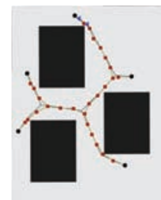


09:20–09:23 WeA3.2

Autonomous Wireless Backbone Deployment with Bounded Number of Networked Robots

Elerson R. S. Santos, Marcos A. M. Vieira
Computer Science Department
Universidade Federal de Minas Gerais, Brazil

- We propose a methodology to interconnect a set of clients:
  1. An Obstacle Avoidance Steiner Tree sets the preliminary path.
  2. A state machine (CEFSM) autonomously guide networked robots to create the network.
- Our methodology needs a bounded number of robots to create the network.

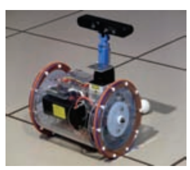


09:23–09:26 WeA3.3

Point Cloud Culling for Robot Vision Tasks Under Communication Constraints

William J. Beksi and Nikolaos Papanikolopoulos
University of Minnesota, USA

- Algorithms for controlling data transmission in a robotic network using a cloud infrastructure
- Highly efficient transfer of RGB-D data from a client (robot) to a server (cloud)
- Reduction of network congestion thus allowing a robot to perform vision tasks in real-time



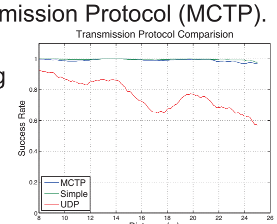
Microvision Robot

09:26–09:29 WeA3.4

Robust Routing and MCTP: Connectivity Management of Mobile Robotic Teams

James Stephan[1], Jonathan Fink[2], Benjamin Charrow[1], Alejandro Ribeiro[1], and Vijay Kumar[1]
[1]University of Pennsylvania [2]U.S. A.R.L.

- We examined robust routing solutions and developed the Multi-Confirmation Transmission Protocol (MCTP).
- We showed that by using a combination of robust routing and MCTP a mobile robotic team can successfully navigate complex environments, with minimal communication overhead.



09:29–09:32 WeA3.5

A Centralized-equivalent Decentralized Implementation of Extended Kalman Filters for Cooperative Localization

Solmaz Kia[1], Stephen Rounds[2], Sonia Martinez[3]
[1]UC Irvine [2]John Deere ISG [3]UC San Diego

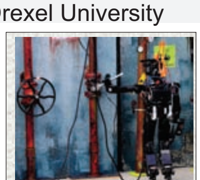
- A novel recursive decentralized cooperative localization (CL) algorithm
- Equivalent to a centralized EKF for CL
- Small communication message size
- Communication only at update stage
- Time-varying connectivity with the only requirement of existence of a spanning tree rooted at robots taking measurements

09:32–09:35 WeA3.6

From Autonomy to Cooperative Traded Control of Humanoid Manipulation Tasks

Jim Mainprice[1], Calder Phillips-Grafflin[1], Halit Bener Suay[1], Daniel Lofaro[2], Dmitry Berenson[1], Sonia Chernova[1], Robert W. Lindeman[1] and Paul Oh[2]
[1]Worcester Polytechnic Institute [2]Drexel University

- Report lessons learned and system design of a teleoperation framework for manipulation tasks with unreliable communication
- Manipulation framework produces fullbody statically-stable trajectories
- System was applied successfully to the valve turning task of the DRC



DRC-Hubo turning a valve

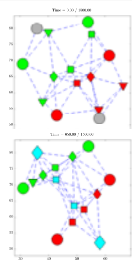
Networked Robots / Swarm Robotics

Chair *Richard Vaughan, Simon Fraser University*
Co-Chair

09:35–09:38 WeA3.7

Route Swarm: Wireless Network Optimization through Mobility

R. K. Williams[1], A. Gasparri[2] and B. Krishnamachari[1]
[1]Univerisity Southern California
[2]Roma Tre University



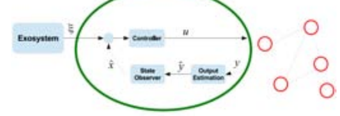
- A novel hybrid architecture for coordinating networked robots in sensing and information routing
- Mobile robotic network is dynamically reconfigured to ensure high quality routes between static wireless nodes.
- High-level centralized routing coupled seamlessly with distributed swarming

09:38–09:41 WeA3.8

Cooperative Dynamic Behaviors in Networked Systems with Decentralized State Estimation

Lorenzo Sabattini, Cristian Secchi, and Cesare Fantuzzi
Univ. of Modena and Reggio Emilia (Italy)

- Control strategy to implement dynamic complex behaviors in multi-robot systems, divided into *leaders* and *followers*
- Decentralized estimation procedure for letting the leaders estimate the state of the system



09:41–09:44 WeA3.9

Adding Transmission Diversity through Radio Switching and Directivity

Christopher Lowrance[1], Adrian Lauf[1],
[1]University of Louisville

- Intelligent directional radio activation while maintaining omni-presence
- Fuzzy logic controller used to make radio selection process
- Simulation results show that radio switching can improve throughput when conditions unfavorable for omni-antenna, despite delay incurred in switching process

09:44–09:47 WeA3.10

Effective Compression of Range Data Streams for Remote Robot Operations using H.264

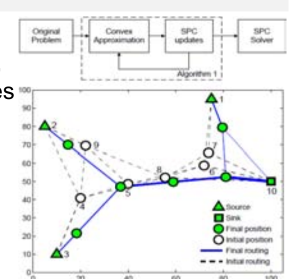
Fabrizio Nenci[1], Luciano Spinello[2], Cyrill Stachniss[1]
[1]University of Bonn [2]University of Freiburg

- Remotely operating robots often have limited communication abilities
- Approach to stream depth images through low bandwidth networks
- Use of H.264 and demultiplexing to reduce the effects of compression artifacts on range data
- Used on Kinect and Velodyne data

09:47–09:50 WeA3.11

Network Lifetime Maximization in Mobile Visual Sensor Networks

Shengwei Yu[1], and C. S. George Lee[2]
[1]Marvell Semiconductor Inc. [2]Purdue University

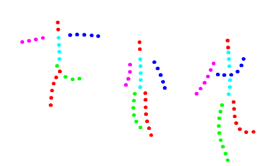


- Simultaneously design mobility, routing, source rate, and video encoding strategies for robotic visual sensor nodes.
- The method shows an edge on lifetime maximization of visual sensor networks.

09:50–09:53 WeA3.12

Task Assignment and Trajectory Optimization for Displaying Stick Figure Animations with Multiple Mobile Robots

Katsu Yamane[1], Jared Goerner[1]
[1]Disney Research, Pittsburgh



- Motion planning for multiple mobile robots displaying stick figure animations
- Consistent body part representation across frames, including occlusions
- Demonstrated in simulation with up to 75 robots

Session WeA3 Red Lacquer RoomWednesday, September 17, 2014, 09:00–10:20

Networked Robots / Swarm Robotics

Chair *Richard Vaughan, Simon Fraser University*
Co-Chair

09:53–09:56 WeA3.13

Worst-Case Optimal Average Consensus Estimators for Robot Swarms

Matthew Elwin, Randy Freeman, and Kevin Lynch
Northwestern University

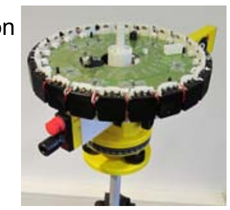
- Decentralized Averaging
  - Unknown Network
  - Consistent Performance
- Robotic Applications
  - SLAM, Formation Control
  - Environmental Modeling

09:56–09:59 WeA3.14

Robust Sensor Cloud Localization from Range Measurements

G. Dubbelman[1], E. Duisterwinkel[2], L. Demi[1], E. Talnishnikh[2], H.J. Wörtche[2], J.W.M. Bergmans[1]
[1]Eindhoven University of Technology [2]INCAS[3]

- Feasibility study on 3-D localization of massive sensor clouds
- Using range-only measurements and no beacons
- Simulations with inlier-outlier models to determine robustness

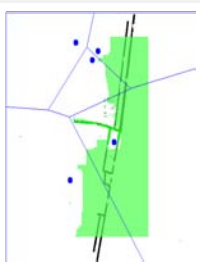


09:59–10:02 WeA3.15

Application of Grazing Guidance Laws to Autonomous Information Gathering

Thomas Apker[1], Shih-Yuan Liu[2], Donald Sofge[3] and J. Karl Hedrick[2]
[1]Exelis, Inc. [2]UC Berkeley [3] Naval Research Lab

- Grazing animals do area coverage autonomously
- They use a 1st order, greedy food-seeker in a Voronoi cell
- A velocity controller allows 2nd order systems to use grazing laws
- Linear estimator covariance models "food", *i.e.* it is "eaten" by sensors`

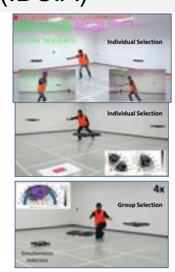


10:02–10:05 WeA3.16

Human-Swarm Interaction Using Spatial Gestures

Jawad Nagi, Alessandro Giusti, Luca M. Gambardella, and Gianni A. Di Caro
Dalle Molle Institute for AI (IDSIA)

- Basic vocabulary of two-handed **spatial gestures** to select robots
- Use of **face engagement** for selection and positioning of robots
- **SVM classifier** for spatial gesture recognition
- Distributed cooperative classification using **distributed consensus**

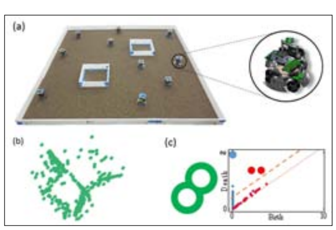


10:05–10:08 WeA3.17

Mapping of Unknown Environments using Minimal Sensing from a Stochastic Swarm

A. Dirafzoon[1], J. Betthauser[1], J. Schornick[1], D. Benavides[1], and E. Lobaton[1]
[1]North Carolina State University

- Swarm of stochastic agents explore an unknown environment
- Only interaction information is used to learn topological features of the space

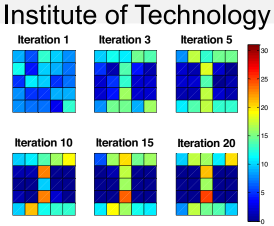


10:08–10:11 WeA3.18

Probabilistic Guidance of Distributed Systems using Sequential Convex Programming

D. Morgan[1], G. Subramanian[1], S. Bandyopadhyay[1], S. Chung[1] and F. Y. Hadaegh[2]
[1]University of Illinois at Urbana-Champaign [2]Jet Propulsion Lab, California Institute of Technology

- Probabilistic guidance of distributed systems used to achieve desired shape
- Model predictive control with sequential convex programs used to generate collision-free trajectories



Networked Robots / Swarm Robotics

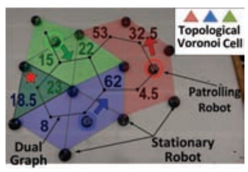
Chair *Richard Vaughan, Simon Fraser University*
Co-Chair

10:11–10:14 WeA3.19

Geodesic Topological Voronoi Tessellations in Triangulated Environments with Multi-Robot Systems

Seoung Kyou Lee[1], Sándor P. Fekete[2] and James McLurkin[1]
[1]Rice University, U.S.A. [2]TU Braunschweig, Germany

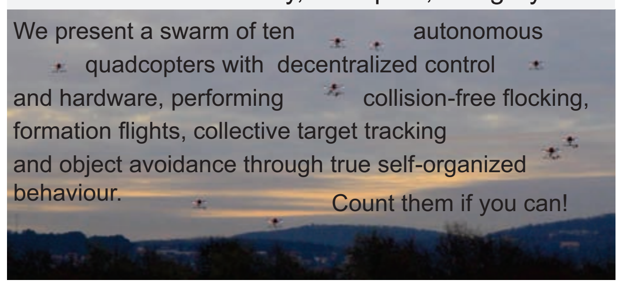
- Present a discrete approximation of the geodesic Voronoi cell using multi-robot triangulation
- Devise a distributed patrolling algorithm and its advanced version using physical data structure
- Compute globally optimal centroid using virtual agents



10:14–10:17 WeA3.20

Outdoor flocking and formation flight with autonomous aerial robots

G. Vásárhelyi[1], Cs. Virágh[1], G. Somorjai[1], N. Tarcai[1], T. Szörényi[1], T. Nepusz[1], T. Vicsek[1],
[1]Eötvös University, Budapest, Hungary



10:17–10:20 WeA3.21

Sponsor Talk: Autonomous Robot Fleets for Automated Warehouses

F. Buzan, T. MacDonald, K. Pankratov, L. Sweet
Symbotic LLC

- Fleets of high-speed autonomous mobile robots navigate within dense 3D structures to pick and place cases in exact sequence via coordinated task and planning
- Deployed in multiple vertical market segments
- *Winner of 2013 Edison Award*

Mechanisms and Actuators / Force and Tactile Sensing

Chair *Allison M. Okamura, Stanford University*
Co-Chair

10:50–11:10 WeB1.1

Keynote: Natural Machine Motion and Embodied Intelligence

Antonio Bicchi
Università di Pisa & Istituto Italiano di Tecnologia

What I think of Robots of the Future, i.e.

- They will move naturally,
- will be soft,
- will be quick but also strong;
- must be robust,
- must be safe,
- must be simple (!),

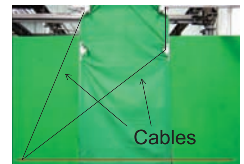
and how I think we can build them, though it's not easy...

11:10–11:13 WeB1.2

Dynamic Trajectory Planning of Planar Cable-Suspended Parallel Robots

Lewei Tang[1], Clément Gosselin[2],Xiaoqiang Tang[1] and Xiaoling Jiang[2] [1]Tsinghua University, Beijing, China, [2]Université Laval, Québec, Canada

- Cable-suspended robots with trajectories that extend beyond the static workspace
- Redundancy increases the dynamic capabilities
- Special frequencies are revealed that simplify trajectory planning
- Determination of feasible ranges



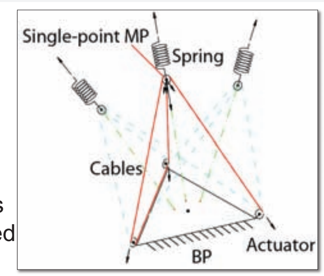
- Experimental validation with 2-dof robot

11:13–11:16 WeB1.3

Workspace Augmentation of Spatial 3-DOF Cable Parallel Robots Using Differential Actuation

Hamed Khakpour[1] and Lionel Birglen[1]
[1]Ecole Polytechnique de Montreal

- Spatial cable differentials are presented
- Comparison between differentially and individually driven cable parallel robots is shown
- Improvement of two types of workspaces is illustrated

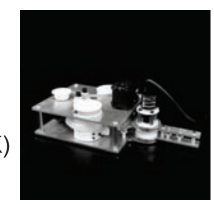


11:16–11:19 WeB1.4

Tendon Routing Resolving Inverse Kinematics for Variable Stiffness Joint

Shouhei Shirafuji[1], Shuhei Ikemoto[1], and Koh Hosoda[1]
[1]Osaka University

- The mechanism to control the position and joint stiffness of a tendon-driven manipulator independently is proposed
- We call it as "tendon routing resolving inverse kinematics" (TRIK)
- The methodology to design this mechanism is introduced

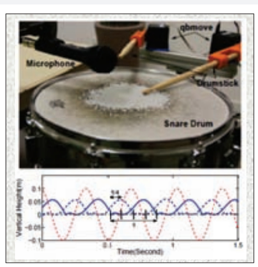


11:19–11:22 WeB1.5

Drum Stroke Variation using Variable Stiffness Actuators

Yongtae G. Kim[1,2], Manolo Garabini[1], Jaeheung Park[2] and Antonio Bicchi[1]
[1]UNIPI, Centro E. Piaggio, Italy, [2]SNU, Korea

- Stroke response can be tuned by stiffness variation.
- Drum rolling stiffness was calculated by modeling the dynamics between drum membrane and drum stick.
- Drum rolling was implemented in simulation and validated experimentally.

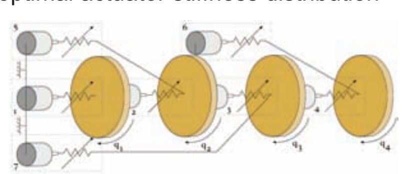


11:22–11:25 WeB1.6

Compliant Robotic Systems on Graphs

Stefan S. Groothuis[1], Stefano Stramigioli[1], and Raffaella Carloni[1]
[1]RaM, University of Twente, The Netherlands

- Modeling methodology of compliant systems actuated by variable stiffness actuators based on graph theory
- For a given task, optimal actuator stiffness distribution can be found
- Framework can assist in design decisions



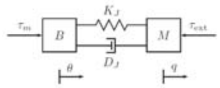
Mechanisms and Actuators / Force and Tactile Sensing

Chair *Allison M. Okamura, Stanford University*
Co-Chair

11:25–11:28	WeB1.7

Reaching desired states time-optimally from equilibrium and vice versa for visco-elastic joint robots with limited elastic deflection

Nico Mansfeld and Sami Haddadin
German Aerospace Center (DLR)

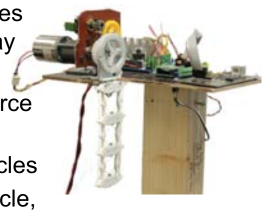


- Considered Problems:
  1. Which states can an elastic joint with limited deflection reach from equilibrium?
  2. How can an elastic joint robot be stopped as fast as possible?
- Solutions for both problems provided for 1-DOF
- Braking extended to n-DOF and verified in experiment

11:28–11:31	WeB1.8

Force-Guiding Particles Chains for Shape-Shifting Display

Matteo Lasagni[1], Kay Römer[1],
[1]Graz University of Technology



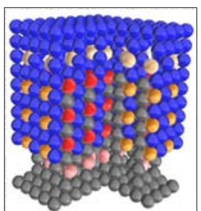
- Folding chains of robotic particles form a programmable 3D display
- Weak and simple mechanisms in particles guide an external force to fold the chain
- Simple and miniaturizable particles
- *Scalability*: the smaller the particle, the higher the resolution and the maximum length of a chain

11:31–11:34	WeB1.9

A class of microstructures for scalable collective actuation of Programmable Matter

P. Hołobut[1], M. Kursa[1], Jakub Lengiewicz[1]
[1] IPPT PAN, Warsaw, Poland

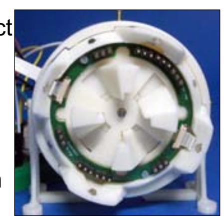
- One of key functionalities of real Programmable Matter
- Applies to large module ensembles
- Strength proportional to volume
- Two types of connections: strong (fixed) and weak (reconfigurable)
- Several actuator designs
- Analytical results & DEM simulations


collective actuator

11:34–11:37	WeB1.10

HiGen: A High-Speed Genderless Connection Mechanism with Single-Sided Disconnect for Modular Robots

C. Parrott, T. J. Dodd and R. Groß
The University of Sheffield



- Connects to another unit in a way that allows either side to disconnect in the event of failure
- Faster than existing mechanical genderless connectors
- Creates clearance between units, aiding modular self-reconfiguration
- Passes power and communication

11:37–11:40	WeB1.11

Stretchable Electroadhsion for Soft Robots

J. Germann[1], B. Schubert[1] and D. Floreano[1]
[1]Laboratory of Intelligent Systems,
Ecole Polytechnique Fédérale de Lausanne

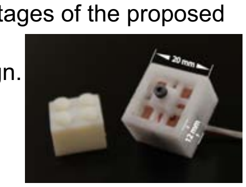
- Completely soft and stretchable electrically-controllable adhesive.
- Simple fabrication for easy integration with soft robots.
- Tunable shear and normal adhesion force.

11:40–11:43	WeB1.12

Miniature Capacitive Three-Axis Force Sensor

Rachid Bekhti[1], V. Duchaine[1], P. Cardou[2]
[1]École de Technologie Supérieure
[2]Laval University

This project's research goal is to **develop systematic**, **inexpensive**, method to **enhance** the design of multi-axis force sensors. Some advantages of the proposed approach are:



- Compactness and simple design.
- A good overall accuracy.
- A large range with acceptable cross-axis sensitivity.
- A good robustness against noise and hysteresis.

Mechanisms and Actuators / Force and Tactile Sensing

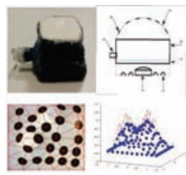
Chair *Allison M. Okamura, Stanford University*
Co-Chair

11:43–11:46 WeB1.13

A Framework for Dynamic Sensory Substitution

Artashes Mkhitaryan and Darius Burschka
Technische Universität München, Germany

- Automatic toolbox for configuration of new sensing modalities
- Dynamic selection of an optimal processing chain for a specific measurement task.
- Extension of perceptual capabilities of a platform with limited number of physical sensors



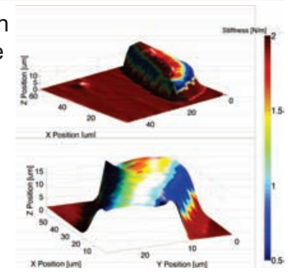
Camera-based force sensor

11:46–11:49 WeB1.14

High-throughput analysis of the morphology and mechanics of tip growing cells using a microrobotic platform

D. Felekis[1], H. Vogler[2], G. Mecja[1], S. Muntwyler[1], M. S. Sakar[1], U. Grossniklaus[2] and B. J. Nelson[1]
[1]IRIS, ETH Zürich [2]University of Zürich

- Automated micromanipulation and characterization of single cells
- 3D topography and stiffness maps
- Real-time probing and intracellular sensing

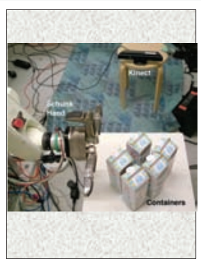


11:49–11:52 WeB1.15

What's in the Container? Classifying Object Contents from Vision and Touch

Püren Güler[1], Yasemin Bekiroğlu[1], Xavi Gratal[1], Karl Pauwels[2] and Danica Kragic[1]
[1]KTH [2]University of Granada

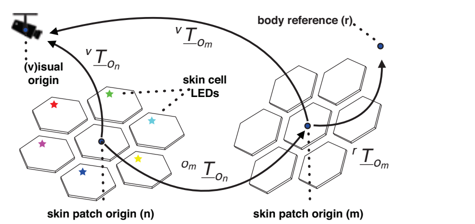
Our robot identifies the content of the container by grasping prior to applying manipulation actions to the container. We investigate the benefits of using unimodal (visual or tactile) or bimodal (visual-tactile) sensory data. Our results show that the visual and the tactile data are complementary.



11:52–11:55 WeB1.16

3D Spatial Self-organization of a Modular Artificial Skin

Philipp Mittendorfer, Emmanuel Dean, and Gordon Cheng
ICS, Technische Universität München, Germany



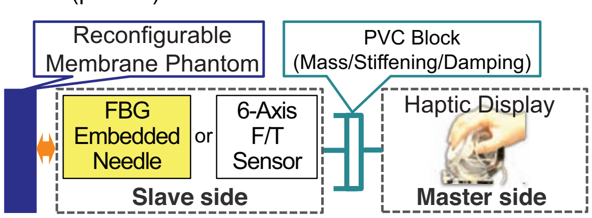
www.ics.ei.tum.de www.cellulARSkin.eu

11:55–11:58 WeB1.17

Detection of Membrane Puncture with Haptic Feedback using a Tip-Force Sensing Needle

Santhi Elayaperumal[1], Jung Hwa Bae[1], Bruce L. Daniel[2] and Mark R. Cutkosky[1]
[1]Stanford University [2]Stanford Hospital

Tip-force sensing resulted in higher membrane detection rate ($p<0.05$) than feedback based on other sensors.

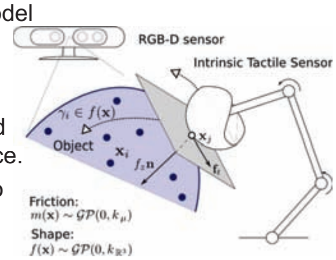


11:58–12:01 WeB1.18

Active Gathering of Frictional Properties from Objects

C. Rosales[1], A. Ajoudani[2], M. Gabiccini[1,2] and A. Bicchi[1,2]
[1]Centro di Ric. "E. Piaggio" [2]Ins. Italiano di Tecn.

- Gaussian Process to model **shape** and **friction** from sensory data.
- Exploration strategy exploits the model to find **geodesics** on the surface.
- Impedance **controller** to perform a successful contour following.



Mechanisms and Actuators / Force and Tactile Sensing

Chair *Allison M. Okamura, Stanford University*
Co-Chair

12:01–12:04 WeB1.19

Localization and Manipulation of Small Parts Using GelSight Tactile Sensing

R. Li[1], R. Platt Jr.[2], W. Yuan[1], A. ten Pas[2], N. Roscup[2], M. A. Srinivasan[1] and E. H. Adelson[1]
[1]MIT [2]Northeastern University

- GelSight fingertips provide high-resolution 3D geometry of grasped parts
- In-hand localization greatly improves performance on a cable insertion task

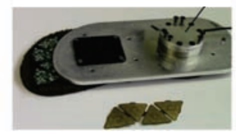
Baxter holds a USB cable with GelSight sensor (left) and obtains the height map for localization (right)

12:04–12:07 WeB1.20

Exploiting global force torque measurements for local compliance estimation in tactile arrays

C. Ciliberto[1], L. Fiorio[1], M. Maggiali[1], L. Natale[1], L. Rosasco[1], G. Metta[1], G. Sandini[1] and F. Nori [1]
[1]Istituto Italiano di Tecnologia

- We equipped iCub feet with 250-pressure-sensors skin.
- We present a method to estimate local skin compliance exploiting a transformation matrix to define a linear regression.
- Validation experiments performed directly on the iCub feet.

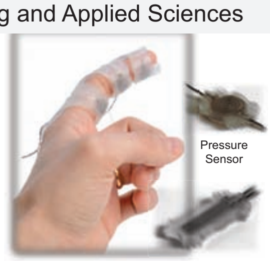


12:07–12:10 WeB1.21

Toward a Modular Soft Sensor-Embedded Glove for Human Hand Motion and Tactile Pressure Measurement

Frank L. Hammond III, Yiğit Mengüç, and Robert J. Wood
Harvard School of Engineering and Applied Sciences

- Soft modular pressure and extension sensors were used to create a soft data glove
- Enabled by novel wire routing soft sensor assembly methods
- Glove provides static and dynamic motion and pressure data during human grasping



Finger Glove

Humanoids and Bipeds III / Human Detection and Tracking

Chair *Sylvain Bertrand, Institute for Human and Machine Cognition*
Co-Chair

10:50–11:10 WeB2.1

Keynote on Humanoids and Bipeds

Dennis Hong
UCLA

11:10–11:13 WeB2.2

3D-SLIP Steering for High-Speed Humanoid Turns

Patrick M. Wensing, David E. Orin
Electrical and Computer Engineering,
The Ohio State University, USA

- Extends 3D-SLIP running control to high-speed turns.
- Captures unique roles of the inside and outside legs.
- Shows single-step changes in turn rate and direction while robust to push disturbances.
- Demonstrates a high-speed turn with a radius that is ¼ that of a 400m track.

3D-SLIP Steering with Whole-Body Control Enables High-Speed Turns

11:13–11:16 WeB2.3

Emergence of humanoid walking behaviors from Mixed-Integer Model Predictive Control

Aurélien Ibanez[1], Philippe Bidaud[1,2] and Vincent Padois[1]
[1] Univ. Pierre et Marie Curie Paris 06, France
[2] DSB-TIS, ONERA, France

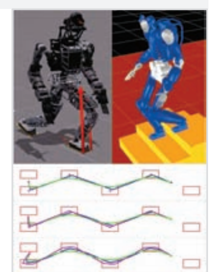
- Novel predictive, ZMP-based approach to walking and balancing
- Use of a linear, mixed-integer model to coordinate discrete shifts and continuous adjustments
- Optimal control of walking motor activity without prior definition of gait patterns

11:16–11:19 WeB2.4

Trajectory generation for continuous leg forces during double support and heel-to-toe shift based on divergent component of motion

Johannes Englsberger[1], T. Koolen[2,3], S. Bertrand[2], J. Pratt[2], Ch. Ott[1] and A. Albu-Schäffer[1]
[1]DLR [2]IHMC [3]MIT

- 3D DCM-based trajectory generators for continuous double support and heel-to-toe trajectories
- Produce continuous leg forces and facilitate toe-off motion
- Allow for walking over uneven terrain
- Tested in simulations and experiments

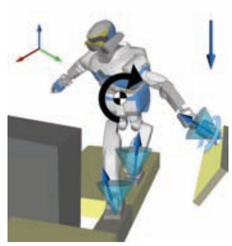


11:19–11:22 WeB2.5

MPC in Multi-Contact Motion Application to a Humanoid Robot

H. Audren[2,1], J. Vaillant[2], A. Kheddar[1,2], A. Escande[1], K. Kaneko[1] and E. Yoshida[1]
[1]CNRS-AIST JRL [2]CNRS-UM2 LIRMM

- Quick generation of CoM trajectories through MPC on a reduced model
- Task-based whole-body controller to track CoM
- Application to object manipulation and multi-contact motion

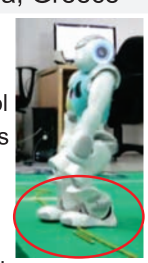


11:22–11:25 WeB2.6

Predictive Control for Dynamic Locomotion of Real Humanoid Robots

Stylianos Piperakis, Emmanouil Orfanoudakis, and Michail G. Lagoudakis
Technical University of Crete, Chania, Greece

- Cart and Table model with ZMP control
- Preview control with inverse system
- Constrained linear model predictive control
- Rigid body interpolation for feet trajectories
- Sensor fusion for state estimation
- Handling of sensor noise, delay, and bias
- Real-time omnidirectional walk on NAO
- 10*ms* control cycle, 21*cm*/*s* on rough terrain



Humanoids and Bipeds III / Human Detection and Tracking

Chair *Sylvain Bertrand, Institute for Human and Machine Cognition*
Co-Chair

11:25–11:28 WeB2.7

A Robot-Machine Interface for Full-functionality Automation using a Humanoid

Heejin Jeong[1], Sungwook Cho[1] and D.H Shim[1]
[1]Korea Advanced Institute of Science and Technology

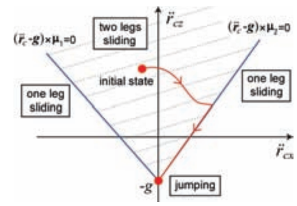
- RMI for a humanoid to pilot an airplane consists of Recognition, Decision, and Action.
- To validate, PIBOT (**pi**lot ro**bot**) system is developed using a small humanoid robot and flight simulation equipment designed for humans.
- Simulation results: It can fly the airplane from cold start to landing.

11:28–11:31 WeB2.8

Planar Sliding Analysis of a Biped Robot in Centroid Acceleration Space

Taku Senoo and Masatoshi Ishikawa
University of Tokyo, Japan

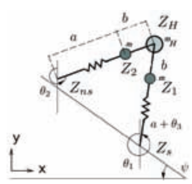
- State transition between sliding and takeoff is formulated in centroid acceleration space
- Characteristics of the formulated diagram are derived by comparison with a cone of friction
- Concrete behavior of a 2-DOF model is analyzed with numerical simulation



11:31–11:34 WeB2.9

Energy Based Control of Compass Gait Soft Limbed Bipeds

Isuru S. Godage, Yue Wang, and Ian D. Walker
Clemson University, SC, USA.



- Investigate energy based control of compass gait soft bipeds.
- Consider CL and IDA-PBC controllers to evaluate performance, stability, control effort, and speed variation.
- IDA-PBC controller showed better results over CL methods.
- Findings help in extending and developing novel controllers to soft limb robots for practical applications

11:34–11:37 WeB2.10

Analytical Control Parameters of the Swing Leg Retraction Method using an Instantaneous SLIP Model

Natan Shemer, Amir Degani,
Technion-Israel Institute of Technology

- The Swing Leg Retraction method is known to increase the robustness of legged running against ground height variations.
- Using an instantaneous SLIP model we find optimal parameters analytically and adapt them to the SLIP.
- We finally show simulations and experiments on the ParkourBot robot.

11:37–11:40 WeB2.11

Task-Oriented Whole-Body Planning for Humanoids based on Hybrid Motion Generation

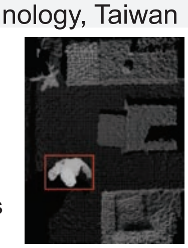
M. Cognetti, P. Mohammadi, G. Oriolo, M. Vendittelli
Sapienza University of Rome, Italy

- A humanoid is assigned a task (e.g., manipulation) that requires stepping
- The C-space submanifold compatible with task is explored by concatenating feasible elementary motions
- A hybrid scheme generates stepping and whole-body motions concurrently
- Sample plans generated for NAO are validated by dynamic playback in V-REP

11:40–11:43 WeB2.12

Real-Time People Detection and Tracking for Indoor Surveillance Using Multiple Top-View Depth Cameras

T.-E. Tseng[1], A.-S. Liu[1], P.-H. Hsiao[1], C.-M. Huang[2], L.-C. Fu[1],IEEE Fellower
[1]National Taiwan University, Taiwan
[2]National Taipei University of Technology, Taiwan



- Real-time indoor surveillance system
  - With multiple depth cameras
  - From zenithal (top-view) position
- Detect human based on
  - the hemiellipsoid head model
- Have 96% of F-score and outperforms than other algorithms

Humanoids and Bipeds III / Human Detection and Tracking

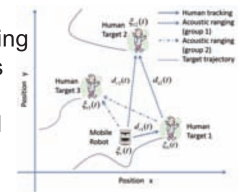
Chair *Sylvain Bertrand, Institute for Human and Machine Cognition*
Co-Chair

11:43–11:46 WeB2.13

Robot-Assisted Human Indoor Localization Using the Kinect Sensor and Smartphones

C. Jiang[1], M. Fahad[1], Y. Guo[1], J. Yang[2], Y. Chen[1]
[1]Stevens Inst. of Tech. [2]Florida State University

- A robot-assisted localization system that uses the Kinect sensor and smartphone-based acoustic ranging to localize indoor moving persons
- An extended Kalman filter based localization algorithm is proposed for real-time dynamic position estimation
- Real robot-smartphone experiments

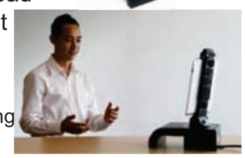


11:46–11:49 WeB2.14

Gesture-Based Attention Direction for a Telepresence Robot

K. P. Tee, R. Yan, Y. Chua,
Z. Huang and S. Liemhetcharat
Institute for Infocomm Research, A*STAR

- Gesture-based attention direction using Localist Attractor Network and Short-Term Memory
- Fusion of gesture, speech and head cues to determine attention target
- Experiment results:
  - 90% accuracy
  - Robot as good as human in directing attention



11:49–11:52 WeB2.15

Kinect-based People Detection and Tracking from Small-Footprint Ground Robot

A. Pesenti Gritti[1], O. Tarabini[1], J. Guzzi[2], G. A. Di Caro[2], V. Caglioti[1], L. M. Gambardella[2], A. Giusti[2]
[1]Politecnico di Milano [2]IDSIA, USI/SUPSI

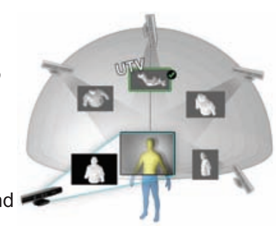
- Depth image processing and candidate legs 3D point clusters extraction
- Human legs classification based on supervised machine learning
- Combined usage of Kalman and PDAF filters to track legs and people barycenters over time

11:52–11:55 WeB2.16

Robust articulated upper body pose tracking under severe occlusions

M. Sigalas[1,2], M. Pateraki[1] and P. Trahanias[1,2]
[1]Institute of Computer Science - FORTH
[2]University of Crete, Computer Science Dept.

- Articulated upper body pose tracking
- Employment of the ***User Top View*** facilitates:
  - Exemption of the initialization requirement
  - coping with severe intra- and inter-personal **occlusions**

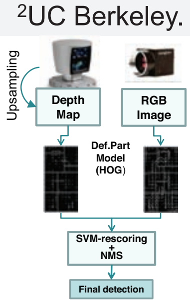


11:55–11:58 WeB2.17

Pedestrian Detection Combining RGB And Dense LIDAR Data

Cristiano Premebida[1], João Carreira[1,2],
Jorge Batista[1] and Urbano Nunes[1]
[1]ISR, DEEC, Univ. of Coimbra. [2]UC Berkeley.

- New dense depth-map upsampling method using LIDAR only
- 3D Velodyne and mono-camera fusion (experiments: KITTI dataset)
- Def. Part-Models + SVM-based rescoring strategy
- High performance on KITTI benchmarking

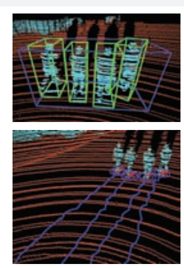


11:58–12:01 WeB2.18

Confidence-Based Pedestrian Tracking in Unstructured Environments Using 3D Laser Distance Measurements

Marcel Häselich, Benedikt Jöbgen,
Nicolai Wojke, Jens Hedrich, Dietrich Paulus
Active Vision Group, University of Koblenz-Landau, Germany

- Ground removal & 3D LRF features
- Clustering with dp-means
- Classification with a SVM
- Confidence-based particle filter
- Trails store the information where pedestrians moved
- Especially designed for unstructured environments



Humanoids and Bipeds III / Human Detection and Tracking

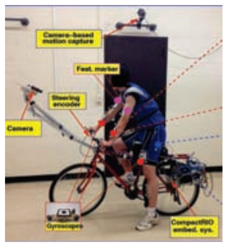
Chair *Sylvain Bertrand, Institute for Human and Machine Cognition*
Co-Chair

12:01–12:04 WeB2.19

Whole-Body Pose Estimation in Physical Rider-Bicycle Interactions with a Monocular Camera and a Set of Wearable Gyroscopes

Xiang Lu[1], Kaiyan Yu[2],Yizhai Zhang[3], Jingang Yi[2], and Jingtai Liu[1]
[1]Nankai University, China [2]Rutgers Univesity, USA
[3]Northwestern Polytechnical University, China

- Proposed a whole-body pose estimation scheme by fusion of an onboard camera and a set of wearable gyroscopes for the rider-bicycle system
- Single feature points and physical interaction constraints are used to enhance the robust fusion results
- The performance is validated and demonstrated through extensive experimental tests

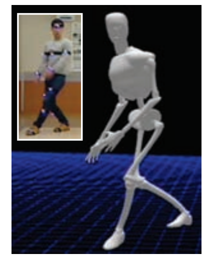


12:04–12:07 WeB2.20

Pedalvatar: An IMU-Based Real-Time Body Motion Capture System

Yang Zheng, Ka-Chun Chan, Charlie C.L. Wang
The Chinese University of Hong Kong

- A foot rooted kinematic model to capture motions with a static foot
- A state machine to control the switch of roots to reconstruct full-body motions
- An IMU-based system can be used outdoor to capture body motions in real-time



12:07–12:10 WeB2.21

Sponsor Talk: TOYOTA – Partner Robot

Joseph Djugash
Toyota Motor Eng. & Manuf. North America

- Enriching **Quality of Life** through Robotic Innovations
- Build robots that embody "**kindness**" & "**intelligence**" and assist with human activities in:
  - Elder care
  - Manufacturing
  - Mobility

Collision Detection and Avoidance / Sensing II

Chair *Bruce MacDonald, University of Auckland*
Co-Chair

10:50–11:10	WeB3.1

Keynote: *Bayesian Perception & Decision From Theory to Real World Applications*

Christian Laugier
Inria France

- **Multi-Sensors Bayesian Fusion** *for Open & Dynamic Environments*
- **Situation Awareness** *using Sensing data & Semantic knowledge*
- Future Scene changes **Prediction** & **Collision Risk Assessment**
- **Decision making** under uncertainty *& Application to Automatic Driving*

11:10–11:13	WeB3.2

Real-Time Collision Avoidance in Human-Robot Interaction Based on Kinetostatic Safety Field

M. Parigi Polverini, A.M. Zanchettin, P. Rocco
Politecnico di Milano, Italy

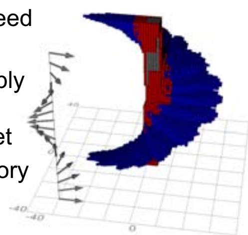
- Safety assessment for human-robot interaction
- Complete geometry of robot and obstacles
- Real-time control law capturing relative position and velocity

11:13–11:16	WeB3.3

Determining States of Inevitable Collision using Reachability Analysis

Andreas Lawitzky, Anselm Nicklas, Dirk Wollherr and Martin Buss
LSR, Technische Universität München, Germany

- Motion safety has to be guaranteed beyond limited time horizons
- The set of states leading inevitably to a collision is equal to the backwards minimal reachable set
- This set is determined using theory from reachability analysis

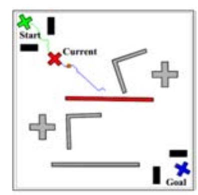


11:16–11:19	WeB3.4

Collision Prediction Among Polygons with Arbitrary Shape & Unknown Motion

Yanyan Lu, Zhonghua Xi and Jyh-Ming Lien
Department of Computer Science, George Mason University, USA

- Advance collision prediction beyond disc robots
- Provide a complimentary approach to those that consider behavior and dynamics with simple shapes
- Significantly reduce the number of replans while maintain higher success rate

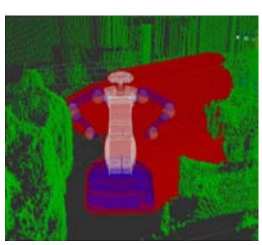


11:19–11:22	WeB3.5

Unified GPU Voxel Collision Detection for Mobile Manipulation Planning

A. Hermann[1], F. Drews[1], J. Bauer[1], S. Klemm[1], A. Rönnau[1], R. Dillmann[1]
[1] FZI Karlsruhe, Germany

- Efficient collision detection for robotic planning and monitoring
- Highly parallelized algorithms executed on GPU
- Use-case optimized structures: Octree, Voxel map, Voxel list
- Live point cloud and Swept Volume handling

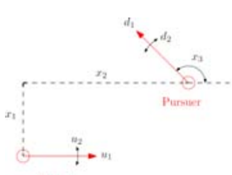


11:22–11:25	WeB3.6

A Practical Reachability-Based Collision Avoidance Algorithm

Charles Dabadie[1], Shahab Kaynama[2] and Claire J. Tomlin[2]
[1]ISAE Supaero [2]UC Berkeley

- Pursuer-evader framework
- Pursuer considered as unpredictable
- Dynamical capacities considered
- Safe piecewise constant control using reachability analysis
- Very light online computation
- Application to Pioneer ground robots



Collision Detection and Avoidance / Sensing II

Chair *Bruce MacDonald, University of Auckland*
Co-Chair

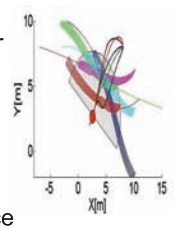
11:25–11:28 WeB3.7

Time Scaled Collision Cone Based Planning in Dynamic Environments

B.Gopalakrishnan, A.K Singh,K.M Krishna
RRC, IIIT Hyderabad, India

- **Two primary Contributions:**

1) Computationally efficient method, for computing the intersecting space of non-linear and non-convex collision cone constraints of large number of predicted obstacle trajectories.
2) Optimization framework to connect the current state to the solution space in time optimal fashion.



11:28–11:31 WeB3.8

A Representation Method Based on the Probability of Collision

S.A.M. Coenen[1], J.J.M. Lunenburg[1], M.J.G. van de Molengraft[2] and M. Steinbuch[3]
[1]Eindhoven University of Technology

- Probabilistic integration of sensor measurements
- Time dependent occupancy probability model
- Robot uncertainty: bivariate normal distribution
- Combine occupancy probability with position uncertainty
- Select safe velocity based on probability of collision

11:31–11:34 WeB3.9

Real-Time 3D Collision Avoidance for Biped Robots

Arne-Christoph Hildebrandt[1], Robert Wittmann[1], Daniel Wahrmann, Alexander Ewald[1] and Thomas Buschmann[1]
[1]Technische Universität München

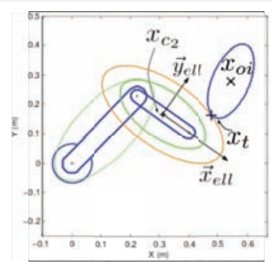
- Allows to overcome **arbitrarily shaped** obstacles
- Locally optimized trajectories exploiting **all swing-foot DoFs**
- **Real-time** application and experimental validation

11:34–11:37 WeB3.10

Ensuring Safety in Human-Robot Coexistence Environment

Chi-Shen Tsai[1], Jwu-Sheng Hu[2] and Masayoshi Tomizuka[1]
[1]UC Berkeley, [2]NCTU Taiwan

- Safety index is evaluated in ellipsoid coordinates attached to robot links.
- An optimization problem is to generate trajectory iteratively with receding horizon strategy.
- The problem is approximated as a QP for online feasibility.

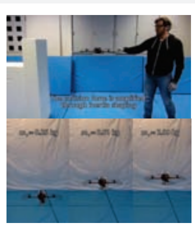


11:37–11:40 WeB3.11

A Unified Framework for External Wrench Estimation, Interaction Control and Collision Reflexes for Flying Robots

Teodor Tomić[1], Sami Haddadin[2],
[1]German Aerospace Center (DLR) [2]Leibniz University Hanover

- An external wrench estimator for flying robots enables:
- Interaction: impedance and admittance control; inertia shaping
- Collision reflexes: detection, reaction and contact location

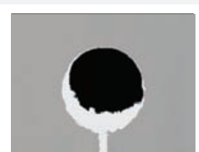


11:40–11:43 WeB3.12

Deterioration of Depth Measurements Due to Interference of Multiple RGB-D Sensors

Roberto Martín Martín, Malte Lorbach and Oliver Brock
Robotics and Biology Lab, Technische Universität Berlin

- Are you using Kinect sensors? Then you should know that they can greatly interfere with each other!
- Exhaustive analysis of interference between two RGB-D active sensors
- Propose simple guidelines to minimize the interference



Black = failure due to interference on a sphere

Collision Detection and Avoidance / Sensing II

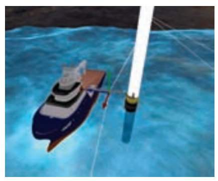
Chair *Bruce MacDonald, University of Auckland*
Co-Chair

11:43–11:46 WeB3.13

IMU/LIDAR based positioning of a gangway for maintenance operations on wind farms

Pierre Merriaux[1], Rémi Boutteau[1], Pascal Vasseur[2] and Xavier Savatier[1]
[1]IRSEEM [2]LITIS

- Exteroceptive system for the contactless control of a motion-compensated gangway
- Algorithm evaluated in real-time 3D simulation chain fed with data from actual measurements



11:46–11:49 WeB3.14

A Quantitative Evaluation of Surface Normal Estimation in Point Clouds

Krzysztof Jordan[1] and Philippos Mordohai[1]
[1]Stevens Institute of Technology

- Surface normal estimation from unorganized point clouds is well-studied and has many applications
- We evaluate the effects of implementation choices on normal estimation in small neighborhoods
- Results on data with ground truth corrupted by additive noise

Color-coded error maps

11:49–11:52 WeB3.15

View Planning for 3D Object Reconstruction with a Mobile Manipulator Robot

J. I. Vasquez[1], L.E. Sucar[1], R. Murrieta-Cid[2] [1]INAOE, Mexico [2]CIMAT Mexico

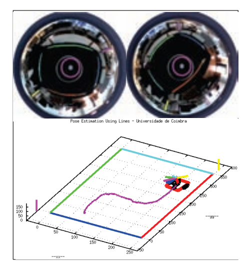
- The proposed method plans views directly in the configuration space.
- It is based on a fast evaluation and rejection of candidate configurations.
- The utility function is implemented as a series of filters.
- We present experiments with a real mobile manipulator robot.

11:52–11:55 WeB3.16

Planar Pose Estimation for General Cameras using Known 3D Lines

Pedro Miraldo and Helder Araujo,
Institute for Systems and Robotics
Dep. Electrical and Computer Engineering
University of Coimbra, Portugal

- First planar solution for the pose using known 3D straight lines, under the framework of generalized camera models;
- Simple, fast and robust formulation that can be easily implemented;



11:55–11:58 WeB3.17

GPS-based Preliminary Map Estimation for Auto. Vehicle Mission Preparation

Yohan Dupuis[1], P. Merriaux[2], P. Subirats[1], R. Boutteau[2], X. Savatier[2], P. Vasseur[3]
[1]Cerema [2]IRSEEM [3]LITIS

- Map estimation from a small set of of vehicular GPS traces collected from low cost devices.
- Map estimation compared to digital maps and RTK INS/GPS solution.
- Median error of 2.96m compared to RTK INS/GPS solution

11:58–12:01 WeB3.18

Dynamic Objects Tracking with a Mobile Robot using Passive UHF RFID Tags

Ran Liu, Goran Huskic, and Andreas Zell
University of Tuebingen

- Dynamic objects tracking using the signal strengths from RFID tags.
- The VFH+ (Vector Field Histogram) serves as a local path planner for obstacle avoidance and navigation.
- Our solution provides an alternative of the-state-of-the-art object tracking approaches.

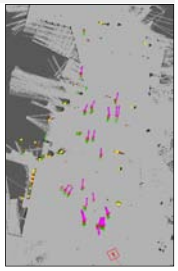
Collision Detection and Avoidance / Sensing II

Chair *Bruce MacDonald, University of Auckland*
Co-Chair

12:01–12:04 WeB3.19

Spatio-Temporal Motion Features for Laser-based Moving Objects Detection and Tracking

X. Shen[1], S. Kim[2] and M. H. Ang Jr.[1]
[1]National University of Singapore
[2]Singapore-MIT Alliance for Research and Technology



- Motion features, similar to optical flow, were extended for LIDAR sensors to detect moving objects while sensors are moving.
- Sensing uncertainties were incorporated to improve the accuracy.
- Support Vector Machine classification was performed to find moving objects.

12:04–12:07 WeB3.20

The Role of Target Modeling in Designing Search Strategies

Alessandro Renzaglia, Narges Noori
and Volkan Isler
University of Minnesota, USA

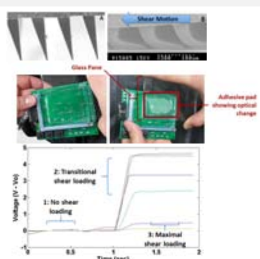
Motivating fish tracking application

- Problem: Searching for an unknown mobile target in a bounded 2D area
- We investigate what impact the target motion model has on designing search strategies
- We consider three target models: Stationary, Adversarial, Stochastic
- For each model, strategies are presented and compared in simulation

12:07–12:10 WeB3.21

Advances in Fibrillar On-Off Polymer Adhesive: Sensing and Engagement Speed

Nicholas Wettels[1], Aaron Parness[1]
[1]NASA Jet Propulsion Laboratory



- Gecko inspired fibrillar adhesive
- Fast actuation (<16 msec)
- Senses
  - Pad engagement
  - Range (up to 60 cm)
  - Normal Loading (up to 175N)

Surgical Robotics II / Teleoperation and Telerobotics

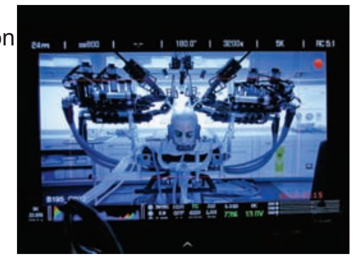
Chair *William R. Hamel, University of Tennessee*
Co-Chair

14:00–14:20 WeC1.1

Keynote: Surgical Robotics: Transition to Automation

Blake Hannaford
University of Washington

- Surgery is a very challenging application for autonomy
- Very unstructured environment
- High cost of error
- Need for automation with human accountability



14:20–14:23 WeC1.2

Bimanual Telerobotic Surgery With Asymmetric Force Feedback: A daVinci surgical system implementation

Omid Mohareri[1], Caitlin Schneider[1], and Septimiu Salcudean[1]
[1]Robotics and Control Lab, University of British Columbia

- A novel control framework to enable haptic feedback for two-handed tasks in teleoperated robot-assisted surgery
- The technique is implemented on the da Vinci surgical system using the da Vinci Research Kit (dVRK) controllers and user studies have been conducted.

14:23–14:26 WeC1.3

First 3D Printed Medical Robot for ENT Surgery

Konrad Entsfellner, Ismail Kuru, Thomas Maier , Jan D.J. Gumprecht, and Tim C. Lueth - Technical University Munich

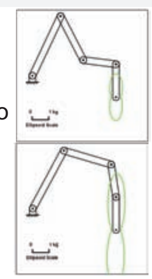
- Challenging interventions in ENT surgery due to small anatomic structures
- Demand for cheap, simple and customizable single-use robots
- Development and evaluation of 3D printed robot using selective laser sintering of PA2200
- Monolithic structure, compliant linear mechanisms

14:26–14:29 WeC1.4

Mass and Inertia Optimization for Natural Motion in Hands-On Robotic Surgery

Joshua G. Petersen[1], Ferdinando Rodriguez y Baena[1],
[1]Imperial College London

- In hands-on robotic surgery, the surgeon controls a tool attached to the robot's end effector by applying forces directly.
- End effector mass and inertia contribute to the user's ability to move the tool and therefore, the performance of the surgery.
- Optimization of the mass/inertia in the redundancy allows for easier, more uniform, and more natural tool motion.

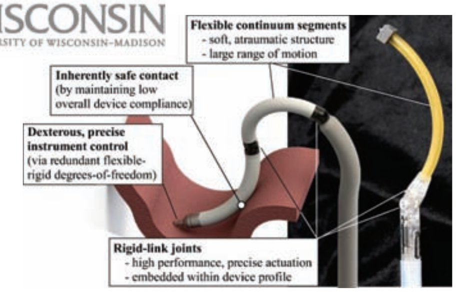


14:29–14:32 WeC1.5

Interleaved Continuum-Rigid Manipulation Approach

Development and Functional Evaluation of a Clinical Scale Manipulator

Benjamin Conrad, Michael Zinn
WISCONSIN
UNIVERSITY OF WISCONSIN–MADISON

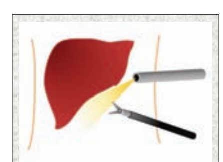


14:32–14:35 WeC1.6

Using Monocular Images to Estimate Interaction Forces During Minimally Invasive Surgery

Ehsan Noohi, Sina Parastegari, Miloš Žefran
University of Illinois at Chicago

- Lack of haptic feedback in MIS can lead to tissue damage
- Augmented Reality can enhance the MIS image with force information
- Force is estimated from the organ deformation & tool penetration depth
- Proposed algorithm introduces **virtual template** concept
- In-vitro experiments with lamb liver are presented



Surgical Robotics II / Teleoperation and Telerobotics

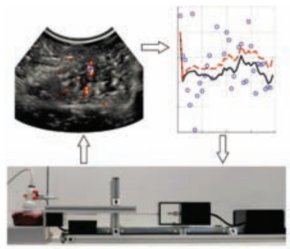
Chair *William R. Hamel, University of Tennessee*
Co-Chair

14:35–14:38 WeC1.7

Recursive Estimation of Needle Pose for Control of 3D-Ultrasound-Guided Robotic Needle Steering

Troy Adebar and Allison Okamura
Stanford University

- Unscented Kalman filter allows accurate needle tip measurements from noisy 3D ultrasound.
- This significantly improves image-guided robotic steering accuracy in *ex vivo* liver tissue.



14:38–14:41 WeC1.8

Development of Multi-Axial Force Sensing System for Haptic Feedback Enabled Minimally Invasive Robotic Surgery

Dong-Hyuk Lee[1], UiKyum Kim[1], and Hyouk Ryeol Choi[1]
[1]Sungkyunkwan Univ., Korea

- 3-Axial Cartesian force and grasping force sensing capability
- High-resolution based on capacitive sensing
- Considerations for low-cost fabrication and disposability

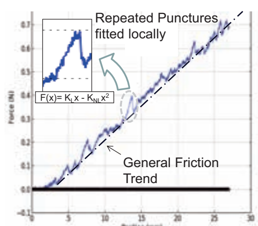
14:41–14:44 WeC1.9

Estimation of Needle-Tissue Interaction based on Non-linear Elastic Modulus and Friction Patterns

Inko Elgezua, Yo Kobayashi, and Masakatsu G. Fujie, Fellow IEEE.

Fujie Laboratory, Waseda University

- Needle Tissue interaction is analyzed based on:
  - Non-Linear elastic modulus
  - Friction patterns
- Four different interaction states were found.
- A novel algorithm for puncture detection was also proposed.



14:44–14:47 WeC1.10

Design and Realization of Grasper-Integrated Force Sensor for Minimally Invasive Robotic Surgery

Uikyum Kim[1], Dong-Hyuk Lee[1], Hyungpil Moon[1], Ja Choon Koo[1] and Hyouk Ryeol Choi[1]
[1]Sungkyunkwan University, Korea

- Grasper-integrated force sensor
  - Capacitive-type sensor
  - Triangular prism structure
- Measuring sensing elements
  - Normal and shear forces
  - Pulling and grasping forces

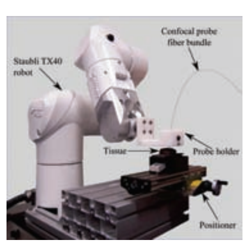
Sensorized forceps

14:47–14:50 WeC1.11

A biomechanical model describing tangential tissue deformations during contact micro-probe scanning

B. Rosa[1,2], J.Szewczyk[2] and G.Morel[2]
[1]KU Leuven, Belgium [2]ISIR, UPMC-CNRS-INSERM, France

- Tangential deformations occur when sweeping a probe over the surface of soft tissues.
- A simple 2D model with local elastic deformations and Coulomb friction is proposed.
- Experiments involving robotically controlled movements of an endomicroscopic probe prove the validity of the model.

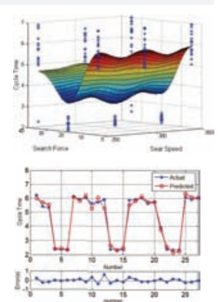


14:50–14:53 WeC1.12

Industrial Robotic Assembly Process Modeling Using Support Vector Regression

Binbin Li, Heping Chen, Tongdan Jin
Texas State University San Marcos

- Propose an assembly process modeling method based on support vector regression that constructs a model by observing the relationship between the assembly parameters and assembly output.
- Demonstrate the effectiveness of proposed method by experiments using a robotic valve body assembly process in automotive manufacturing.
- Prove the accuracy of the method and the proposed algorithm is capable of modeling complex assembly processes.



Surgical Robotics II / Teleoperation and Telerobotics

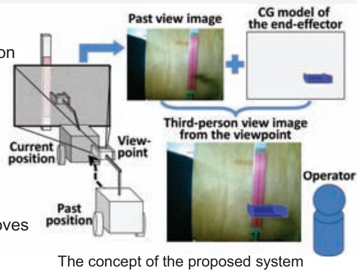
Chair *William R. Hamel, University of Tennessee*
Co-Chair

14:53–14:56	WeC1.13

Teleoperation System using Past Image Records for Mobile Manipulator

Ryosuke Murata[1], Sira Songtong[2], Hisashi Mizumoto[3], Kazuyuki Kon[1] and Fumitoshi Matsuno[1]
[1]Kyoto University [2]Komatsu Ltd. [3]NEC Corporation, Japan

- A new user interface for a mobile manipulator focusing on the manipulation task
- A user can operate the end-effector from the virtual third-person viewpoint
- The experiment shows that the proposed system reduces operators' workloads and improves situation awareness



The concept of the proposed system

14:56–14:59	WeC1.14

Virtual Fixtures for Object Telemanipulation

H. Hawkeye King[1,2], Blake Hannaford[1],
[1]University of Washington
[2]Imperial College London

- Evaluation of virtual fixtures compares manual and assisted telemanipulation.
- Experiments use the Raven II surgical system, with Mantis Duo Master.
- Advantages and disadvantages of state-of-the-art VF design are illustrated.

14:59–15:02	WeC1.15

Investigating Human Perceptions of Robot Capabilities in Remote Human-Robot Team Tasks based on First-Person Robot Video Feeds

Cody Canning, Thomas Donahue and Matthias Scheutz, HRI Lab, Tufts University, USA

- We investigate possible effects of *simulated* versus *real* first-person robot video feeds in HRI team tasks
- We found a complex interplay between task investment, robot appearance, and realism of 1st-person video feed as they affect human perceptions of robot teammates

15:02–15:05	WeC1.16

Designing Human-Robot Interaction Paradigms for Multi-robot Manipulation

Bennie Lewis[1] and Gita Sukthankar[1]
Department of EECS (CS)
University of Central Florida[1]

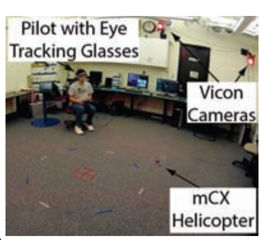
- Examination of expert-novice differences in user performance with different types of intelligent interfaces.
- Source code and robot design available at: ial.eecs.ucf.edu/code.php

15:05–15:08	WeC1.17

Modeling Visuo-Motor Control and Guidance Functions in Remote-Control Operation

Jonathan Andersh[1], Bin Li[1], and Bérénice Mettler[1]
[1]University of Minnesota

- Characterize **coupling between gaze and human control input** during remote control flight
- Model the **visuo-motor mechanisms from** experimental data
- **Estimate vehicle state and task elements from** gaze data

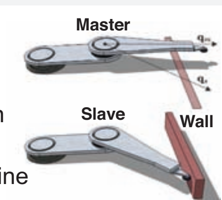


15:08–15:11	WeC1.18

Transparency Compensation for Bilateral Teleoperators with Time-Varying Delays

Erick J. Rodríguez-Seda
United States Naval Academy

- Closed-loop stability guaranteed regardless of time-varying delays
- Transparency compensated when the slave robot transitions between free motion and hard contact
- Perceived impedance adapted online
- Position drifts reduced while in contact
- Stable interaction with non-passive human operators



Surgical Robotics II / Teleoperation and Telerobotics

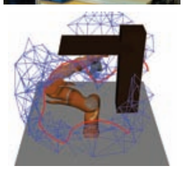
Chair *William R. Hamel, University of Tennessee*
Co-Chair

15:11–15:14	WeC1.19

Model-free Path Planning for Redundant Robots using Sparse Data from Kinesthetic Teaching

D. Seidel[1], C. Emmerich[1] and J. J. Steil[1]
[1]Bielefeld University

- purely data-driven approach for autonomous path planning for redundant robot arm (LWR IV)
- data gathered by structured user interaction: kinesthetic teaching in confined spaces
- Instantaneous Topological Map + bootstrapping heuristics learns a navigation graph of the obstacle-free workspace

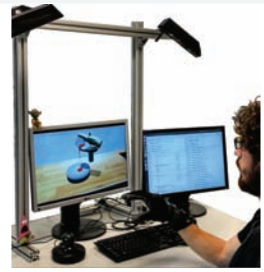


15:14–15:17	WeC1.20

Learning Task Outcome Prediction for Robot Control from Interactive Env.

Andrei Haidu[1], Daniel Kohlsdorf[2] and Michael Beetz[1]
[1]Universität Bremen [2]GATECH

- Extraction and learning of action and common sense knowledge from a cooking based game running on a robot-simulator with realistic rigid body physics.
- Task outcome prediction algorithm for the given system



Learning by Demonstration / Industrial and Manufacturing Robotics

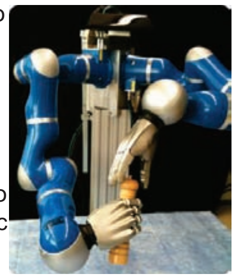
Chair *Lynne Parker, University of Tennessee*
Co-Chair

14:00–14:20 WeC2.1

Keynote: Machine Learning of Motor Skills for Robotics

Jan Peters
IAS, TU Darmstadt & MPI for Intelligent Systems

- Machine learning (ML) is crucial to endow robots both with more abilities and more autonomy.
- However, off-the-shelf ML rarely scales to robotics.
- We present recent successes at domain-appropriate approaches to robot learning for anthropomorphic robots.



14:20–14:23 WeC2.2

A Robust Autoregressive Gaussian Process Motion Model Using l1-Norm Based Low-Rank Kernel Matrix Approximation

Eunwoo Kim, Sungjoon Choi, and Songhwai Oh
Seoul National University, Korea

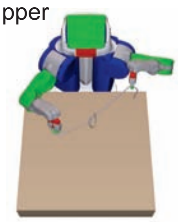
- Address the **measurement noise or outlier** issues by proposing a robust AR-GP model
- Show the relationship between GP and low-rank kernel approximation
- For **robustness**, **l1-norm based** low-rank kernel approximation is proposed
- Successfully avoided moving pedestrians without any collisions and arrived at the goal

14:23–14:26 WeC2.3

Learning from Demonstrations for Manipulation of Deformable Objects

Alex Lee, Sandy Huang, Dylan Hadfield-Menell, Eric Tzeng and Pieter Abbeel
University of California, Berkeley

- Schulman et al. [ISRR 2013] predict gripper motions for a new scene by first finding a registration between training scene and new scene, and then extrapolating this registration to transfer training scene gripper motion to new scene
- Challenge addressed: optimizing the new scene's gripper motion when predicted motion is not executable by robot

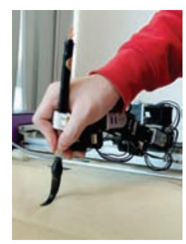


14:26–14:29 WeC2.4

Robot Learns Chinese Calligraphy from Demonstrations

Yuandong Sun[1] Huihuan Qian[1,3] Yangsheng Xu[2,3]
[1]The Chinese University of Hong Kong
[2]The Chinese University of Hong (Shenzhen)
[3]Shenzhen Institutes of Advanced Technology

- Proposed a new approach to stroke parameterization
- Applied Locally Weighted Linear Regression to map from stroke parameters to brush trajectory
- The robot can learn to write calligraphy from demonstrations

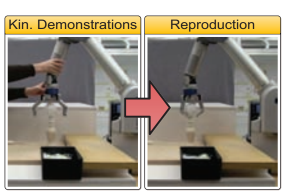


14:29–14:32 WeC2.5

Learning to Sequence Movement Primitives from Demonstrations

Simon Manschitz[1,2], Jens Kober[2,3], Michael Gienger[2] and Jan Peters[1]
[1]TU Darmstadt [2]Honda RI-EU [3]Univ. Bielefeld

- Sequence demonstrated
- Robot learns when to perform which action
- Graph structure generalizes from demonstrations
- Switching behavior learned with multiple classifiers

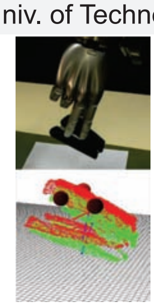


14:32–14:35 WeC2.6

Kinematically Optimised Predictions of Object Motion

Dominik Belter[1,2], Marek Kopicki[1], Sebastian Zurek[1] and Jeremy Wyatt[1]
[1]Univ. of Birmingham [2]Poznan Univ. of Technol.

- This paper shows how to obtain learned simulator of specific objects
- The learner predicts trajectories for the object. These are optimised post prediction to minimise interpenetrations according to the collision checker
- The method is experimentally verified



Learning by Demonstration / Industrial and Manufacturing Robotics

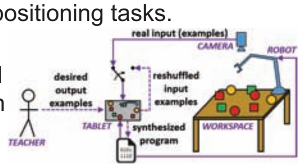
Chair *Lynne Parker, University of Tennessee*
Co-Chair

14:35–14:38	WeC2.7

Program Synthesis by Examples for Object Repositioning Tasks

Ashley Feniello, Hao Dang, and Stan Birchfield
Microsoft Research

- A learning-by-demonstration framework is presented.
- Tablet-based interface enables rapid robot teaching.
- Generic stack-based concatenative domain-specific language models object repositioning tasks.
- Human readable programs are learned through a novel learning algorithm based on human demonstrations.



14:38–14:41	WeC2.8

LAT: A Simple Learning from Demonstration Method

Benjamin Reiner, Wolfgang Ertel,
Heiko Posenauer and Markus Schneider
Univ. of Appl. Sci. Ravensburg-Weingarten

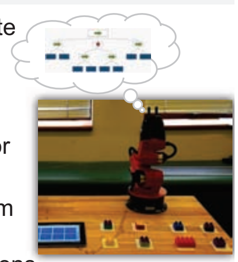
- Learning by Averaging Trajectories
- Very easy and efficient mathematics
- Approximate a normal distribution over trajectories
- Join trajectories by multiplying normal distributions
- Linear time complexity

14:41–14:44	WeC2.9

Discovering Task Constraints Through Observation and Active Learning

Bradley Hayes, Brian Scassellati
Yale University

- We use Active Learning to expedite robot task comprehension from human demonstrations
- We present a query generation strategy that encourages instructor demonstration diversity
- Small groups of instructors perform better than an individual given the same number of total demonstrations

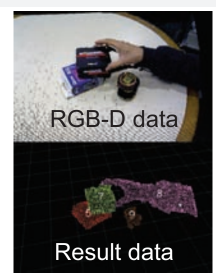


14:44–14:47	WeC2.10

Unsupervised object individuation from RGB-D image sequences

S. Koo[1], D. Lee[1], and D.-S. Kwon[2]
[1]Dep. EE and IT, TUM, Germany
[2]Dep. ME, KAIST, Korea

- Integration of location-based and feature-based object segmentation methods based on the infant's object indexing theory.
- Computational efficiency and robustness in stacking, unstacking, and occluding tasks.



14:47–14:50	WeC2.11

Grasp Planning Based on Grasp Strategy Extraction from Demonstration

Yun Lin, Yu Sun,
[1]University of South Florida

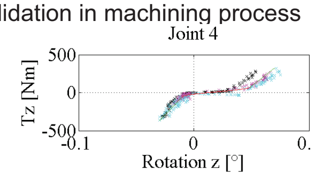
- We extracted the thumb placement and grasp type from human demonstration
- Both human strategies
  - are independent of robotic kinematics
  - represent human intentions
  - highly constrain the hand configuration space

14:50–14:53	WeC2.12

Stiffness Modeling of Industrial Robots for Deformation Compensation in Machining

Ulrich Schneider[1], Mahdi Momeni-K[1],
Matteo Ansaloni[2] and Alexander Verl[1]
[1]Fraunhofer IPA [2]University of Modena

A new stiffness modeling and identification method for industrial robots is presented and validated on a KR125. 36 nonlinear functions are used to describe the stiffness of robot joints. Validation in machining process shows the improvement achieved through compliance compensation based on wrench measurement on the TCP.



Learning by Demonstration / Industrial and Manufacturing Robotics

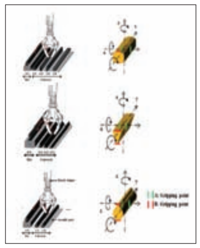
Chair *Lynne Parker, University of Tennessee*
Co-Chair

14:53–14:56 WeC2.13

A Study on Data-Driven In-Hand Twisting Process Using a Novel Dexterous Robotic Gripper for Assembly Automation

Fei Chen, Ferdinando Cannella, Carlo Canali, Mariapaola D'Imperio, Traveler Hauptman, Giuseppe Sofia, Darwin Caldwell
Department of Advanced Robotics, Istituto Italiano di Tecnologia, Italy

- Design a novel reconfigurable industrial gripper for precise twisting
- Analyze the kinematic and dynamic
- Study the twisting course
- Study the success condition for twisting based on theoretical and experimental study



14:56–14:59 WeC2.14

Velocity Coordination and Corner Matching in a Multi-Robot Sewing Cell

J. Schrimpf[1], M. Bjerkeng[2] and G. Mathisen[2]
[1]Norwegian University of Science and Technology
[2]SINTEF ICT

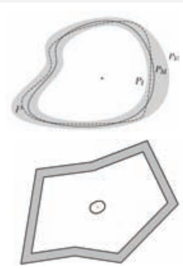
- A sewing demonstrator is presented and the control algorithms are described.
- A leader/follower coordination strategy is proposed to achieve corner matching.
- Experiments are included, demonstrating corner matching.

14:59–15:02 WeC2.15

On the Location of the Center of Mass for Parts with Shape Variation

Fatemeh Panahi A. Frank van der Stappen
Utrecht University

- General model for shape variation
- Characterize worst-case displacement of center of mass (COM)
- k-facet outer approximation of COM locus in O(kn log n) time, where n is object complexity
- Bounds on diameter of COM locus for **fat** objects



15:02–15:05 WeC2.16

Design and motion planning of body-in-white assembly cells

S. Pellegrinelli[1,2,3], N. Pedrocchi[1], L. Molinari Tosatti[1], A. Fischer[2] and T. Tolio[1,3]
[1]ITIA-CNR [2]Technion [3]Politecnico di Milano

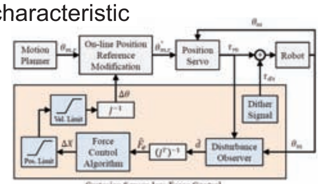
- Multi-robot cell for body-in-white assembly
- **Automatic** and **simultaneous** identification of **cell design** and **multi-robot motion plan**
- 4-step iterative algorithm for **global optimum** identification addressing collision detection
- Decrease of the engineer-to-order time

15:05–15:08 WeC2.17

Cartesian Sensor-less Force Control for Industrial Robots

Hyunchul Cho, Minjeong Kim, Hyunkyu Lim and Donghyeok Kim
Hyundai Heavy Industries Co. Ltd.

- Contact forces were estimated using a DOB.
- Frictions at each joint were suppressed by the dither.
- The desired impedance characteristic was realized with the position servo of HHI's robot controller.



Cartesian Sensor-less Force Control

15:08–15:11 WeC2.18

Improving the Sequence of Robotic Tasks with Freedom of Execution

Sergey Alatartsev and Frank Ortmeier
Otto-von-Guericke University of Magdeburg

- Robot tasks often allow a certain freedom of execution
- This freedom is used to optimize: position and orientation of the end-effector and robot configuration
- Proposed approach is evaluated on scenarios from cutting/deburring domain

Details and Demo

Learning by Demonstration / Industrial and Manufacturing Robotics

Chair *Lynne Parker, University of Tennessee*
Co-Chair

15:11–15:14 WeC2.19

Parallel Active/Passive Force Control of Industrial Robots with Joint Compliance

Arun Dayal Udai[1], Abdullah Aamir Hayat[1], Subir Kumar Saha[2]
Indian Institute of Technology Delhi

- Active force control is attained using external force control.
- In parallel a passive joint compliant-like behavior is proposed which is based on actuator current limiting.
- The proposed controller makes the system safe against any hazards due to pinching, trapping and impact.
- A precise force/position control was also be obtained.

15:14–15:17 WeC2.20

Automated guidance of peg-in-hole assembly tasks for complex-shaped parts

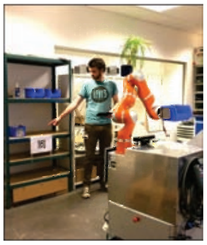
Hee-Chan Song[1], Young-Loul Kim[1], and Jae-Bok Song[1]
[1]Korea university, Seoul, Korea

- We propose an assembly strategy for complex-shaped parts which performs force control based on visually-obtained geometric information and CAD models.
- A proposed guidance algorithm is based on selecting an optimal assembly direction.
- An impedance control scheme is used to control the contact force.

15:17–15:20 WeC2.21

Intuitive skill-level programming of handling tasks on a mobile manipulator

Mikkel Rath Pedersen[1], Dennis Levin Herzog[1] and Volker Krüger[1]
[1]Aalborg University Copenhagen, Denmark



- Novel skill-level programming approach for industrial robots, combining a GUI and gesture recognition for task programming
- Thorough evaluation of the approach, verifying that the use case task can be programmed in as little as two minutes

Localization and Mapping IV / Locomotion, Navigation, and Mobility

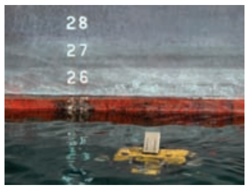
Chair *Gianluca Antonelli, Univ. of Cassino and Southern Lazio*
Co-Chair

14:00–14:20 WeC3.1

Keynote: Toward Persistent SLAM in Challenging Environments

Ryan Eustice
University of Michigan

- SLAM has come a long way in the last couple of decades
- This talk will describe some of our current work toward fielding operational vehicles that use SLAM as their main navigation scheme in long-term deployments



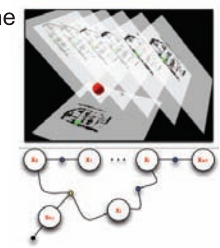
Autonomous Ship Hull Inspection

14:20–14:23 WeC3.2

Simultaneous Localization and Planning on Multiple Map Hypotheses

Timothy Morris, Feras Dayoub,
Peter Corke and Ben Upcroft
QUT, CyPhy Lab

- Online ranking of maps to determine the most useful at any particular moment.
- Map u**tility determined by both localization and planning performance over locally accurate windows of odometry.**
- Factor graph used for robust exclusion of aliased localization.

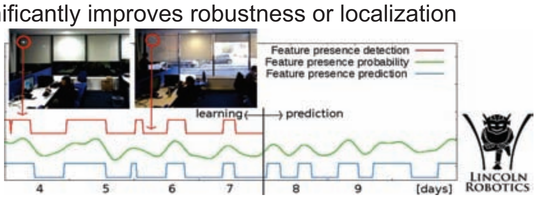


14:23–14:26 WeC3.3

Long-Term Top. Localization in Changing Environments using Spectral Maps

T. Krajník [1], J. P. Fentanes[1],O.M.Mozos[1],
Tom Duckett[1], Johan Ekekrantz[2], Marc Hanheide[1]
[1]University of Lincoln, UK [2]KTH, Sweden

- learns long-term environment dynamics
- predicts environment appearance at a given time
- significantly improves robustness or localization

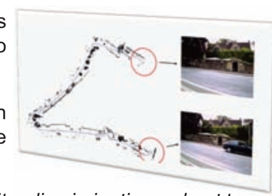


14:26–14:29 WeC3.4

SAIL-MAP : Loop-Closure Detection Using Saliency-Based Features

Merwan BIREM[1], Jean-Charles QUINTON[1],
François Berry[1] and Youcef MEZOUAR[1]
[1]Blaise Pascal University - Institut Pascal

- **The problem :** Given two images what is the probability that these two images shows the same scene.
- **Solution :** Use the salient region as feature to match between the different images.



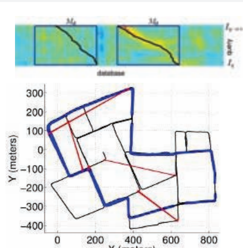
Salient regions are known to be quite *discriminative*, *robust* to viewpoint change and image perturbations, as well as having a high *repeatability* rate

14:29–14:32 WeC3.5

Visual Place Recognition using HMM Sequence Matching

Peter Hansen[1] and Brett Browning[2]
[1]Carnegie Mellon University in Qatar
[2]Carnegie Mellon University/NREC

- Visual place recognition using query/database sequence matching in HMM framework.
- Local and flexible velocity/state transition constraints.
- Similarity matrix rank reduction for robust scoring.
- Evaluated on multiple datasets.

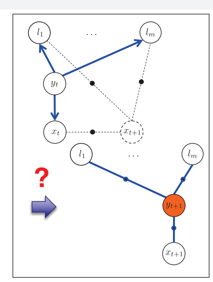


14:32–14:35 WeC3.6

Linear-Time Estimation with Tree ADF and Low-Rank Approximation

Duy-Nguyen Ta[1], Frank Dellaert[1],
[1]Georgia Institute of Technology

- Two filtering-based SLAM methods maintaining tree structures to achieve **linear-time** complexity
- **Tree Assumed Density Filtering** optimally projects densities to trees
- **ITF** reduces information loss using **low-rank approximation** with **new latent variables**



Localization and Mapping IV / Locomotion, Navigation, and Mobility

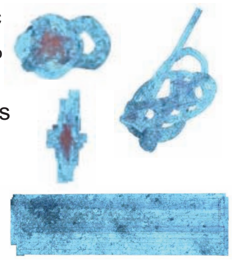
Chair *Gianluca Antonelli, Univ. of Cassino and Southern Lazio*
Co-Chair

14:35–14:38	WeC3.7

Large-Scale Image Mosaicking using Multimodal Hyperedge Constraints from Multiple Registration Methods within the Generalized Graph SLAM Framework

M. Pfingsthorn, A. Birk, F. Ferreira,
G. Veruggio, M. Caccia and G. Bruzzone

- Large scale marine image mosaic
- Uncertain loop hypotheses (~20% outliers) used as hyperedges
- Two separate registration methods fused in multimodal constraints
- Prefilter (bottom) outperforms state-of-the-art (top) by orders of magnitude



14:38–14:41	WeC3.8

Localization Algorithm Based on Zigbee Wireless Sensor Network with Application to an Active Shopping Cart

Shengnan Gai, Eui-Jung Jung,
Byung-Ju Yi，Hanyang University

- This paper proposed a probability localization algorithm based on hybrid sensor system with application to an active shopping cart (ASC)in a given experimental environment.
- The hybrid sensor system helps to improve the localization performance of the ASC

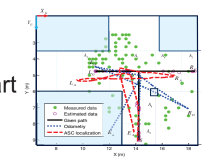


Fig. 1 Comparison of the proposed ASC localization method and odometry method

14:41–14:44	WeC3.9

RF Odometry for Localization in Pipes Based on Periodic Signal Fadings

Carlos Rizzo[1], Vijay Kumar[2],
Francisco Lera[1] and José Luis Villarroel[1]
[1]Univ. of Zaragoza [2]Univ. of Pennsylvania

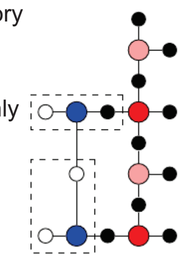
- Accurate localization is a problem inside pipes due to the nature of the environment and the lack of exploitable features.
- We present a RF odometry-like method for in-pipe longitudinal localization based on periodic received signal fadings.

14:44–14:47	WeC3.10

Multi-Vehicle Localisation with Additive Compressed Factor Graphs

Lachlan Toohey, Oscar Pizarro,
and Stefan B. Williams
ACFR, University of Sydney

- Minimises bandwidth to solve full history for each vehicle using all information
- Permits relinearisation of local states
- Size of data transmitted dependent only on intervehicle observation rate not local sensor measurement rate
- Single iteration equivalent to single iteration of centralised solution.

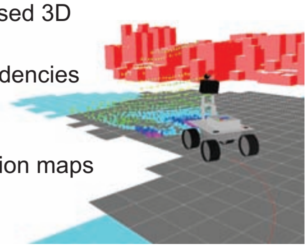


14:47–14:50	WeC3.11

Building Local Terrain Maps Using Spatio-Temporal Classification for Semantic Robot Localization

Stefan Laible and Andreas Zell
Cognitive Systems, Univ. of Tuebingen, Germany

- Terrain classification on fused 3D LIDAR and camera data
- Considering spatial dependencies using Conditional random fields
- Building terrain and elevation maps for semantic localization

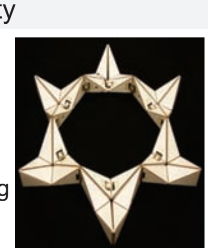


14:50–14:53	WeC3.12

HexaMorph: A Reconfigurable and Foldable Hexapod Robot Inspired by Origami

Wei Gao, Ke Huo, Jasjeet S. Seehra,
Karthik Ramani and Raymond J. Cipra
Purdue University

- A starfish-like hexapod robot designed for modularity, foldability and reconfigurability
- Capable of performing the self-deploying and locomotive squirming



Localization and Mapping IV / Locomotion, Navigation, and Mobility

Chair *Gianluca Antonelli, Univ. of Cassino and Southern Lazio*
Co-Chair

14:53–14:56	WeC3.13

On the Optimal Selection of Motors and Transmissions for Electromechanical and Robotic Systems

Siavash Rezazadeh, Jonathan Hurst
Oregon State University

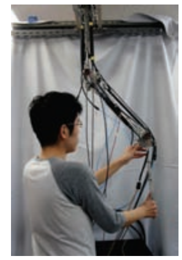
- A general approach for electromechanical systems, with particular application to legged robots
- Selection based on the trade-off between agility and efficiency
- Considering the option of customized motor windings using multi-objective optimization methods

14:56–14:59	WeC3.14

Active Behavior of Musculoskeletal Robot Arms Driven by Pneumatic Artificial Muscles for Receiving Human's Direct Teaching Effectively

Shuhei Ikemoto[1], Yuji Kayano[1] and Koh Hosoda[1]
[1]Osaka University, Japan

- So far, we have proposed a direct teaching method for musculoskeletal robots actuated by PAMs.
- In this research, we propose a method to generate active behavior of the robot during the teaching phase.
- The validity has been successfully confirmed by an experiment

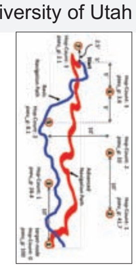


14:59–15:02	WeC3.15

Received Signal Strength based Bearing-only Robot Navigation in a sensor network field

Nikhil Deshpande[1], Edward Grant[2],
Mark Draelos[3] and Thomas C. Henderson[4]
[1]IIT, Italy, [2]NCSU, [3]Duke University, [4]University of Utah

- Bearing estimation using RSS and particle filtering (PF) for map-less, ranging-less navigation in WSN
- Basic node-to-node navigation – upto 15% better than without PF
- Advanced scheme uses surface fit to generate intermediate way-points in WSN – upto 23% better than basic scheme



Outdoor Trajectory Comparison

15:02–15:05	WeC3.16

GeckoGripper: A Soft Robotic Gripper using Gecko-Inspired Fiber Adhesives

Sukho Song[1], Carmel Majidi[1], and Metin Sitti[1,2]
[1]Carnegie Mellon University [2]Max-Planck Institute for Intelligent Systems

- A soft, inflatable gripper based on controllable adhesion mechanisms of gecko-inspired fiber adhesives with stretch of a membrane
- Pick-and-place manipulations of various non-planar 3D parts using the adhesion control mechanisms and superior adaptability of the membrane

15:05–15:08	WeC3.17

Design and Architecture of a Series Elastic Snake Robot

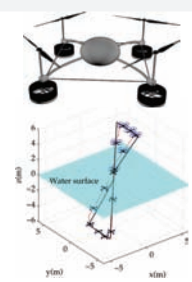
David Rollinson, Yigit Bilgen, Ben Brown, Florian Enner, Steven Ford, Curtis Layton, Justine Rembisz, Mike Schwerin, Andrew Willig, Pras Velagapudi and Howie Choset
Carnegie Mellon University

15:08–15:11	WeC3.18

Hybrid Unmanned Aerial Underwater Vehicle: Modeling and Simulation

Paulo Drews-Jr[1,3], Armando Neto[2] and Mario Campos[3]
[1]Fundação Universitaria Rio Grande - Brazil
[2]Universidade Federal de São João Del-rei – Brazil
[3]Universidade Federal de Minas Gerais – Brazil

- A novel quadrotor-like aerial-underwater platform design capable of transitioning from air to water (or vice-versa) in a simple and rapid way;
- We provide a closed-loop model of the system and discuss some simulated experiments



Localization and Mapping IV / Locomotion, Navigation, and Mobility

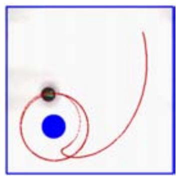
Chair *Gianluca Antonelli, Univ. of Cassino and Southern Lazio*
Co-Chair

15:11–15:14	WeC3.19

Circumnavigation by a Mobile Robot Using Bearing Measurements

Ronghao Zheng and Dong Sun
Department of Mechanical and Biomedical Engineering
City University of Hong Kong

- The problem of steering a mobile robot to achieve a circular motion around a target is considered.
- The control schemes require only bearing measurements and deal with point target and disk target.
- The proposed control schemes is verified by experiments on an e-puck robot.



Micro/Nano Robotics II / Impedance, Compliance, and Force Control

Chair *Dong Sun, City University of Hong Kong*
Co-Chair

15:50–16:10	WeD1.1

Keynote: Soft, printable, and small: an overview of manufacturing methods for novel robots at Harvard

Robert Wood
Harvard University

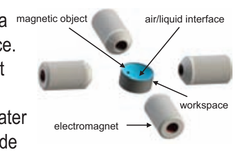
Traditional manufacturing methods tend to be ineffective for robots with sub-millimeter scale features, robots made entirely from soft materials, or robots requiring extremely low cost and lead times. This talk will highlight alternative manufacturing methods employed at Harvard for robots such as the RoboBee (right), squishy robots, and printable robots.

16:10–16:13	WeD1.2

Modeling and experiments of high speed magnetic micromanipulation at the air/liquid interface

Mohamed Dkhil, Aude Bolopion,
Stéphane Régnier, Michaël Gauthier
Femto-st Institute, University Pierre and Marie Curie

- Modeling and identification of the motion of a magnetic micro-object on a air/liquid interface.
- Good repeatability of motion for micro-object with size larger than 50 µm.
- The velocity of the micro-object on the air/water interface should be 10 times larger than inside water.



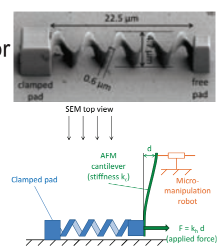
planar magnetic device

16:13–16:16	WeD1.3

Assembly and Mechanical Characterizations of Polymer Microhelical Devices

S. Alvo, D. Decanini, L. Couraud,
A.-M. Haghiri-Gosnet and G. Hwang
Laboratory for Photonics and Nanostructures, CNRS, France

- Polymer MicroHelical Devices (PMHD) for large range force sensor
- In-situ SEM nanorobotic manipulation to reveal the mechanical properties of PMHD
- PMHD enlarges the force range up to 12 μN from 91× higher stiffness than conventional microhelix

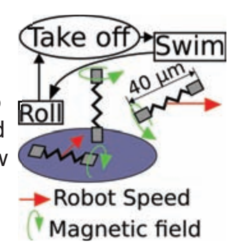


16:16–16:19	WeD1.4

Controllable Roll-to-Swim Motion Transition of Helical Nanoswimmers

Antoine Barbot, Dominique Decanini and
Gilgueng Hwang
Laboratory for Photonics and Nanostructures, CNRS, France

- Roll-to-Swim (RTS) for improving the propulsion robustness of microrobot in fluid
- RTS is a multimodal robot able to roll on the surface under flow and swim over obstacles by corkscrew motion
- RTS can be controlled either manually or by visual servoing

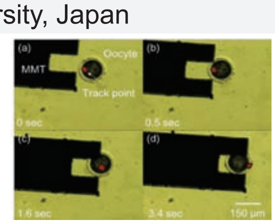


16:19–16:22	WeD1.5

Three-Dimensional Rotation of Bovine Oocyte by Using Magnetically Driven On-chip Robot

Lin Feng, Bilal Turan, U Ningga, and F. Arai
Nagoya University, Japan

We present an approach for three-dimensional rotation of a single oocyte. By using a customer-designed micro-robot, oocyte orientation control was achieved with maximum speeds of 3 rad/s and accuracy of 7 degrees.



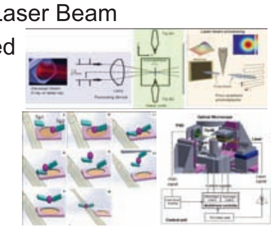
Oocyte rotation by using MMT microfork.

16:22–16:25	WeD1.6

Robust Nanomanipulation Control Based on Laser Beam Feedback

Nabil Amari[1], David Folio[1], Antoine Ferreira[1]
[1]Laboratoire PRISME; INSA-CVL, France

- Nanomanipulation under the Laser Beam
- Control strategy of two-fingered nanomanipulation system tracking a Laser Spot
- Measuring and estimating the position of the laser beam using Particle Filter
- Experimental validation of the concept



Micro/Nano Robotics II / Impedance, Compliance, and Force Control

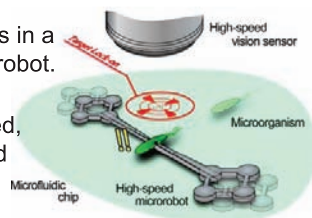
Chair *Dong Sun, City University of Hong Kong*
Co-Chair

16:25–16:28 WeD1.7

Microrobotic Platform for Mechanical Stimulation of Swimming Microorganism on a Chip

Belal Ahmad[1], Tomohiro Kawahara[1], Takashi Yasuda[1] and Fumihito Arai[2]
[1]Kyushu Institute of Technology [2]Nagoya University

- The developed platform realizes mechanical stimulation of swimming microorganisms in a microfluidic chip by microrobot.
- *Paramecium* with 1 mm/s swimming speed is tracked, magnified, stimulated, and observed by the platform.

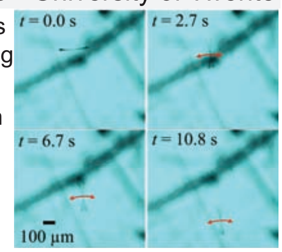


16:28–16:31 WeD1.8

Magnetic-Based Motion Control of Sperm-Shaped Microrobots using Weak Oscillating Magnetic Fields

Islam S. M. Khalil*, Kareem Youakim*, Alonso Sánchez† and Sarthak Misra†
*German University in Cairo †University of Twente

- A sperm-shaped microrobot is fabricated and controlled using oscillating fields (~5 mT)
- Flagellated swim (at 45 Hz) in water and on the bottom of a petri-dish are achieved at average speeds of 158 μm/s and 6 μm/s, respectively.

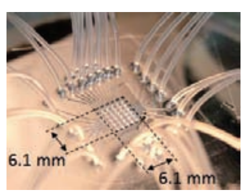


16:31–16:34 WeD1.9

On-chip Flexible Scaffold for Construction of Multishaped Tissues

P. Chumtong[1], M. Kojima[1], M. Horade[1], K. Ohara[2], K. Kamiyama[1], Y. Mae[1], Y. Akiyama[3], M. Yamato[3], and T. Arai[1]
[1]Osaka University [2]Meijo University
[3]Tokyo Women's Medical University

- Flexible microscaffold made of PDMS facilitates the fabrication of many different tissue shapes.
- Round and lattice shaped tissues are fabricated by seeding NIH3T3 on the chip with prepared scaffolds.

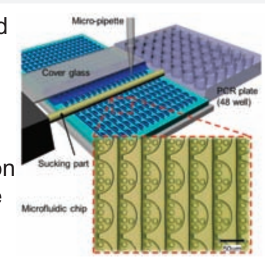


16:34–16:37 WeD1.10

Cell Isolation System for Rare Circulating Tumor Cell

T Masuda[1], S Yilling[1], S W Eui[1], M Niimi[1]
A Yusa[2], H Nakanishi[3] and F Arai[1]
[1]Nagoya Univ [2]ASTF [3]Aichi Cancer Center

- We have successfully designed and demonstrated the size-based isolation of cells using a microfluidic device employing the convective self-assembly, thereby achieved the separation and collection of purified single tumor or rare cells.

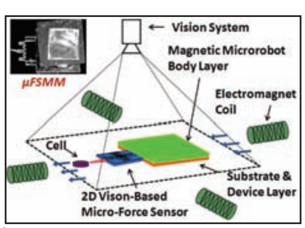


16:37–16:40 WeD1.11

Incorporating In-situ Force Sensing Capabilities in a Magnetic Microrobot

Wuming Jing[1], David J. Cappelleri[1],
[1]School of Mechanical Engineering, Purdue University

- **M**icro **F**orce **S**ensing **M**agnetic **M**icrorobot (**μFSMM**)
- 2D vision-based micro-force sensor
- Magnetic microrobot body
- In-situ force sensing capability with mobility
- Stiffness calibrated with micro force sensing probe
- Characterized relationship between force and magnetic field/input current

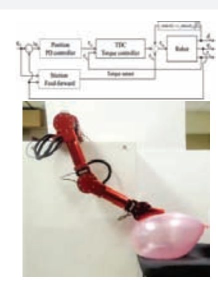


16:40–16:43 WeD1.12

Joint Space Torque Controller Based on Time-Delay Control with Collision Detection

Sung-moon Hur[1], Sang-Rok Oh & Yonghwan Oh[1]
[1]Interaction and Robotics Research Center, KIST, Seoul, Korea

- This research addresses a control method for friction-existing robot manipulators and safe motion with its environment
- Time-Delay Control(TDC) with **stiction feed-forward friction compensator** is implemented to overcome friction
- **Collision detection method** using dynamic model and the residual generator



Micro/Nano Robotics II / Impedance, Compliance, and Force Control

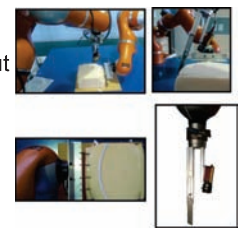
Chair *Dong Sun, City University of Hong Kong*
Co-Chair

16:43–16:46 WeD1.13

Force/vision control for robotic cutting of soft materials

Philip Long, Wisama Khalil and Philippe Martinet
École Centrale de Nantes, IRCCyN UMR CNRS 6597, France

- Cooperative robot control to cut deformable object
- Force control ensures cut without damage to surrounding area
- Vision update ensures robot can react to object deformations
- Second robot applies a pulling force to facilitate separation

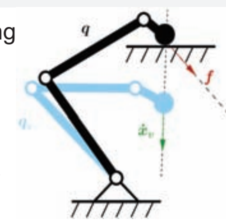


16:46–16:49 WeD1.14

Hierarchical Inequality Task Specification for Indirect Force Controlled Robots using Quadratic Programming

Ewald Lutscher and Gordon Cheng,
Technische Universität München

- Virtual set point selection according to force/positioning equality and inequality tasks on Cartesian and joint level
- Inherent compliance of the underlying indirect force controller is preserved



16:49–16:52 WeD1.15

Fast Dual-Arm Manipulation Using Variable Admittance Control

Magnus Bjerkeng[1], Johannes Schrimpf[2], Torstein Myhre[3] and Kristin Y. Pettersen[2]
[1]SINTEF ICT [2]NTNU ITK [3]NTNU IPK

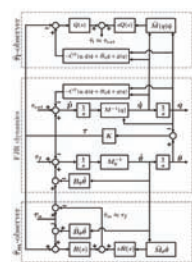
- Human interaction and dual-arm cooperative handling.
- Force control and trajectory tracking.
- 14 DOF experiments using two redundant robots.

16:52–16:55 WeD1.16

External Torque Sensing Algorithm for Flexible-Joint Robot based on Disturbance Observer Structure

Young Jin Park[1] and Wan Kyun Chung[1]
[1]POSTECH

- Torque sensing algorithm of FJR is proposed
  - based on the DOB structure
  - to estimate both actuating motor torque and external link torque simultaneously
- Actuating motor toque is then utilized to motor disturbance compensation



16:55–16:58 WeD1.17

Implicit Force Control for an Industrial Robot with Flexible Joints and Flexible Links

Roberto Rossi, Luca Bascetta, Paolo Rocco
Politecnico di Milano, Italy

- **Compliance model** including joints, links and contact elasticity
- **Force Control** algorithm based on compliance model
- Limit cycles due to **friction** suppressed by variable control gain

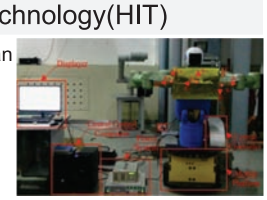
16:58–17:01 WeD1.18

Cartesian Space Synchronous Impedance Control of Two 7-DOF Robot Arm Manipulators

Minghe Jin, Zijian Zhang, Fenglei Ni, Hong Liu
Harbin Institute of Technology(HIT)

- Synchronous Errors Of The Cartesian Space

$$\varepsilon_{cj} = G_j^{-1} X_{cj} - G_i^{-1} X_{ci}$$
$$\dot{\varepsilon}_{cj} = G_j^{-1} \dot{X}_{cj} - G_i^{-1} \dot{X}_{ci}$$
$$\ddot{\varepsilon}_{cj} = G_j^{-1} \ddot{X}_{cj} - G_i^{-1} \ddot{X}_{ci}$$



- Cartesian Space Synchronous Impedance Controller

$$J^{-T}(\theta)\tau_i(t) = \hat{M}_{Xi}(X_i)\ddot{u}_i(t) + \hat{C}_{Xi}(X_i,\dot{X}_i)\dot{u}_i(t) + \hat{G}_{Xi}(X_i) + \hat{F}_{Xi}(\dot{X}_i) - \hat{F}_{ext} - K_{pi}r(t) - K_{di}\dot{r}(t)$$

Micro/Nano Robotics II / Impedance, Compliance, and Force Control

Chair *Dong Sun, City University of Hong Kong*
Co-Chair

17:01–17:04 WeD1.19

Fully Omnidirectional Compliance in Mobile Robots Via Drive-Torque Sensor Feedback

Kwan Suk Kim[1], Alan S. Kwok[1],
Gray C. Thomas[1] and Luis Sentis[1]
[1]The University of Texas at Austin

- Holonomic mobile base
- External force sensed by torque sensor on drivetrain
  → Omnidirectional Compliance

17:07–17:10 WeD1.21

Fuzzy Learning Variable Admittance Control for Human-Robot Cooperation

Fotios Dimeas, Nikos Aspragathos
University of Patras, Greece

- A fuzzy model reference learning system modifies online the gains of the admittance controller
- Adaptation to the minimum jerk trajectory model

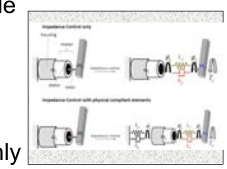
✓ Combination of expert knowledge and adaptation facilitates human-robot cooperation
✓ Less human effort, less time required and more accurate positioning on p2p movements

17:04–17:07 WeD1.20

Augmenting impedance control with structural compliance for improved contact transition performance

Dongwon Kim, R. Brent Gillespie,
Brandon J. Johnson, and Xingjian Lai
University of Michigan

- A spring-damper coupler reduces the impedance to the environment while improving performance in contact transition tasks.
- We present a simple method for estimating interaction forces and regulating the contact force with only one position sensor and without a priori knowledge of the environment.



Unmanned Aerial Systems II / Legged Robots II

Chair *Raffaella Carloni, University of Twente*
Co-Chair

15:50–16:10 WeD2.1

Keynote: Material-Handling – Paradigms for Humanoids and UAVs

Paul Oh
University of Nevada, Las Vegas (UNLV)

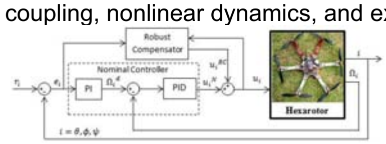
Perhaps subtle is the observation that robotics is in a "step change"; the recent DARPA Robotics Challenge (DRC) and various large-scale projects (e.g. FP7 European Commission) reveal that today's robots can compound the IT revolution with mobile material-handling capabilities. The supply-chain bottleneck occurs at the "tails" where support infrastructures differ from location-to-location. This talk posits how today's humanoids and UAVs have the potential to overcome bottlenecks by accelerating material-handling

16:10–16:13 WeD2.2

Robust Attitude Controller for Uncertain Hexarotor Micro Aerial Vehicles (MAVs)

Dafizal Derawi[1], Nurul Dayana Salim[1], Hairi Zamzuri[1], Hao Liu [2], Mohd Azizi Abdul Rahman [1], and Saiful Amri Mazlan[1]
[1]Universiti Teknologi Malaysia [2]Beihang Uni.

- Robust, decoupled, linear time-invariant control
- Nominal controller: PI+PID & Robust compensator
- Uncertainties (equivalent disturbances): parametric uncertainties, coupling, nonlinear dynamics, and ext. disturbances

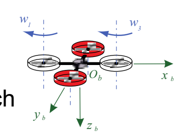


16:13–16:16 WeD2.3

Emergency Landing for a Quadrotor in Case of a Propeller Failure: A Backstepping Approach

Vincenzo Lippiello, Fabio Ruggiero, Diana Serra,
Department of Electrical Engineering and Information Technology, Università di Napoli Federico II, Italy

- A backstepping approach is proposed to cope with the failure of a quadrotor propeller.
- A birotor configuration with fixed propellers is considered.
- Theory shows that the birotor can reach any point in the Cartesian space.
- Simulation tests are presented.



16:16–16:19 WeD2.4

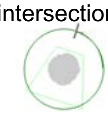
Guaranteed Road Network Search with Small Unmanned Aircraft

Michael Dille[1,2], Ben Grocholsky[2], and Sanjiv Singh[2]
[1]SGT / NASA Ames [2]Carnegie Mellon University

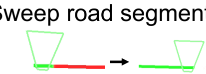
- Guaranteed capture of road-bound evaders
  - Mapping abstract pursuit-evasion to UAV motions
- Unbounded-speed evaders
  - Larger, slower UAV teams
- Bounded-speed evaders
  - Smaller, faster UAV teams

Primitive motions:

- Guard intersection



- Sweep road segment



16:19–16:22 WeD2.5

A Ground-Based Optical System for Autonomous Landing of a Fixed Wing UAV

Weiwei Kong[1], Dianle Zhou[1], Yu Zhang[1], Daibing Zhang[1], Xun Wang[1], Boxin Zhao[1], Chengping Yan[1], Lincheng Shen[1], Jianwei Zhang[2]
[1]National University of Defense Technology [2]University of Hamburg

- A novel ground-based platform with a large field of view (FOV), eliminating the dependency of GNSS.
- AdaBoost algorithm has been applied to track the target.
- Several real flights in outdoor environments support the accuracy of the system.

16:22–16:25 WeD2.6

On Crop Height Estimation with UAVs

David Anthony[1], Sebastian Elbuam[1], Aaron Lorenz,[1] and Carrick Detweiler[1]
[1]University of Nebraska-Lincoln

- Develops a low flying UAV system to estimate crop heights with a 2D laser scanner
- Algorithm computes crop height to within 5cm of ground truth
- Cluttered laser scans are filtered to control vehicle altitude

Unmanned Aerial Systems II / Legged Robots II

Chair *Raffaella Carloni, University of Twente*
Co-Chair

16:25–16:28 WeD2.7

Model-aided State Estimation for Quadrotor MAVs with Wind Disturbances

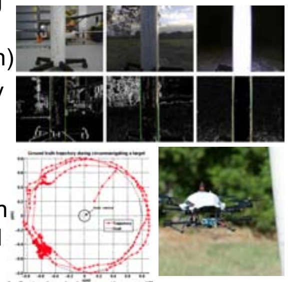
D. Abeywardena[1], Z. Wang[2], G. Dissanayake[1]
S. Waslander[3] and S. Kodagoda[1]
[1]U. Of Tech. Sydney [2]KTH [3]U. Of Waterloo

- Effect of wind on Quadrotor dynamic is modeled and employed for state estimation
- Sensing package - monocular camera and IMU
- Observability analysis proves that both quadrotor pose and wind can be estimated simultaneously
- Experiments in Vicon room with industrial grade FAN using an ARDrone quadrotor

16:28–16:31 WeD2.8

Inspection of Pole-Like Structure using Vision controlled VTOL UAV and Shared Autonomy

Inkyu Sa[1], Stefan Hrabar[2] and Peter Corke[1]
[1]QUT, CSIRO Brisbane, Australia



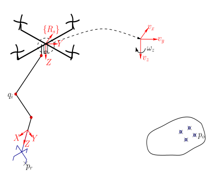
- Image based visual servoing using line features (Camera+IMU for de-rotation)
- The use of shared autonomy for easy&safe inspection of pole-like structures
- Indoor and outdoor (day&night) experiments with reliable ground truth (VICON and Leica) for validation.
- No GPS is used.

16:31–16:34 WeD2.9

Image-based control for dynamically cross-coupled aerial manipulation

R. Mebarki, V. Lippiello, and B. Siciliano
PRISMA Lab
University of Napoli Federico II

- Quadrotor endowed with a robotic arm and a fixed camera.
- Visual servoing controller for the positioning of assembling parts.
- Integral Backstepping low-level controller for velocity regulation.
- Simulation results.



Sketch of the robotic system

16:34–16:37 WeD2.10

The Quadroller: Modeling of a UAV/UGV Hybrid Quadrotor

Jared R. Page and Paul E. I. Pounds
University of Queensland

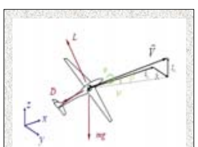
- Driving mode uses passive wheels to double range
- Skateboard steering uses existing flight control mixing
- Aircraft tilts sideways to turn

16:37–16:40 WeD2.11

Persistent monitoring with a team of autonomous gliders using static soaring

J.J. Acevedo[1], N.R.J. Lawrance[2],
B.C. Arrue[1], S. Sukkarieh[2] and A. Ollero[1]
[1]University of Sevilla [2]University of Sydney

- Cooperative patrolling missions to minimize the **refresh time.**
- **Distributed algorithm** based on coordination variables.
- **Exploiting thermal sources** to gain energy and **keep the mission**.
- One-to-one coordination for **dynamic thermal allocation.**



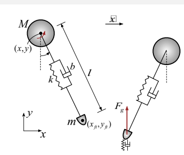
Forces and euler angles for the model

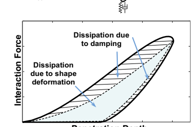
16:40–16:43 WeD2.12

Compliant Terrain Legged Locomotion Using a Viscoplastic Approach

Vasileios Vasilopoulos, Iosif S. Paraskevas and Evangelos G. Papadopoulos
National Technical University of Athens

- Legged robot compliant foot-terrain interaction
- Proposed new viscoplastic impact model for interaction
- Results show that compliance affects gait response
- Developed a novel controller to compensate for terrain compliance





Unmanned Aerial Systems II / Legged Robots II

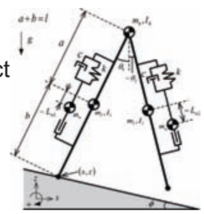
Chair *Raffaella Carloni, University of Twente*
Co-Chair

16:43–16:46 WeD2.13

Passive Dynamic Walking of Compass-like Biped Robot with Dynamic Absorbers

Yukihiro Akutsu[1], Fumihiko Asano[1], Isao Tokuda[2]
[1]JAIST [2]Ritsumeikan Univ.

- Passive compass gait with dynamic absorbers (DAs) is investigated
- Speeding-up is achieved by the effect of DAs with suitable parameters
- Numerical simulations show some interesting nonlinear phenomena
- Dominant dynamics of DAs is modeled and its effect is analyzed

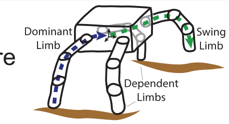


16:46–16:49 WeD2.14

More Solutions Means More Problems: Resolving Kinematic Redundancy in Robot Locomotion on Complex Terrain

Brian Satzinger[1], Jason I. Reid[2], Max Bajracharya[2], Paul Hebert[2] and Katie Byl[1]
[1]UCSB [2]JPL

- RoboSimian has 7-DOF limbs.
- For quadruped walking, 3 DOFs are often sufficient (to pick footholds).
- To resolve redundancy efficiently and tractably, we combine an RRT search (for dominant and swing legs) with well-designed IK tables (for dependent limbs).

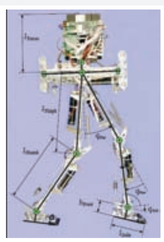


16:49–16:52 WeD2.15

Hopping control for the musculoskeletal bipedal robot: BioBiped

Maziar A. Sharbafi[1], Katayon Radkhah[2], Oskar von Stryk[2] and Andre Seyfarth[1]
[1]Lauflabor, [2]Sim Group, TU Darmstadt

- **Method:** two-layer controller
- Virtual model control for bouncing
- Velocity based leg adjustment (VBLA) for swinging the leg
- **Achievements:**
- Hopping patterns similar to humans
- From in-place to forward hopping by tuning few control parameters



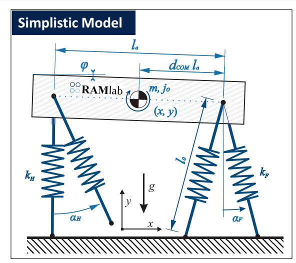
BioBiped Robot

16:52–16:55 WeD2.16

A Passive Dynamic Quadruped that Moves in a Large Variety of Gaits

Zhenyu Gan, C. David Remy,
University of Michigan, Robotics and Motion Laboratory

- A rigid main body and four massless springs, **passive** model, no energy losses, energetically conservative
- With a single passive dynamic quadrupedal model, we can produce 6 kinds of different gaits.



16:55–16:58 WeD2.17

Velocity Disturbance Rejection for Planar Bipeds Walking with HZD-Based Control

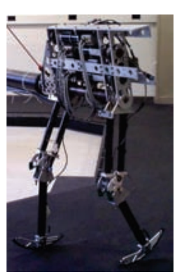
David Post & James Schmiedeler
Aerospace & Mechanical Engineering, University of Notre Dame, USA

Approach

- Modify desired joint trajectories within a step in response to velocity disturbances.
- Make modifications via heuristics extracted from simulations of disturbed walking under orbital stabilization control.

Experimental Results

- Real-time implementation on 5-link biped ERNIE.
- Reduced step-to-step velocity variations in undisturbed walking.
- More rapid return to desired velocity post-disturbance.
- Ability to reject larger disturbances without gait failure.



16:58–17:01 WeD2.18

Reactive Posture Behaviors for Stable Legged Locomotion over Steep Inclines

A. Roennau[1], G. Heppner[1], M. Nowicki[2], J. M. Zoellner[1] and R. Dillmann[1]
[1]FZI, Karlsruhe, Germany [2]PUT, Poznan, Poland

- Behavior-based control system for a hexapod robot with 4 joints per leg
- Hybrid system architecture with deliberate and reactive components
- Three independent posture behaviors react on disturbances and keep the robot stable in all terrains
- Autonomous adaptation to inclines

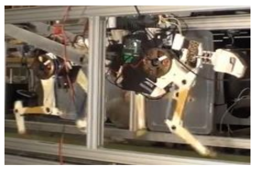
Unmanned Aerial Systems II / Legged Robots II

Chair *Raffaella Carloni, University of Twente*
Co-Chair

17:01–17:04 WeD2.19

The Effect of Leg Impedance on Stability and Efficiency in Quadrupedal Trotting

Will Bosworth[1], Sangbae Kim[1], Neville Hogan[1,2]
[1]Dept of Mechanical Engineering, MIT, USA
[2]Dept of Brain & Cog Sci, MIT, USA

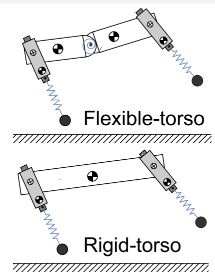


- A simulation of the MIT Cheetah robot performing a trot gait with tuned leg impedance control.
- Shows how stability is more sensitive to knee impedance than hip; that efficiency is not sensitive to impedance.
- Simulation data compares favorably with experimental data of the MIT Cheetah trotting.

17:04–17:07 WeD2.20

On the Energetics of Quadrupedal Bounding With and Without Torso Compliance

Qu Cao and Ioannis Poulakakis
University of Delaware, USA



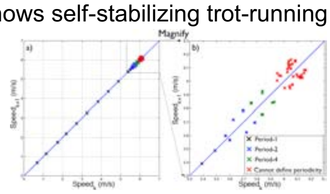
- Two reduced-order models are proposed to study the energetics of quadrupedal bounding
- Cyclic motions with minimum cost of transport are generated
- Torso compliance enhances gait efficiency at high speeds

17:07–17:10 WeD2.21

Self-stabilizing quadruped trot-running and period-doubling bifurcations

Jongwoo Lee[1], Dong Jin Hyun[1],
Jooeun Ahn[1], Sangbae Kim[1], and Neville Hogan[1]
[1]Mechanical Engineering, MIT, USA

- The dynamics of a quadruped robot model with impedance control is analyzed using simulation.
- The simulation study shows self-stabilizing trot-running at various speeds.
- At high speeds, period-doubling bifurcation is observed , which might limit the performance.



Computer Vision II / Recognition

Chair *Philippe Martinet, Ecole Centrale de Nantes*
Co-Chair

15:50–16:10 WeD3.1

Keynote: Semantic Parsing in Indoors and Outdoors Environments

Jana Kosecka
George Mason University

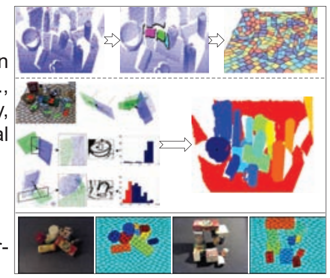
- Simultaneous segmentation and categorization of open scenes sensory data into background and object categories
- Efficient processing of video and multiple sensor modalities
- Semantic refinement for finer object discrimination

16:10–16:13 WeD3.2

A Model-free Approach for the Segmentation of Unknown Objects

U. Asif, M. Bennamoun,and F. Sohel
The University of Western Australia

- Initial segmentation:
  - Gradient-based seeding.
  - Regions grow based on structural variations (i.e., 3D proximity, planarity, and surface normal orientation).
- Perceptual grouping:
  - Shape between regions.
  - Homogeneity of inter-region connectivity.



16:13–16:16 WeD3.3

Automatic detection of pole-like structures in 3D urban environments

Federico Tombari[1], Nicola Fioraio[1],Tommaso Cavallari[1]
Samuele Salti[1], Alioscia Petrelli[1],Luigi Di Stefano[1]
[1]University of Bologna

- Detection of pole-like structures (lamp posts, traffic signs, light poles,..) in 3D urban data acquired with a LiDAR

- Local-global description and classification approach to reject false positives: first point-wise, then cluster-wise
- Use of context to discriminate wrt. tree trunks

16:16–16:19 WeD3.4

Real-time and Low Latency Embedded Computer Vision Hardware Based on a Combination of FPGA and Mobile CPU

Dominik Honegger[1], Helen Oleynikova[1],
and Marc Pollefeys[1]
[1]ETH Zürich

- Stereo camera setup with an FPGA as an additional layer between camera and CPU
- System calculates dense disparity images with 752*480 resolution at 60 fps
- 5 Watt power consumption, 50 grams total weight

16:19–16:22 WeD3.5

Multi-View Terrain Classification using Panoramic Imagery and LIDAR

Sarah Taghavi Namin[1,2], Mohammad Najafi[1,2]
and Lars Petersson[1]
[1]NICTA [2]The Australian National University

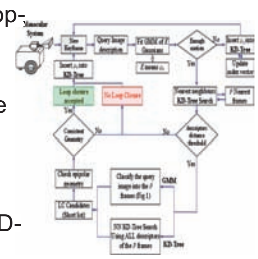
- Several views along the road
  ➡ Several 2D feature vectors for each 3D point
- Choosing the best 2D view with Consensus 2D View Selection
- 3D Enhanced CRF:
  -Robust against over-smoothing
  -Learning from previous mistakes

16:22–16:25 WeD3.6

Efficient Real-Time Loop Closure Detection Using GMM and Tree Structure

Mohammed Boulekchour and Nabil Aouf
Cranfield University, Shrivenham, UK

- Two new methods for visual loop-closure detection are proposed.
- The first technique uses Bayes Decision Theory for loop closure detection based on Gaussian Mixture Model (GMM).
- A new technique based on a combination of GMM with the KD-Tree data structure.



Computer Vision II / Recognition

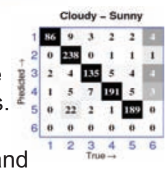
Chair *Philippe Martinet, Ecole Centrale de Nantes*
Co-Chair

16:25–16:28 WeD3.7

Place Categorization using Sparse and Redundant Representations

H. Carrillo, Y. Latif, J. Neira and J. A. Castellanos
University of Zaragoza

- Novel formulation of the place categorization problem by posing it as an **L1-minimization problem**.
- Faster training phase and performance comparable to state-of-the-art methods.
- Online robot operation with on-the-fly and active learning phase.

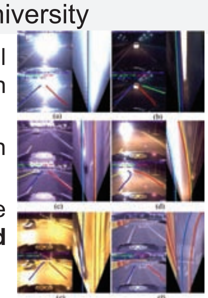


16:28–16:31 WeD3.8

Real-Time Global Localization of Intelligent Road Vehicles in Lane-Level via Lane Marking Detection and Shape Registration

Dixiao Cui, Jianru Xue,
Shaoyi Du and Nanning Zheng
IAIR, Xi'an Jiaotong University

- Real-time **centimeter-level** global localization of intelligent vehicles in urban environments
- Innovative Shape Registration based **Cross Validation** scheme
- Cross-validating detected lane markings and a GPS based **road shape prior**

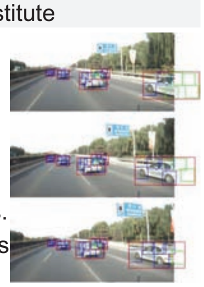


16:31–16:34 WeD3.9

On-road Vehicle Detection through Part Model Learning and Probabilistic Inference

C. Wang[1], H. Zhao[1], C. Guo[2], S. Mita[2], H. Zha[3]
[1]Key Lab of Machine Perception, Peking Univ.,
[2]Toyota Central R&D Labs,
[3]Toyota Technological Institute

- On-road vehicle detection, focus on vehicle pose inference on part instances by addressing the issues of partial observation and varying viewpoints.
- Vehicle appearance and geometric models are learnt from image samples.
- Road-structure based viewpoint maps are generated by statistic of vehicles.



16:34–16:37 WeD3.10

Real-time Depth Enhanced Monocular Odometry (Open Source)

Ji Zhang, Michael Kaess and Sanjiv Singh
Robotices Institute at Carnegie Mellon University

- RGB-D visual odometry that is able to utilize sparsely provided depth
- Register a depthmap using depth from RGB-D cameras or lidars, and involve three types of features in solving for motion: depth from depthmap, depth by SFM, and depth unavailable
- Tested with 3 sensor setups, rated #2 on KITTI benchmark using depth from Velodyne (compared to stereo VO)

16:37–16:40 WeD3.11

MEVO: Multi-Environment Stereo Visual Odometry

Thomas Koletschka, Luis Puig,
and Kostas Daniilidis
University of Pennsylvania

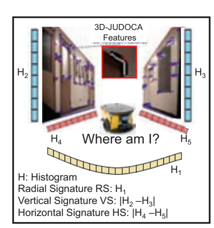
- Robust **stereo visual odometry** for both indoor and outdoor environments
- **Increased accuracy** over using just one feature type
- **Efficient line stereo** and frame-to-frame **matching** with sub-pixel accuracy and occlusion handling

16:40–16:43 WeD3.12

Place Recognition and Self-Localization in Interior Hallways by Indoor Mobile Robots: A Signature-Based Cascaded Filtering Framework

Khalil Ahmad Yousef , Johnny Park and Avinash Kak
Electrical and Computer Engineering, Purdue University, USA

- We propose a cascaded filter approach to robot self-localization. The filter cascade consists of a prefilter followed by an arbitrary number of filters.
- All filters are based on signatures learned using a model of the environment based on 3D junction features (3D-JUDOCA).
- We describe a novel method for designing, selecting, and matching the signatures for both the prefiltering stage and subsequent filtering stages.
- Our experimental validation is based on a large network of hallways.



Self Localization by a Mobile Robot

Computer Vision II / Recognition

Chair *Philippe Martinet, Ecole Centrale de Nantes*
Co-Chair

16:43–16:46 WeD3.13

Automated Perception of Safe Docking Locations with Alignment Information

Siddarth Jain[1] and Brenna Argall[12]
[1]Northwestern University, USA
[2]Rehabilitation Institute of Chicago, USA

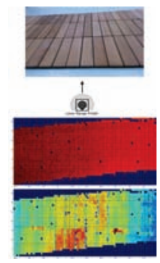
- **Novel method**: Perception of safe and oriented docking locations from depth data
- **Formulation**: Geometric features, no fiducial/landmark requirements, for rectangular & circular structures
- **Evaluation**: A variety of docking structures and configurations from varied viewpoints

16:46–16:49 WeD3.14

Terrain Classification Using Laser Range Finder

Krzysztof Walas[1], Michal Nowicki[1],
[1]Poznan University of Technology,
60-965 Poznan, Poland

- Intensity and depth values
- Feature vector – statistical values and 2D Fast Fourier Transform
- 98% correctly recognized terrain samples for 12 terrain types
- Low computational cost – classification of 4 m^2 in 88 ms



16:49–16:52 WeD3.15

A Novel Feature for Polyp Detection in Wireless Capsule Endoscopy images

Yixuan Yuan and Max Q.-H. Meng
Department of Electronic Engineering,
The Chinese University of Hong Kong, China

- Propose a new feature integrating the Gabor filter and Monogenic-Local Binary Pattern (M-LBP) methods in color components.
- Achieve average polyp detection accuracy, sensitivity and specificity at 91.43%, 88.09%, and 94.78%.

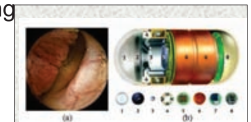


Fig. (a) Illustration of polyps (b) Components diagram of a WCE.

16:52–16:55 WeD3.16

Automation of "Ground Truth" Annotation for Multi-View RGB-D Object Instance Recognition Datasets

Aitor Aldoma[1], Thomas Fäulhammer[1],
Markus Vincze[1],
[1]Vienna University of Technology

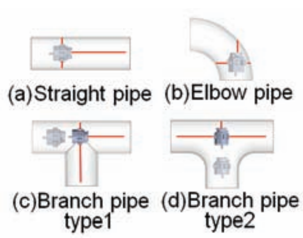
- Automatic annotation without constraints on scene layouts through exploitation of multiple viewpoints:
  - Single-view recognition in all frames.
  - Scene reconstruction through visual features and common objects.
  - 3D Hypothesis Verification.
  - “Ground-truth” projection.

16:55–16:58 WeD3.17

Recognition of Inside Pipeline Geometry by Using PSD Sensors for Autonomous Navigation

Y. S. Choi[1], H. M. Kim[1], J. S. Suh[1], H. M. Mun[1],
S. U. Yang[1], C. M. Park[1] and H. R. Choi[1]
[1]Sungkyunkwan University, Korea

- Recognition method by using PSD sensors
- Recognition of pipeline geometry
- Distinction of T-branch and miter
- Detection of pipeline element type

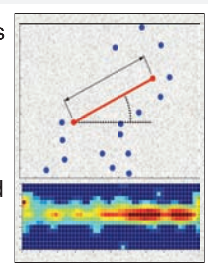


16:58–17:01 WeD3.18

Large Scale Place Recognition using Geometrical Landmark Relations

Marian Himstedt[1], Jan Frost[1], Sven Hellbach[2],
Hans-Joachim Böhme[2] and Erik Maehle[1]
[1]University of Lübeck [2]HTW Dresden

- Detect landmarks in 2D range scans
- Estimate relative orientations and distances of landmarks
- Generate scan signatures (GLARE) with landmark relations
- GLAREs are viewpoint invariant and highly discriminative



Computer Vision II / Recognition

Chair *Philippe Martinet, Ecole Centrale de Nantes*
Co-Chair

17:01–17:04 WeD3.19

Evaluation of Feature Selection and Model Training Strategies for Object Category Recognition

Haider Ali and Zoltan-Csaba Marton
German Aerospace Center (DLR)

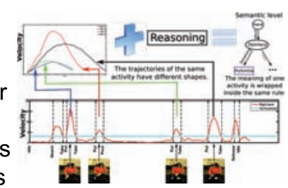
- Quantifying the generalizing power of object category recognition between datasets.
- Evaluating the VFH, ESF and PFH features and their (full and partial) combinations.
- Analyzing the results given by features selection methods (mRMR and MaxRel).
- Improving the categorization accuracy obtained through adapting the training set.

17:04–17:07 WeD3.20

Automatic Segmentation and Recognition of Human Activities from Observation based on Semantic Reasoning

K. Ramirez-Amaro[1], M. Beetz[2] and G. Cheng[1]
[1]Institute for Cognitive Systems, Technical University of Munich, Germany.
[2]Institute for Artificial Intelligence, University of Bremen, Germany.

In this paper, we propose a framework that combines different signals via semantic reasoning to enable robots for *on-line* segmentation and recognition of human activities by understanding what it sees from videos with 85% accuracy.

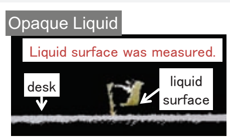


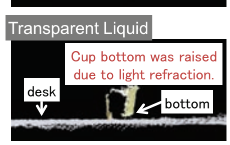
17:07–17:10 WeD3.21

Detection of Liquids in Cups Based on the Refraction of Light with a Depth Camera Using Triangulation

Yoshitaka Hara[*1], Fuhito Honda[*1], Takashi Tsubouchi[*1], and Akihisa Ohya[*1]
[*1] University of Tsukuba, Japan

- For opaque liquids, *the liquid surface* is measured
- In the case of transparent liquids, *the raised bottom* is measured
- We formulated it theoretically based on the refraction of light
- Our method **can detect liquids of various transparency** in cups





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IROS 2014 Author Index

M

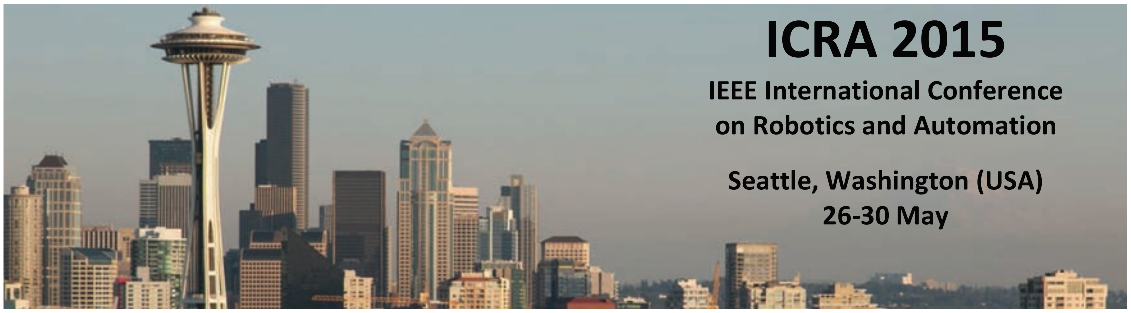
S

T

U

V

W



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ICRA is the IEEE Robotics and Automation Society's flagship conference and is a premier international forum for robotics researchers to present their work. The 2015 conference will be held May 26-30, 2015 at the Washington State Convention Center in Seattle, WA, USA.

The conference will include plenary and mini-plenary sessions, contributed paper sessions, workshops and tutorials, an industrial forum, exhibits, and robot challenges as well as some events that are new to ICRA, such as a PhD forum, a career fair, and a developing countries forum.

Contributed Papers

Papers reporting on novel research in robotics and automation are invited. All papers will be reviewed using a single-blind review process: authors declare their names and affiliations in the manuscript for the reviewers to see, but reviewers do not know each other's identities, nor do the authors receive information about who has reviewed their manuscript.

Prospective authors should submit PDF versions of their paper. Six pages in standard ICRA format are allowed for each paper, including figures. A maximum of two additional pages can be purchased. Authors are invited to submit a video to complement their submission. Detailed instructions for submission are available on the conference website.

Paper Presentation

Papers will be presented in two modes, interactive and oral. Sessions will include both interactive and oral papers, with interactive papers having brief spotlight oral presentations preceding the interactive portion of the session, which will be held in the session room.

Tutorials and Workshops

Proposals for half-day or full-day workshops and tutorials are invited. Workshops and tutorials will be held on May 26 and 30, before and after the main contributed sessions. Workshops provide an informal forum for participants in an active research area. Tutorials target more established research areas and provide insights to the state of the art, presented by recognized researchers in the field. Detailed instructions for submission are provided on the conference website.

Career Fair and PhD Forum

For the first time, ICRA 2015 will include a Career Fair and a PhD Forum. The Career Fair will provide an opportunity for conference sponsors to have booths and interact with prospective employees. The PhD Forum will provide an opportunity for a group of Ph.D. students to discuss and explore their research interests and career objectives with a panel of established researchers in robotics and automation to help them network with both junior and senior researchers. Information regarding participation in these events will be on the conference website.

Exhibits

The Washington State Convention Center has plentiful and excellent space for exhibits. It is adjacent to the plenary sessions and conference registration, and will be the location for the opening reception and for refreshments during the breaks during the conference. Information for prospective exhibitors will be available on the web site.

Important Dates

1 October 2014: Paper Submission deadline
30 January 2015: Paper acceptance notification
27 February 2015: Final contribution deadline

URL: http://www.icra2015.org