# TuA1: Sensory-motion

Chair: Xuebo Zhang     Co-chair: Bok Seng Yeow
Royal Ballroom     Tuesday, 07-Jun-2016, 9:40-10:40

$09:40 \sim 09:52$

### A Magnetically Actuated Guide-wire Steering System towards **Arteriovenous** Fistula Angioplasty Procedures

Bok Seng Yeow[1], Jinji Sun[1], Jackie Ho[2], Hongliang Ren[1]*
[1]Department of Biomedical Engineering, National University of Singapore (NUS)
[2]Department of Surgery, Yong Loo Lin School of Medicine, NUS

- A new concept for Arterio-venous interventions using magnetically manipulated guide-wires.
- The attached magnetic element is a disposable attachment, potentially for any kind of guide-wires.
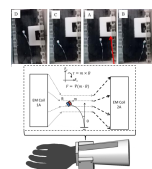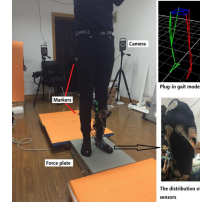- Electro-Magnetic coils used are much smaller than existing art, improving portability.



Figure 1. Overall system concept.

$09:52 \sim 10:04$

### A wearable sensor system for knee adduction moment measurement

[1]Yang Shen, [1]Tao Liu, [2]Qingguo Li, [3]Jingang Yi
[1]Dept. of Mech. Eng., Zhejiang University, China,
[2]Dept. of Mech. And Mate. Eng., QU, Canada
[1]Xiaoyu Xie, [1]Bo Wen and [4]Yoshio Inoue
[3]Dept. of Mech. And Aero. Eng., RU, USA,
[4]School of Systems Eng., KUT, Japan

- Measurement of knee adduction moment.
- 6 PSECR sensors were used for the collection of pressure during walking.
- A modeling method based on neural network for KAM assessment.
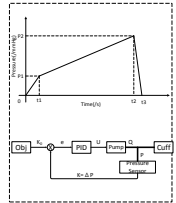- Real-time feedback system for the clinical treatment of knee OA.



$10:04 \sim 10:16$

### The Method of Linear Inflation Control in Ambulatory Blood Pressure Measurement at Finger

Pandeng Zhang, Jie Zhang, Quanli Qiu, Jia Liu
Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences, China
Ye Chen
Department of Nursing, Yiyang Medical College, China

- 1) In order to reduce measurement time, we use the similar method of inflation method in ProBP 3400;
- 2) In order to lessen patient discomfort, we use the similar finger cuff in ClearSight;
- 3) In order to reduce the power cost and sensitiveness of the finger cuff position, we remove the PPG signal in ClearSight.
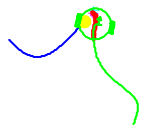


$10:16 \sim 10:28$

### Vision-based Moving Target Interception With A Mobile Robot Based On Motion Prediction And Online Planning

Xuebo Zhang, Yongxin Wang and Yongchun Fang
Institute of Robotics and Automatic System, Nankai University, China

- A vision-based moving target interception approach is proposed based on motion prediction and online planning;
- Fusion of two motion prediction approaches with historical motion data is proposed to forecast the robot motion.
- An optimal path is selected from a set of the third order Bezier curves.
- Simulation results show the effectiveness of the proposed method.
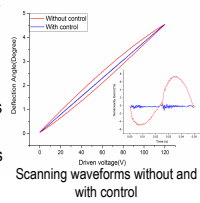


Moving target interception

$10:28 \sim 10:40$

### Hysteresis compensation for piezoelectric laser scanner with open-loop control method

Chen Wei, Jiao Guohua and Lv Jiancheng
Shenzhen Institudes of Advanced Technology, CAS, China
Zhu Lei and Ji Ming
Xi'an Institute of Applied Optics, China

- A model to describe the hysteresis features of a piezoelectric laser is presented.
- The model is simple and the parameters are easily calculated.
- An open-loop controller based on the model is proposed and applied.
- The nonlinearity caused by hysteresis effect is significantly reduced.



Scanning waveforms without and with control

# TuA2: Adaptive Control-I

Chair: Ning Sun     Co-chair: Qingsong Xu
Sunflower Room     Tuesday, 07-Jun-2016, 9:40-10:40

09 : 40 ∼ 09 : 52

### A New Triple-Stage Stabilizing Control Method for Two-Wheeled Inverted Pendulum Robots

Ning Sun, Yiming Wu, Yongchun Fang, and He Chen
Institute of Robotics and Automatic Information System (IRAIS),
Nankai University, P. R. China

- We propose a novel triple-stage stabilizing control approach for a two-wheeled inverted pendulum robots.
- It can drive the robot to move from its initial pose and position to the desired one while maintaining small pendulum tilting angle.
- Numerical simulation studies are included to verify the effectiveness of the proposed control approach.



09 : 52 ∼ 10 : 04
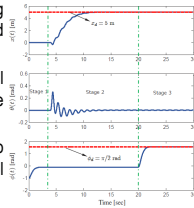
### Robust Stabilizability of MIMO Delay Systems: Bounds on Delay Radii

Tian Qi
School of Automation Science and Engineering,
South China University of Technology, China
Jing Zhu
College of Automation Engineering,
Nanjing University of Aeronautics and Astronautics, China
Jie Chen
Department of Electronic Engineering,
City University of Hong Kong, Hong Kong SAR, China

- MIMO Systems have unknown constant delays
- What is the largest ranges of constant delays such that there exists LTI controllers that can stabilize the system?
- How to design a LTI controller that can stabilize all the systems within delay range?

10 : 04 ∼ 10 : 16

### Adaptive Robot Control for Human-dominant Interactions using a General Task Function

Shangke Lyu and Chien Chern Cheah
EEE, Nanyang Technological University, Singapore

- Co-existence of human and robot in the same workspace
- Describe the different tasks by using a general task function
- Integrate both robot tasks and interaction tasks into a general controller



Human-dominant interaction

10 : 16 ∼ 10 : 28
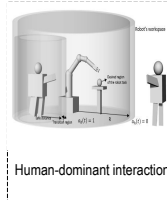
### Adaptive Parameter Estimation with Nonswitching Reaching Law for Variable Structure Control of a Nanopositioning Stage

Yulong Zhang and Qingsong Xu
Department of Electromechanical Engineering, University of Macau,
Macau, China

- A new motion controller is proposed for a piezo-driven nanopositioning stage
- An adaptive approach is developed to estimate the uncertainties and errors in real time
- A nonswitching type of reaching law for variable structure control of the discrete-time system is applied to regulate the position state
- The effectiveness has been verified by conducting experimental studies
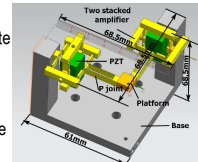


10 : 28 ∼ 10 : 40

### Two Kinds of High-Performance Gyro Stabilized Platform Control Strategies

Shuang Cong, G. L. Sun, Q. Liu, W. W. Shang and H.H. Shen
Department of Automation, University of Science and Technology of China, P. R. China

- Active disturbance rejection control (ADRC) and disturbance rejection control based on velocity disturbance observer (VDOB) are proposed
- To eliminating all factors of affecting the accuracy
- The ADRC is a more real time control strategy, and the VDOB control has a higher precision control for the gyro stabilized platform
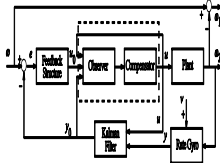


Fig. 1 Diagram of disturbance rejection and filter control of gyro-stabilized platform
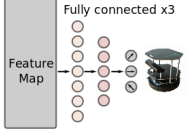
# TuA3: Learning

Chair: Youfu Li    Co-chair: Lei Tai

Apsara Room    Tuesday, 07-Jun-2016, 9:40-10:40

$09:40 \sim 09:52$

## A Robot Exploration Strategy Based on Q-learning Network

Lei Tai and Ming Liu

Department of Mechanical and Biomedical Engineering, City University of Hong Kong

- A revised DQN framework for moving robot.
- Raw sensor information was used.
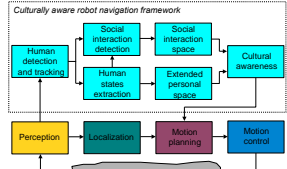- Validating in several simulated environments.

Feature Map

Fully connected x3

$09:52 \sim 10:04$

## Towards Culturally Aware Robot Navigation

Xuan Tung Truong and Trung Dung Ngo

The More-Than-One Robotics Laboratory, University of Brunei Darussalam

Yongsheng Ou

Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciecnes

- A culturally aware robot navigation capable of enabling mobile service robots to politely and respectfully navigate among humans in social environments
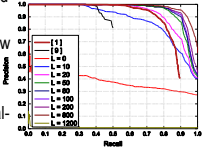
Culturally aware robot navigation framework

Block diagram of the culturally aware robot navigation

$10:04 \sim 10:16$

## Matching-Range-Constrained Real-Time Loop Closure Detection with CNNs Features

Dongdong Bai, Chaoqun Wang, Bo Zhang, Xiaodong Yi and Yuhua Tang

College of Computer, National University of Defense Technology,  China

- Use the feature generated by the pre-trained CNNs for loop closure detection
- Constrain the matching range of current view of robot to improve loop closure detection performance
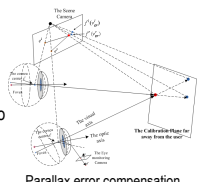- Provide a efficient method to implement real-time loop closure detection in large-scale scene

Precision-Recalls on City Centre dataset

$10:16 \sim 10:28$

## Parallax Error Compensation for Head-Mounted Gaze Trackers based on Binocular Data

Dan Su and Youfu Li

City University of Hong Kong, Hong Kong SAR, China

Caihua Xiong

Huazhong University of Science and Technology, China

- The parallax error of HMGT caused by the spatial offset is analyzed.
- Two parallax compensation methods for binocular gaze tracking setups are proposed.
- A comparative study is conducted on these two methods to ensure the effectiveness of our compensation approach.
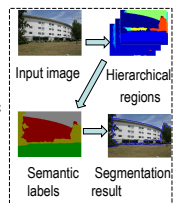
Parallax error compensation

$10:28 \sim 10:40$

## Hierarchical Image Segmentation Using Semantic Edge Constraint

Ding Yuan and Jingjing Qiang

school of Astronautics, Beihang University, Beijing, China

- Image segmentation via hierarchical mechanism
- Semantic label propagation by using spatially consistency constraint
- Salient edge detection combined with semantic edge constraint

Input image

Hierarchical regions

Semantic labels

Segmentation result

# TuB1: Soft robot/Electrics

Chair: Wang Zheng    Co-chair: Matsuno Takahiro
Royal Ballroom    Tuesday, 07-Jun-2016, 11:00-12:00

11 : 00 ∼ 11 : 12

### A Soft Stretchable Bending Sensor and Data Glove Applications

Zhong Shen and Juan Yi and Zheng Wang
Department of Mechanical Engineering, University of Hong Kong, Hong Kong
Xiaodong Li and Lo Hin Pei Mark and Yong Hu
Department of Orthopaedics and Traumatology, University of Hong Kong, Hong Kong

- Introduction.
- Senor and sensor glove
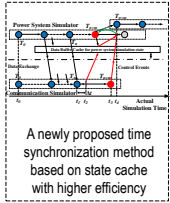- Sensor and sensor glove evaluation
- Conclusions

11 : 12 ∼ 11 : 24

### Overview of the Co-simulation Methods for Power and Communication System

Yi Tang , Feng Li , Qi Wang , Bin Chen
School of Electrical Engineering, Southeast University, China
Ming Ni
NARI Technology Co. Ltd. , China

- Introduce co-simulation methods for power and communication system and collate existing co-simulation platform.
- Put forward a new synchronization method for power and communication system based on state cache.
- Analyze time efficiency of each co-simulation method and compare result shows advantages of newly proposed method in time efficiency.
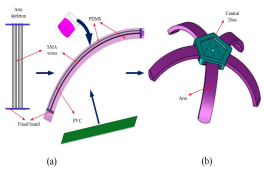
A newly proposed time synchronization method based on state cache with higher efficiency

11 : 24 ∼ 11 : 36

### Locomotion of an actinomorphic soft robot with soft composite structures

Hu Jin, Erbao Dong, Min Xu, Xia Su, Chunshan Liu , Jie Yang

Precision Machinery and Precision Instrumentation, University of Science and Technology of China, China

- The design and fabrication of an actinomorphic soft robot with soft composite structures was introduced.
- An adulation heating (AH) strategy was built based on the resistance feedback of the SMA wires.
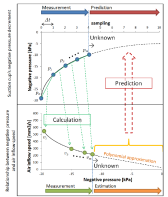- The actinomorphic soft robot exhibit multi-gait locomotion under undulatory gait.

Design and fabrication of an actinomorphic soft robot

11 : 36 ∼ 11 : 48

### Real time prediction of suction cup's negative pressure decrement without previous measurement of air inflow speed

Takahiro Matsuno and Shugen Ma
Department of Robotics, Ritsumeikan University, Japan

- This study proposes a prediction method of the negative pressure decrement
- The method predicts in the attached state of the suction cup.
- The unknown air inflow speed is estimated by polynomial approximation.
- From the result of experimental verification, the proposed prediction method shows well prediction result.

Real time prediction method of pressure decrement

11 : 48 ∼ 12 : 00

### A Soft Robotic Glove for Hand Motion Assistance

Juan Yi, Zhong Shen, Zheng Wang
Mechanical Engineering, The University of Hong Kong, China
Chaoyang Song
Mechanical and Aerospace Engineering, Monash University, Australia

- Description: A cable driven glove actuated with pneumatic actuators
- Functions: Hand motion assistance
- Merits on performance: High adaptability, motion smoothness, and user safety to the system;  On design: Light
- What we have done: Design, fabrication, modeling, testing
- Conclusion and Future work

# TuB2: VR/AR

Chair: Yantao Shen     Co-chair: Zhongliang Jiang
Sunflower Room     Tuesday, 07-Jun-2016, 11:00-12:00

$11:00 \sim 11:12$

### Compliance Control Based on PSO Approach for Physical Human-Robot Interaction

Jiang Zhongliang, Sun Yu, Lei Long
Harbin Institutes of Techology Shenhen Graduate School, China
Hu Ying, Chenyu Xiao
Human-Machine Intelligence-Synergy Systems, CAS, China
Jianwei Zhang
University of Hamburg

- Safe way of human-robot interaction of surgical robot;
- Building physical model of controller by watching details of cat's legs;
- Particle Swarm Optimization (PSO) is used to obtain suitable parameters of system;
- Verification of system stability by root-locus method.
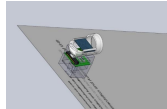
Structure of RSSSII

$11:12 \sim 11:24$

### Finger-Eye: A Wearable Text Reading Assisitive System for the Blind and Visually Impaired

Zhiming Liu, Yudong Luo, Jose Cordero, Na Zhao, and Yantao Shen*
Dept. of Electrical and Biomedical Engr., University of Nevada, Reno, USA

- Finger-Eye, a portable and refreshable text reading system for BVI, is being developed.
- The fingertip-electrode interface of the current Electrotactile Braille Display is developed.
- A new OCR prototype method based on computer vision is developed for text reading.
- Experiments show that our system can run fast and reliable for OCR to generate E-Braille code.
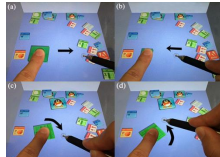
3-D Finger-Eye model: The fingertip-electrode interface with a camera added for optical feedback

$11:24 \sim 11:36$

### The Design and Research of 3D Desktop Interface based on the Pen + Touch

Jibin Yin and Yang Gao
Kunming University of Science and Technology, China

- we present a virtual 3D desktop which integrates physics and bimanual input commands based on pen + touch. Objects on the desktop own physical properties, such as mass, dimensions, gravity etc. And they can be dragged casually and collide other objects under the effect of physical properties, just like we manipulate objects in the real word.
- We have designed a series of interaction techniques based on pen + touch input to support the desktop organization by observing people's operation behaviors in the real word.
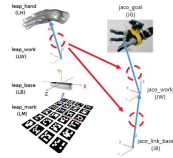
Performing icons by "pen+touch" inputs in 3D desktop interfaces

$11:36 \sim 11:48$

### The Implementation of Augmented Reality in a Robotic Teleoperation System

Yuan Lin and Shuang Song
School of Mechanical Engineering and Automation, HITSZ, China
Max Q.-H. Meng
The Department of Electric Engineering, CUHK, China

- Implemented AR for providing more intuitive and natural user interface.
- Display reconstructed remote scene at local station in an interactive way.
- Automatically generate manipulator control command based on interaction between user and virtual content in real-time.
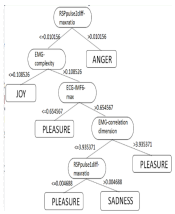
$11:48 \sim 12:00$

### Emotion Recognition based on the multiple physiological signals

Ping Gong, Heather.T Ma, Yutong Wang
ShenZhen Grasuate School, Harbin Institute of Technology, China

- This paper focus on emotion recognition based on the physiological signals
- We used mutiple features to identify the different emotions
- We obtained the better result with less features in emotional recognition

# TuB3: Game Theory/Sensor Fusion

Chair: Hongbing Dong     Co-chair: Qijun Chen
Apsara Room     Tuesday, 07-Jun-2016, 11:00-12:00

$11:00 \sim 11:12$

### Bidding Strategy in Continuous Double Auction Market Based on Fuzzy Cognitive Map

Haijun Luan, and Hongbin Dong
Department of Computer Science and Technology,
Harbin Engineering University, China
Qi Feng
National Natural Science Foundation of China, China
Yue Pan
Systems Engineering Research Institute, China

- We design and analyze a new bidding strategy based on Fuzzy Cognitive Map (Fuzzy Cognitive Map bidding strategy, FCMBS), and build a model for Seller Agents with certain emotions based on FCMBS bidding strategy.
- Experimental results show that agents adopting the FCMBS bidding strategy were superior to the other strategies in terms of trading success rate and profit.



Figure 1. FCM model of seller agent i

$11:12 \sim 11:24$

### A Task Allocation Algorithm Based on Market Mechanism for Multiple Robot Systems

Zhongya Wang, Min Li and Jie Li
School of Mechatronic Engineering and Automation
Shanghai University, China
Jinge Cao, Hanqing Wang

- This paper is used to feed animals for multi-robot systems.
- Bid function is optimized by the proposed task intensity with time urgency is taken into consideration.
- Simulation and experiment verify efficiency of the proposed algorithm.



Flow diagram of market mechanism

$11:24 \sim 11:36$

### A fusion-based Localization Method of Mobile Robot With Equality Geometric Constraint

Zhongli Wang, Xian Wu, Baigen Cai
School of Electronic Information and Engineering, Beijing Jiaotong Univ. China
Chuanqi Tao, Zhiyi Zhang, Yinling Wang
CNR Qingao Sifang Co. Ltd. Qingdao 266111, China

- Localization based on the fusion GNSS+ODO are discussed in details.
- Based on the framework of EKF, the fusion method with linear and nonlinear equality constraints are probed respectively.
- Simulation and real outdoor environment experiments have been conducted, which show the accuracy improvements of localization



$11:36 \sim 11:48$

### A Wearable Multi-modal Human Performance Monitoring System for Video Display Terminal Users: Concept, Development and Clinical Data Validation

Yudong Luo, Na Zhao and Yantao Shen*
Dept. of Electrical and Biomedical Engr., University of Nevada, Reno, USA

- A wearable monitoring system helps UDT user away from vision syndrome and related illness.
- Demonstrated the real time wearable fatigue measurement system and its user interface.
- Developed an efficient algorithm to estimate the human performance from multi-physiological signals.
- Verified the proposed new assessment method using the physiological data of 25 subjects.



A smart wearable system can monitor human performance, relieve fatigue and prevent the related syndrome in the real time

$11:48 \sim 12:00$

### Defects Detecting of Gloves Based on Machine Vision

Xu Sun
College of Electronic and Information Engineering, Tongji University, China
Qijun Chen
College of Electronic and Information Engineering, Tongji University, China

- A new attempt to do defects detecting on soft products with arbitrary shape.
- Visual tracking with Kalman filter and find Contours with Canny algorithm.
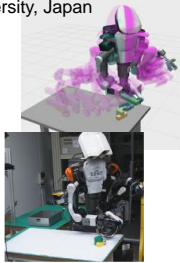- Detect oil on gloves in HSV color space.

# TuC1: Planning

Chair: Weiwei Wan    Co-chair: Haoyao Chen
Sunflower Room    Tuesday, 07-Jun-2016, 14:40-15:40

$14:40 \sim 14:52$

### Integrated Single-arm Assembly and Manipulation Planning using Dynamic Regrasp Graphs

Weiwei Wan, National Inst. of AIST, Japan
Kensuke Harada, Osaka University, Japan

- An integrated single-arm assembly and motion planning algorithm is developed to recursively find how to assemble two objects
- A plenary table surface is used as the supporting fixture for regrasp.
- The algorithm is complete. It is ready to be integrated with force control to perform real-world assembly tasks.
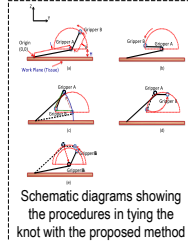- Real-world implementation using HIRO.

$14:52 \sim 15:04$

### Dynamic Trajectory Planning for Robotic Knot Tying

Bo Lu, Henry K. Chu, and Li Cheng
Department of Mechanical Engineering
The Hong Kong Polytechnic University
Hong Hum, Hong Kong

- A new trajectory-based method for enhancing the quality of knot tying is proposed.
- Two grippers are attached to a robotic system to dynamically tie a surgical knot.
- The suture between two grippers is kept in tension to prevent its slippage during the manipulation of the two grippers.
- Experiments were conducted to confirm the feasibility and reliability of this proposed method for surgical knotting.
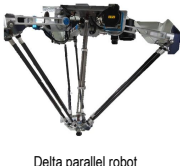
Schematic diagrams showing the procedures in tying the knot with the proposed method

$15:04 \sim 15:16$

### Smooth and Multi-Objective Optimal Motion Planning for Delta Robot

Yalan Zhao and Yunjiang Lou
Mechatronics Engineering and Automation,
Harbin Institute of Technology Shenzhen Graduate School, China

- The motion is smooth by using the fifth-order B-spline profile.
- A simple method of obstacle avoidance is based on the convex hull property of B-spline.
- Time, energy and maximum jerk are taken as optimal performance indices and robot constraints are considered.
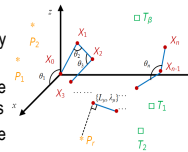- NSGA-II is used to solve the multi-objective optimization problem with nonlinear constraints.

Delta parallel robot

$15:16 \sim 15:28$

### •A Novel Model for Robots to Avoid Obstacles based on Tensor Analysis and Differential Geometry

Shaokun Jin, Yongsheng Ou, Xinyu Wu and Wei Feng
Shenzhen Institutes of Advanced Technology, CAS, China

- A novel method for the manipulator to avoid obstacles meanwhile planning the path.
- DMP is utilized, which generates motions by means of non-autonomous dynamical system.
- The collisions between the links and the obstacles are computed through tensor analysis
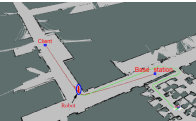- Path planning depends on a curve whose curvature declines gradually.

$15:28 \sim 15:40$

### Autonomous WiFi-Relay Control with Mobile Robots

Yajun Gao, Haoyao Chen, Yanjie Li, Yunhui Liu
School of Mechanical Engineering and Automation,
Harbin Institute of Technology Shenzhen Graduate School, China

- Two models are used to estimate WiFi signal strength depending on different cases.
- An autonomous WiFi-relay control framework is developed.
- A visual-laser SLAM approach is utilized to build the environmental map.
- RRT-based path planning and D* method are used to realize autonomous navigation of relay robot

Network optimization experiment results

# TuC2: Real-time System

Chair: Wenzheng Chi     Co-chair: Tan-Sy Nguyen
Apsara Room     Tuesday, 07-Jun-2016, 14:40-15:40

$14:40 \sim 14:52$

## Real-time Implementation of Panoramic Mosaic Camera based on FPGA

Weiguo Zhou
Harbin Institute of Technology Shenzhen Graduate School, China.
Yunhui Liu
The Chinese University of Hong Kong, Hong Kong
Congyi Lyu, Weihua Zhou, Jianqing Peng, Ruijia Yang, Haiyang Shang

- Image mosaic algorithm comprised of image registration and image fusion.
- Median filter algorithm, color filter algorithm, image enhancement algorithm.
- Xilinx Zynq-7020 FPGA employed as the processing platform.
- Achieve Panoramic image Mosaicing at more than 60 fps freely.



$14:52 \sim 15:04$

## Experimental Study of Trilateration Algorithms for Ultrasound-based Positioning System on QNX-RTOS

Tan-Sy Nguyen and Thai-Hoang Huynh
Department of Automatic Control,
Ho Chi Minh University of Technology, Viet Nam

- An indoor localization system to determine the position of a target in 3D environment using RF and Ultrasound is presented.
- Distances are calculated using TDoA principle, then trilateration algorithms LLS,NLS, CMD and CFD are applied to determine the target position
- Programs of positioning algorithms are developed based on QNX Neutrino RTOS and implemented on real hardware to verify system operation and compare the accuracy



$15:04 \sim 15:16$

## Obstacle Detection Model Implementation Based on Information Fusion of Ultrasonic and Vision

Jimin Wang and Qijun Chen
Department of Control Science and Engineering, Tongji University, China

- Obstacle detection model implementation.
- Ultrasonic model with the ring buffer.
- Vision model with memory function.
- Fusion data from different model, get a more accurate result.



$15:16 \sim 15:28$

## Pose Measurement of a Non-Cooperative Spacecraft Based on Circular Features

Yang Liu, Zongwu Xie, Bin Wang and Hong Liu
State Key Laboratory of Robotics and System,
Harbin Institute of Technology, Harbin, 150001, China

- Pose measurement using two ellipses formed by the adapter ring of non-cooperative satellite.
- A closed-form solution of pose measurement for circle features.
- Have the minimum possible solutions.
- Experimented on both synthetic and real images in comparison with other algorithms.



The stereo vision system of pose measurement

$15:28 \sim 15:40$

## A Human-friendly Robot Navigation Algorithm using the Risk-RRT approach

W. Chi and M. Meng
Department of Electronic Engineering, CUHK, Hong Kong
H. Kono, Y. Tamura, A. Yamashita and H. Asama
Department of Precision Engineering, U-Tokyo, Japan

- A 2-D pedestrian discomfort function with respect to the environmental and personal coefficients.
- A Comfort and Collision Risk (CCR) map combining the comfort risk of pedestrians and collision risk with the static barriers.
- A human-friendly robot navigation method that ensures both the pedestrian comfort and navigation feasibility.



Fig. 1 An illustration of the CCR map with three pedestrians.

# TuD1: Innovative Design-I

Chair: Jianjun Yuan    Co-chair: Xiaochun Mai
Sunflower Room    Tuesday, 07-Jun-2016, 16:00-17:00

16 : 00 ∼ 16 : 12

### Innovative Design of Palletizing System for China's Local Industries

Jianjun Yuan, Member IEEE, and Chunxiang Wang
Robotics Institute, Shanghai Jiao Tong University, China

- Proposed a new type of integrated palletizing system, dual-line high level palletizer and palletizing robot.
- Design discussion and optimization of dual-line high level palletizer, palletizing robot, and its gripper.
- Detailed mechanical structure and implementation.
- Experiment and real demonstration in exhibition.
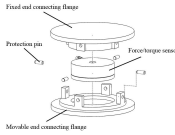

The Palletizing Robot in Exhibition

16 : 12 ∼ 16 : 24

### Design of an Overload Protection Device for Six-axis Force/torque Sensors

Shaokui Weng, Zeyang Xia*, Hao Deng, Yangzhou Gan, and Jing Xiong
Shenzhen Institutes of Advance Technology, Chinese Academy of Sciences, China

- This study developed an overload protection device for six-axis force/torque sensor;
- An application software for the calculation of the key dimensions of the device was designed;
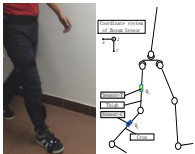- An demonstration application on an end effector was conducted.


An overload protection device

16 : 24 ∼ 16 : 36

### Development of Lower Limb Motion Detection Based on LPMS

Tongyang Sun, Zhijiang Lu and Weiguang Li
South China University of Technology, Guangdong, China
Chunbao Wang and Jian Qin
The First Affliated Hospital, Sun Yat-sen University, Guangdong, China
Quanquan Liu, Lihong Duan, Meng Li and Qihong Liu
Shenzhen Institute of Geriatrics, Guangdong, China
Pengfang Chen, Yajing Shen, Meng Li, Qing Shi, Yulong Wang, Jianjun Wei, Zhengzhi Wu

- A method to detect lower limb motion based on inertial sensor was proposed.
- Quaternion was applied to the attitude expression and calculation.
- The simplified lower limb model experiment was conducted and the result was shown.


Motion detection experiment

16 : 36 ∼ 16 : 48

### A semi-Markov Decision Process Based Power Management for Mobile Devices

Mengxi Zhang, Yanjie Li and Haoyao Chen
School of Mechanical Engineering and Automation,
Harbin Institute of Technology Shenzhen Graduate School, China

- A global power management for mobile devices based on SMDP
- Extending about 53% of usage time and increasing about 51% of total experience in comparison with a fixed policy
- Less state number and computation time
- The model can be applied to other power hunger components.

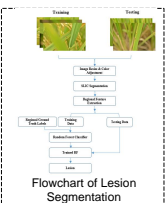| Evaluating Criterions | Fixed policy | Optimal policy |
|---|---|---|
| Usage time (min) | 496 | 760 |
| Total experience | 35724 | 53854 |
| Average experience | 12 | 11.8040 |
| Average GPS experience | 6 | 5.95282 |
| Average LCD experience | 6 | 5.8512 |

Comparison between Fixed policy and Optimal policy

16 : 48 ∼ 17 : 00

### Automatic Lesion Segmentation from Rice Leaf Blast Field Images based on Random Forest

Xiaochun Mai and Max Q.-H. Meng
Department of Electronic Engineering, The Chinese University of Hong Kong

- It is a challenging problem to automatically segment lesion from field images.
- We propose an automatic lesion segmentation method based on superpixel segmentation and random forest classifier.
- 2 datasets collected at different time are used to test the method.
- Superpixel classification performance and lesion segmentation performance is good.


Flowchart of Lesion Segmentation

# TuD2: Parallel Computing

Chair: Peng Yin    Co-chair: Xiao Jia

Apsara Room    Tuesday, 07-Jun-2016, 16:00-17:00

$16:00 \sim 16:12$

### GPU-based Heuristic Escape for Outdoor Large Scale Registration

Peng Yin*, Feng Gu, Decai Li, Yuqing He*, Liying Yang and Jianda Han*

Shenyang Institute of Automation, Chinese Academy of Sciences, China

- A new registration algorithm is proposed based on the coarse-to-fine multi-resolution scheme and a new introduced heuristic local minimum escape method.
- Experiments of the new proposed algorithm is conducted with respect to the environmental point cloud information fusion of an air robot and a surface robot.



$16:12 \sim 16:24$

### GI Bleeding Detection in Wireless Capsule Endoscopy Images Based on Pattern Recognition and A MapReduce Framework

Xiao Jia, Lipeng Cai, Jing Liu, Wenxuan Dai, and Max Q.-H. Meng

Department of Electronic Engineering, The Chinese University of Hong Kong, Hong Kong

- An automated bleeding detection strategy, achieving up to 0.9804 classification accuracy and 0.8498 segmentation precision.
- A distributed machine learning system to handle large WCE datasets.
- A tradeoff between the diagnostic accuracy and processing efficiency.



An overview of the proposed method for bleeding detection.

$16:24 \sim 16:36$

### High-speed Target Tracking base on FPGA

Congyi Lyu[1,2], Yunhui Liu[1], Weiguo Zhou[3], Jianqing Peng[3], Shanshan Yang[3], Huijun Zhang[3] and Linsen Yang[3]

1. The Department of Mechanical and Automation Engineering, The Chinese University of Hong Kong, Hong Kong.

2. School of Mechatronical Engineering, Beijing Institute of Technology, Beijing, China.

3. School of Mechatronical Engineering, Harbin Institute of Technology Shenzhen graduate school, Shenzhen, China.

- This paper present a high speed ball target tracking system based on FPGA.
- The color and corner features can be extracted by a image processing FPGA module.
- The experiments result showed the efficiency and robustness of our proposed tracking system.



FPGA base image features extraction

$16:36 \sim 16:48$

### FPGA-Based Parallel Hardware Architecture For SIFT Algorithm

J.Q. Peng, Y.H. Liu, Fellow, IEEE , C.Y. Lyu, Y.H. Li , W.G. Zhou and K. Fan

Harbin Institute of Technology Shenzhen Graduate School, China

- Overview of the parallel hardware system.
- A brief introduction to sift algorithm.
- A parallel hardware architecture for sift algorithm in real-time.
- Performance comparison(include computation time and keypoints)



$16:48 \sim 17:00$

### Towards Migrating Resource-Consuming Robotic Software Packages to Cloud

Shangmin Wen, Bo Ding, Huaimin Wang, Ben Hu, Hui Liu and Peichang Shi

College of Computer, National University of Defense Technology, China

- A cloud platform which supports the direct deployment of ROS software packages
- Quality of service can be assured even if multiple robots access a highly resource-consuming cloud service
- Three key mechanisms: *Cloud Bridging, On-demand Instantiation* and *Container-Based Isolation*

# TuE1: Calibration

Chair: Chun-Yi Su    Co-chair: Ying Nie
Sunflower Room    Tuesday, 07-Jun-2016, 17:10-17:58

$17:10 \sim 17:22$

## A Novel Calibration Method for the Photometric Stereo System with Non-Isotropic LED Lamps

Ying Nie, Zhan Song, *Ming Ji and Lei Zhu*

Shenzhen Institutes of Advanced Technology, CAS & CUHK
Xi'an Institute of Applied Optics

- A photometric stereo system composed with nonisotropic light source was investigated.
- A multiple-sphere-based approach is proposed for the calibration of light source position;
- A reference-plane-based method is presented for the calibration of principle light direction.
- Radiance model of light source is considered for the accurate description of lighting field.
- Accurate 3D reconstruction can be obtained in comparison with conventional light models.
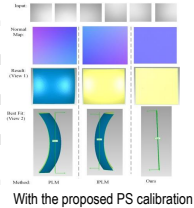
With the proposed PS calibration method, high accuracy 3D reconstruction can be realized.

$17:22 \sim 17:34$

## Kinematics Modeling of Geomagic Touch X Haptic Device based on Adaptive Parameter Identification

Yiming Jiang, Chenguang Yang, Xingjian Wang and Chun-Yi Su
College of Automation Science and Engineering,
South China University of Technology, China

- Structure analysis and kinematics modeling for Geomagic Touch X haptic device
- D-H parameters identification by an adaptive finite-time estimation
- Parameters estimation and experimental verification
- Visualized kinematics model and workspace identification
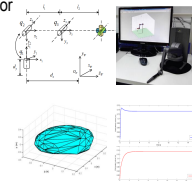
$17:34 \sim 17:46$

## A Geometric Model for Fusing IMU into Monocular Visual Localization of 3-D Mobile Robots

Fan Zheng and Yunhui Liu
Department of Mechanical and Automation Engineering,
The Chinese University of Hong Kong, Hong Kong, China

- Design of nominal error vectors fusing geometric information of IMU-Camera system as estimator feedback
- An estimation algorithm to estimate robot state and feature points without true measurements
- Theoretical proof and simulation validate the convergence of the algorithm using the model

Estimated trajectory
in the simulation
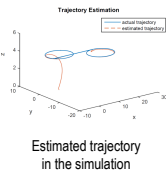
$17:46 \sim 17:58$

## Estimating the DOA and polarization parameters with sparse collocated loop and dipole cross array

Guibao Wang, Feng Zhao and Xiang Liu
School of Physics and Telecommunication Engineering, Shaanxi University of Technology, P. R. China

- Based on the rotational invariance relation, the polarization parameter is obtained.
- The virtual short baselines are obtained, the unambiguous estimates of DOA are achieved.
- The precise but ambiguous estimates of DOA are got by using the long baseline of actual array elements.
- Using virtual baseline method, ambiguities can be disambiguated, the high-precision estimations of DOA are acquired.
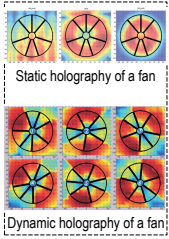
Structure of uniform cross array
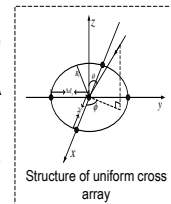
# TuE2: Novel sensor

Chair: Hailin Huang    Co-chair: Martin Kefer
Apsara Room    Tuesday, 07-Jun-2016, 17:10-17:58

$17:10 \sim 17:22$

### Acoustic Holography – A Robot Application

Martin Kefer and Qi Lu
Corporate Research, ABB China (Ltd.), China

- Implementation of laboratory acoustic measurements using a robot arm
- Visualization of acoustic behavior of air-moving objects, such as a fan

  Static holography of a fan
- 2 aspects: static sound pressure and dynamic sound pressure

- High flexibility for acoustic laboratory measurements
- High reliability due to small number of sensors
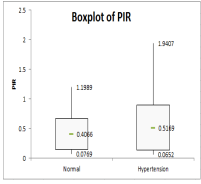
  Dynamic holography of a fan

$17:22 \sim 17:34$

### A Study of Photoplethysmography Intensity Ratio in Hypertension

Yang Chen, Ye Zhu, Heather T.ma and Hailin Huang
ShenZhen Graduate School, Harbin Institute of Technology, China

- The PIR, a new indicator which was strongly correlated with the vascular tone function.
- This study investigate the PIR characteristics between normal control subjects and patients in hypertension.
- The results demonstrate that PIR is strongly associated with BP, which has the potential to provide a possible way for early hypertension prediction.
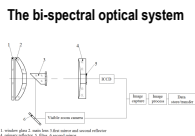
  Boxplot of PIR

$17:34 \sim 17:46$

### IEEE RCAR 2016 Digest Template
### An Optical System in Solar-Blind UV for Corona Discharge

Jiao Guohua,Zhang Yizhou,Dong Yuming,Lu Yuanfu,Lv Jiancheng
Center for Optpelectronic Engineering Technology,Shenzhen Institutes of Advanced Technology Chinese Academy of Sciences,China

- A bi-spectral camera was developed for detecting the corona discharge.
- A new method used to solve in calibration of non-central of FOV in fusion image.
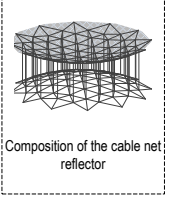- an optical system was designed for the UV band.

  The bi-spectral optical system

$17:46 \sim 17:58$

### Nonlinear Static Analysis of Cable Net for Deployable Antennas

Xiaozhi Qi, Zhao Zhang, Bing Li, Hailin Huang
Harbin Institute of Technology Shenzhen Graduate School, P.R. China
Shuang Liu
School of Mechanical and Power Engineering, East China University of Science and Technology, P. R. China

- A novel deployable cable net antenna supporting mechanism is presented.
- Detailed nonlinear static mechanic performance of the proposed mechanism is analyzed.
- The finite element static model of the cable net structure based on the principle of minimum potential energy is created.
- The effects of different conditions on the cable structural stiffness are also presented

  Composition of the cable net reflector

# WeA1: Special session

Chair: Guanrong Chen     Co-chair: Lianqing Liu
Royal Ballroom     Wednesday, 08-Jun-2016, 9:40-10:40

09 : 40 ∼ 09 : 52

### On Possibilities of Evolutionary Synthesis of Robot Control Sequences

Ivan Zelinka
Faculty of Electrical Engineering and Computer Science, Department of Computer Science and IT4Innovations National Supercomputing Center, VSB-Technical University of Ostrava, Czech Republic

- Bio-inspired computation, based on Darwinian evolution and Mendelian inheritance, can be used for complex structure synthesis.
- Those structures can be understand as a control command sequences.
- An alternative way for swarm robotics exist also. It is based on mutual joining of evolutionary dynamics + complex networks + CML systems.

Control command sequence

09 : 52 ∼ 10 : 04
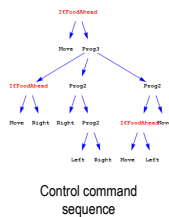
### Finite-Time Formation Tracking Control of Multi-Robot Teams

Guanrong Chen
Department of Electronic Engineering
City University of Hong Kong, China

10 : 04 ∼ 10 : 16

### Tree Robot: an Innovation for STEAM Education

P. Sooraksa, S. Sakorntanunt, A. Jansri and K. Klomkarn
Department of Computer Engineering, KMITL, THAILAND

- Science: Mechanism and structure of trees.
- Technology: Multimedia and robotics.
- Engineering: Informatively intelligent control.
- Art and Mathematics: Minimalist, Ulam numbers and golden ratio.

10 : 16 ∼ 10 : 28

### A Simple Chaotic Drawing Robot: STEAM 2.0

Kitdakorn Klomkarn and Pitikhate Sooraksa
Department of Computer Engineering, Faculty of Engineering, KMITL, Bangkok, 10520 Thailand

- Science: phenomenon from Chua's circuit.
- Technology: Application in Cleaning robot .
- Engineering: Chua's circuit design.
- Art: Chaotic drawing robot.
- Mathematics:Simmulation nonlinear
- differential equation by MATLAB.
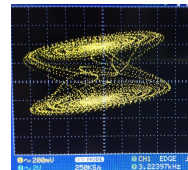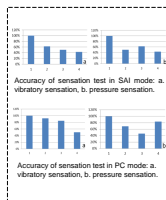
Two scroll from Chua's circuit

10 : 28 ∼ 10 : 40

### The Quantitative Evaluation of Electrotactile Stimulation Mode

Kai He, Peng Yu, Mi Li, Yang Yang, Lianqing Liu
State Key Laboratory of Robotics, Shenyang Institute of Automation, Chinese Academy of Sciences (CAS), China

- experiments of tactile feeling recognition in a trial-and-error way.
- Set up the evaluation function based on the physiological character of cutaneous receptor.
- SAI mode is the best stimulation mode for Meissner's corpuscle.
- PC mode is the best stimulation mode for Merkel's disk.

Accuracy of sensation test in SAI mode: a. vibratory sensation, b. pressure sensation.

Accuracy of sensation test in PC mode: a. vibratory sensation, b. pressure sensation.

# WeA2: Recognition

Chair: Qinghai Liao    Co-chair: Gaoqiang Yang
Sunflower Room    Wednesday, 08-Jun-2016, 9:40-10:40

$09:40 \sim 09:52$

### Face Recognition By Combining Cauchy Estimator and Discriminant Analysis

Xipeng Yang
State Key Laboratory of Digital Publishing Technology, China
Jun Cheng and Wei Feng
Shenzhen Institutes of Advanced Technology, China
Hong Liang, Zhengyao Bai, and Dapeng Tao
School of Information Science and Engineering, Yunnan University, China

- Based on Cauchy estimator theory, we proposed a novelty dimensional reduction algorithm termed CEDA.
- CEDA preserves both local and global geometric information of the input samples.
- CEDA overcomes the large errors caused by samples that are easy to confuse.

$09:52 \sim 10:04$
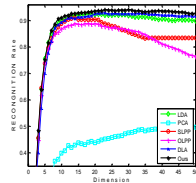
### Environment Feature Recognition Algorithm for Rescue Robot Based on a 2D Laser Radar

Xizhe Zang, *Member, IEEE*, *Can Zhang,* Yixiang Liu, and Jie Zhao, *Member, IEEE*
State Key Laboratory of Robotics and System, Harbin Institute of Technology, China

- Introduction
- The Structure of Rescue Robot Platform and the Control System Design
- Main Processes of the Environment Feature Recognition Algorithm
- Experiment Platform , Experiment Environment , Parameter Setting and the Experimental Result

Overview of the rescue robot platform

$10:04 \sim 10:16$

### A Flexible Object Tracking System for Planary Motion

Qinghai Liao, Wencong Zhang, Peng Shi, Ming Liu
Department of Mechanical and Biomedical Engineering
City University of Hong Kong, China

- Arbitrarily mounting and tracking
- Accurate mathematical model.
- Automatic parameters calibration and inverse kinematic.
- High efficiency and low coupling.

$10:16 \sim 10:28$
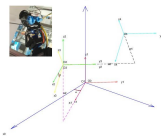
### Facial Expression Recognition with PCA and LBP Features Extracting from Active Facial Patches

Yanpeng Yanpeng Liu[a], Yuwen Cao[a], Yibin Li[a], Ming Liu[d], Rui Song[a],Yafang Wang[b], Zhigang Xu[c] , Xin Ma[a]†
[a,b,c] School of {Control Science and Engineering, Life Sciences, Computer Science and Technology},Shandong University, China
[d] Department of Mechanical and Biomedical Engineering, City University of Hong Kong, HK

- This paper proposes an algorithm based on the combination of gray pixel value and LBP features.
- Principal component analysis (PCA) is used to reduce dimensions of the features.
- The paper uses extended Cohn-Kanade (CK+) database to validate the algorithm.
- Softmax regression classifier is used to classify the six basic facial expressions

TABLE I    RESULT OF CONTRAST EXPRIMENTS

| Facial expressions | Classification Result | | | |
|---|---|---|---|---|
| | Exp. one | Exp. two | Exp. three | Exp. four |
| Anger | 0.744 | 0.844 | 0.856 | 0.956 |
| Disgust | 0.839 | 0.932 | 0.949 | 0.966 |
| Fear | 0.780 | 0.840 | 0.800 | 0.920 |
| Happy | 0.986 | 0.986 | 0.993 | 1.000 |
| Sad | 0.732 | 0.696 | 0.875 | 0.857 |
| Surprise | 0.934 | 0.940 | 0.970 | 0.982 |
| Average | 0.869 | 0.905 | 0.932 | 0.963 |

$10:28 \sim 10:40$

### A New Algorithm For Obstacle Segmentation in Dynamic Environments Using a RGB-D Sensor

Gaoqiang Yang, Fucai Chen, Wen chen and Mu Fang
VisionNav Robotics Limited, HongKong
Yun-Hui Liu and Luyang Li
Department of Mechanical and Automation Engineering, CUHK, HongKong

- Detect obstacles using a RGB-D sensor in dynamic environments.
- Segment the moving objects from the background with a patch of images.
- Discriminate between the moving obstacles and the static obstacles.
- Construct the 2D obstacles occupancy map based on the obstacle information.
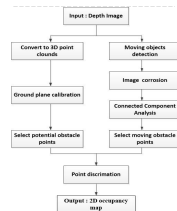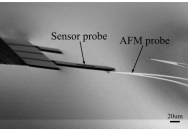
# WeA3: Micro/Nano Robotics

Chair: Hao Yang     Co-chair: Xiongheng Bian
Apsara Room     Wednesday, 08-Jun-2016, 9:40-10:40

09 : 40 ∼ 09 : 52

### Biomechanical analysis of yeast cell based a piezoresistive cantilever sensor

Wenkui Xu, Liguo Chen, Haibo Huang*, Leilei Zhang, Xiangpeng Li, Yadi Li, Lining Sun
Robotics and Microsystems Center, College of Mechanical and Electrical Engineering & Collaborative Innovation Center of Suzhou Nano Science and Technology, Soochow University, China

- Measuring quantitatively Young's Modulus of a single yeast cell.
- For calibrating a piezoresistive cantilever's elastic coefficient in SEM.
- Analyzing the force curves by applying Hertz-Sneddon model allows the extraction of yeast cell Young's Modulus.
- Young's Modulus is 2.9 ± 2.2Mpa
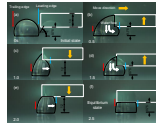


Calibrating elastic coefficient of probe in SEM

09 : 52 ∼ 10 : 04

### Behavior of a Water Drop Moving Inside Parallel Plates

Xiongheng Bian, Haibo Huang, Liguo Chen
Robotics & Microsystem Center &Collaborative Innovation Center of SuZhou Nano Science and Technology,Soochow University Suzhou,China

- Used in **digital microfluidic** experiment to reduce driving voltage.
- **Droplet** moving from single-plate structure (open part) into **parallel-plates** structure (covered part) .
- Physical mechanism analysis.
- Repeatedly **relaxing and squeezing** the drop.
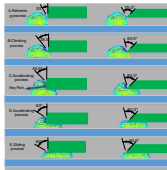


10 : 04 ∼ 10 : 16

### Simulation About The Factor of Droplet Move Inward Parallel Plates with Smoothed Particle Hydrodynamics

Xiongheng Bian and Haibo Huang and Liguo Chen
Robotics & Microsystem Center &Collaborative Innovation Center of SuZhou Nano Science and Technology, Soochow University

- Droplet Move Inward Parallel Plates.
- Simulation about based on Smoothed Particle Hydrodynamics method.
- Different heights of the gap and different shapes of the upper plate.
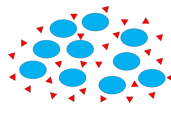- Verified by compared the droplet's position and moving speed.



10 : 16 ∼ 10 : 28

### A Congestion Avoidance Algorithm Based on Quorum Sensing for Nanorobot Navigation in Blood Vessels

Qingying Zhao, Min Li and Jun Luo
School of Mechatronic Engineering and Automation, Shanghai University, China

- This paper presents a quorum sensing algorithm to coordinate nanorobots and avoid congestion in blood vessels.
- A method to determine the maximum value of nanorobots number in different vessels depending on vessel diameter is adopted.
- Simulations have been conducted to evaluate the effectiveness of the algorithm.
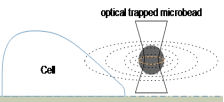


The amount of molecule increases in proportion to the number of nanorobots

10 : 28 ∼ 10 : 40

### Active Disturbance Rejection Control of Single Cell Migration Induced by Chemoattractant-loaded Microbead

Ke Meng and Yong Wang
Automation Department, University of Science and Technology of China, China
Hao Yang and Dong Sun
Mechanical and Biomedical Engineering Department, City University of Hong Kong, Hong Kong, China

- Cell migration is induced by an optically controlled chemoattractant-loaded microsource bead.
- An active disturbance rejection control strategy of cell migration is presented.
- The effectiveness of the proposed control strategy is verified by both simulation and experiments.

# WeB1: Computer Vision

Chair: Yadi Li    Co-chair: Xuebo Zhang
Royal Ballroom    Wednesday, 08-Jun-2016, 11:00-12:00

$11:00 \sim 11:12$

### An Adaptive Real-time Video Defogging Method Based on Context-Sensitiveness

Wei Song, Bangfei Deng, Haibing Zhang, Qianbo Xiao, Shudi Peng

State Grid Chongqing Electric Power CO.
Electric Power Research Institute

- An adaptive real-time video defogging method based on context-sensitiveness
- Improved guide filtering algorithm
- Improving the single-frame image defogging effect within a limited computation time
- Multi-strategy integration video defogging method

$11:12 \sim 11:24$

### Nighttime lane markings recognition based on Canny detection and Hough transform*

Yadi Li, Liguo Chen, Haibo Huang, Xiangpeng Li,,Wenkui Xu, Liang Zheng, Jiaqi Huang

School of Mechanical and Electric Engineering & Collaborative Innovation Center of Suzhou Nano Science and Technology, Soochow University, China

- A method proposed for the lane line detection which illuminated only by car light.
- The proposed algorithm can overcome the influence of uneven light and other disturbances.
- Experimental results have verified the effectiveness of the proposed algorithm.

Processing flow chart of lane line
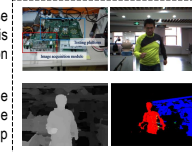
$11:24 \sim 11:36$

### Integration of a Stereo Matching Algorithm on Chip for Real-Time 3-D Sensing

Baowen Chen
Shenzhen Institute of Information Technology, China
Jun Jiang, Jun Cheng and Jie Chen
Shenzhen Institutes of Advanced Technology, CAS, China
The Chinese University of Hong Kong, China

- We use a color stereo pair to compute costs, and use the corresponding gray one as the guidance. This optimization can bypass the matrix inversion operation effectively with the edge-preserving property.
- We analyze the efficiency and performance for some most important algorithms. The analysis validates the optimized one is most suitable to be integrated on chip or in other size-aware systems.
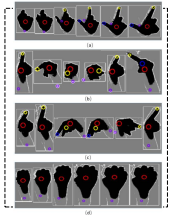- We provide a general design method for size-aware embedded systems.

The top is the prototyping system and the left input image, the bottom is the corresponding disparity map using our method and 3-D point clouds with a sub-pixel processing.

$11:36 \sim 11:48$

### Dynamic Hand Gesture Recognition Using HMM-BPNN Model

Lu Zhou, Zhang Li-Shuang, SUN Lei and Zhang Xue-Bo
Institute of Robotics and Automatic, Nankai University, China

- A new method combining Hidden Markov Model and BP Neutral Network.
- Solve the problem of dynamic hand gesture recognition.
- Hand gesture feature modeled with the method of HMM and BPNN as the classifier
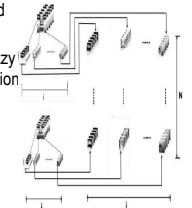- The results of simulation and experiment verify the feasibility of the proposed method.

$11:48 \sim 12:00$

### Emotion Recognition based on the multiple physiological signals

Mengting Chen, Heather T. Ma* Jie Li, Huanhuan Wang
ShenZhen Grasuate School, Harbin Institute of Technology, China

- This paper focus on emotion recognition based on the micro-expression sequences
- We employ weight of feature and weighted fuzzy classification to enhance the effective information in the micro-expression sequences
- Our method have superior performance and achieve very promising results in micro-expression recognition
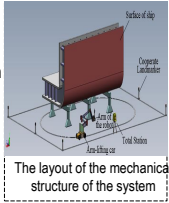
# WeB2: Localization

Chair: Zihang Meng     Co-chair: Chen Chen
Sunflower Room     Wednesday, 08-Jun-2016, 11:00-12:00

$11:00 \sim 11:12$

### IEEE RCAR 2016 Digest Template
### Research of Positioning Method for Automatic Spraying on Large Ship Block Surfaces

Zihang Meng and Changle Li
State Key Laboratory of Robotics and System, HIT, China
Ge Li，Jie Zhao and Jihong Yan
State Key Laboratory of Robotics and System, HIT, China

- This paper puts forward a positioning technology used for the ship block automatic spraying.
- The influence of the position of the total station on the positioning accuracy is analyzed.
- This conclusion is verified through the calibration in the experiment.
- The feasibility of this scheme applied to positioning of large curved surfaces is also demonstrated.

The layout of the mechanical structure of the system

$11:12 \sim 11:24$

### OBD Small Sample Acquisition and Processing Based on Improved Grey System Theory

Aiguo Zhou, Xiufeng Xu and Lang Yang
School of Mechanical and Energy Eng., Tongji University, China

- Design an acquisition system for vehicle real-time data based on OBD(On-Board Diagnosis).
- Process small samples of vehicle data with improved grey model.
- Alarm danger early according to current data or predicted tendency.
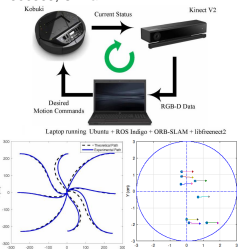- Hardware and process methods have been verified in a Buick Lacrosse.

OBD data collection hardware

$11:24 \sim 11:36$

### A Localization and Navigation Method with ORB-SLAM for Indoor Service Mobile Robots

S. Wang, Y. Li, Y. Sun, X. Li, N. Sun, X. Zhang, N. Yu*
Institute of Robotics and Automatic Information Systems
Tianjin Key Laboratory of Intelligent Robotics
Nankai University, Tianjin 300353, China

- We present an efficient, yet economic and simple solution for indoor autonomous robots.
- The system consists of a basic mobile platform, a Kinect V2 sensor and a computing unit.
- Within the ROS environment, the ORB-SLAM algorithm, pointcloud processing methods and a feedback controller have been developed and implemented for localization, obstacle detection and avoidance, and navigation.
- Experimental results demonstrated the efficacy of the system architecture and algorithms.

$11:36 \sim 11:48$

### Real-time Target Tracking and Positioning on FPGA

Chen Chen, Weiguo Zhou, Jianqing Peng, Xin Jiang, Peng Li
School of Mechanical Engineering and Automation, Harbin Institute of Technology Shenzhen Graduate School,China
Yunhui Liu
the Department of Mechanical and Automation Engineering, The Chinese University of Hong Kong, China
Congyi Lyu
Beijing Institute of Technology, China

- Target recognition module based on color of the target
- Target tracking module
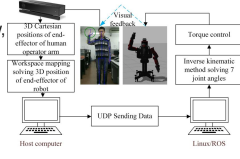- Monocular vision localization model module

$11:48 \sim 12:00$

### An Intuitive Human Robot Interface for Tele-operation

Lijun Zhao, Yihuan Liu, Ke Wang and Peidong Liang
State Key Lab of Robotics and Systems, Harbin Institute of Technology , China

- Robot tele-operation can be employed in many areas such as exploration, security, surgery and even entertainment .
- An intuitive human robot interface for real-time tele-operation are proposed.
- Workspace mapping and IK solver method are also discussed.
- Simulation on ROS and real robot platform experiment are carried out .

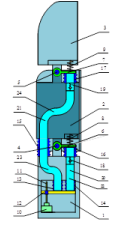The whole human robot interaction interface flaw diagram

# WeB3: Grasping

Chair: Caizhi Fan    Co-chair: Zonggao Mu
Apsara Room    Wednesday, 08-Jun-2016, 11:00-12:00

11 : 00 ∼ 11 : 12

### Coupled and Self-adaptive Fluid-actuated Finger for Flexible Pinch and Power Grasp

Jie Lin and Wenzeng Zhang
Department of Mechanical Engineering, Tsinghua University, China

- COSAF finger – A coupled and self-adaptive fluid-actuated robot finger for flexible pinch and power grasp.
- COSAF finger adopts fluid transmission mechanism with single-direction valves to achieve stable motions.
- The rotation speeds of two joints of the COSAF finger show a linear relationship which can be changed conveniently by changing the radiuses of flexible pipes.
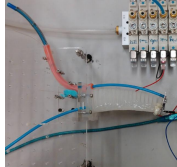
The structure of the COSAF finger

11 : 12 ∼ 11 : 24

### Soft Damper for Quick Stabilization of Soft Robotic Actuator

Feng Ni, Andreas Henning, Kai Tang and Lilong Cai
Department of Mechanical Engineering
Hong Kong University of Science and Technology
Hong Kong

- A soft damper is able to alleviate the oscillation during the rapid actuation of soft actuator.
- A soft damper utilizes compliant structure so that it can be seamlessly embedded into soft robotic system.
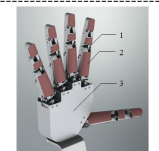- Low cost and off-the-shelf materials are used to develop and build soft damper.

Overview – soft damper embedded into soft robotic actuator.

11 : 24 ∼ 11 : 36

### Recognition of the three-dimensional shape of objects grasped for PESA multi-fingered robot hand

Zhihao Liao, Wenzeng Zhang, DahYun Kim, DaeYun IM, Kyomin Lim, Takeo Miyoshi
Department of Mechanical Engineering, Tsinghua University, China

- Recognize the general shape of the object using a distance sensors array on the palm.
- Recognize the size of the object using touching and angle sensors on the fingers.
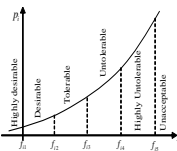- Combining the shape and the size to speculate what the object is.

1-angle sensor; 2-pressure sensor; 3-distance sensor.

11 : 36 ∼ 11 : 48

### Multi-Objective Motion Planning of Space Flexible Manipulator System

Yihuan Liao and Caizhi Fan
College of Aerospace Science and Engineering, National University of Defense Technology, China

- The multi-objective motion planning of a space flexible manipulator system is investigated.
- Physical Programming Method is used to convert the multi-objective optimization problem to a single-objective one.
- A hybrid optimization approach incorporating Gauss pseudospectral method with direct shooting method is proposed.
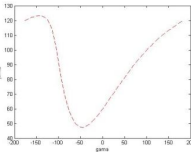
Preference function of Physical Programming Method

11 : 48 ∼ 12 : 00

### Fault Tolerance Kinematics and Trajectory Planning of a 6-DOF Space Manipulator under a Single Joint Failure

Zonggao Mu, Bing Zhang, Wenfu Xu, Bing Li
Shenzhen Graduate School, Harbin Institute of Technology, China
Bin Liang
Department of Automation, Tsinghua University, China

- the workspace of the manipulator for post-failure are analyzed based on the actual situation of joint failure.
- The analytical inverse kinematics equation of the 5-DOF formed from the 6-DOF manipulator with locking single joint is derived to ensure the completion of part tasks in the workspace.
- the concept of fault-tolerant angle is introduced. Then the relationship between the fault-tolerance angle and the locked joint is established.

The overall relationship between the angle rotating about the X-axis and joint 2 diagram
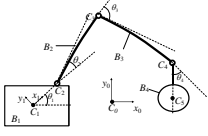
# WeC1: Manipulation

Chair: Hao Deng    Co-chair: Zeyang Xia
Royal Ballroom    Wednesday, 08-Jun-2016, 14:40-15:40

$14:40 \sim 14:52$

### Robust optimal motion planning for vibration reduction of free-floating flexible manipulator system

Caizhi Fan and Yihuan Liao
Institute of space technology, National University of Defense Technology, China

- This paper deals with the motion planning method for vibration reduction of a flexible manipulator with state uncertainty.
- A linear covariance method is applied to calculate the robust performance index.
- A hybrid optimization algorithm incorporating genetic algorithm (GA) and sequential quadratic programming algorithm (SQP) is proposed to solve the parameter optimization problem.
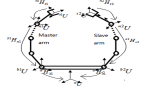


Simplified model of a free-floating flexible redundant manipulator

$14:52 \sim 15:04$

### Coordination Control Of Dual-Arm Robot Based On Modeled Predictive Control

Ming Jiang
College of Electronic,Communication and Physics, Shandong University of Science and Technology, Qingdao, 266590,China.
Ming-Qu Fan,Ai-Min Li
College of Electrical Engineering and Automation, Shandong University of Science and Technology, Qingdao, 266590,China.
Xue-Wen Rong,Hui Kong, Rui Song
School of Control Science and Engineering ,Shandong University, Jinan,250061,China.

- Coordination control of dual-arm robot based on modeled predictive control is proposed.
- The motion prediction model of the manipulator is established.
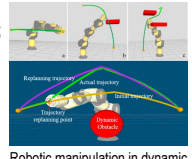- The slave arm can acquire the position and direction of the master arm synchronously .



Dual-arm coordinate systems and interrelationships

$15:04 \sim 15:16$

### Robotic Manipulation Planning Using Dynamic RRT

Hao Deng, Zeyang Xia, and Jing Xiong*
Shenzhen Institutes of Advance Technology, Chinese Academy of Sciences, China

- This study proposed a method to resolve manipulation planning in dynamic environment;
- A planner using dynamic RRT was designed;
- Global planning with local replanning strategy was adopted;
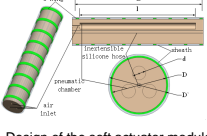- Experiments in 2D and high dimension planning space were conducted;



Robotic manipulation in dynamic environment

$15:16 \sim 15:28$

### A Three-chambed Soft Actuator Module with Omnidirectional Bending Motion

Jihong Yan; Hongbing Dong; Xinbin Zhang; Jie Zhao
State Key Laboratory of Robotics and System, Harbin Institute of Technology, China

- Design and fabrication of a three-chambed soft actuator module with omnidirectional bending motion.
- The effect of geometrical parameters on the module bending properties was investigated by FEM methods.
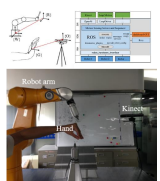- Preliminary tests as proof of concept and assessment of performances were implemented.



Design of the soft actuator module

$15:28 \sim 15:40$

### Motion Sensing Based Framework for Robot Manipulation

Hao Deng, Zeyang Xia*, Shaokui Weng, Yangzhou Gan, Peng Fang and Jing Xiong
Shenzhen Institutes of Advance Technology, Chinese Academy of Sciences, China

- This study proposed a user-friendly and straight-forward interaction mode on robot manipulation;
- A three-layer structured framework on ROS for motion sensing manipulation was designed;
- Hardware abstraction for motion sensing input devices and general manipulation commands were achieved;
- Experiments on physical robotic system were conducted.



Motion sensing-based framework

# WeC2: Rehabilitation Robot

Chair: Dingguo Zhang     Co-chair: Gao Huang
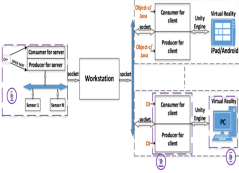Sunflower Room     Wednesday, 08-Jun-2016, 14:40-15:40

$14:40 \sim 14:52$

### Development of Lower Limb Rehabilitation Evaluation System Based on Virtual Reality Technology

ShiHui SHEN
Department of Mechanical and Biomedical Engineering
City University of Hong Kong, China
Chang Gao, Yong Zhao, Haojian Lu, Yajing Shen, Chunbao Wang, Tongyang Sun, Quanquan Liu, Qing Shi, Jianjun Long, Yulong Wang, Zhengzhi Wu, Jian Qin, Weiguang Li, Massimiliano Zecca, Atsuo Takanishi

- Introduce a rehabilitation evaluation system
- Addresses the principle of the motion tracking system
- Discuss the potential applications and long-term impacts

$14:52 \sim 15:04$

### Mechanism Design of an Ankle Robot MKA-III for Rehabilitation Training

Z.j. Lu[1], C.b. Wang [2], L.h. Duan [3], Q.q. Liu, T.y. Sun[1], Z.x. Lu, Y.j. Shen, Q. Shi, Y.l. Wang[4], J.j. Long[4], J.j. Wei, W.g. Li[1], A. Takanishi and Z.z. Wu[3]
1. South China University of Technology, Guangdong, China
2. The First Affliated Hospital, Sun Yat-sen University, Guangdong, China
3. Shenzhen Institute of Geriatrics, Guangdong, China
4. Shenzhen Second People's Hospital, Guangdong, China

- The concept of subjective awareness and objective training was proposed.
- An ankle rehabilitation robot MKA-III with three degrees for early rehabilitation of hemiplegia.
- Each part of the mechanism design was introduced in detail.
- Control strategies, position control, force control were proposed.
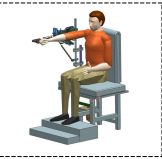
MKA-III

$15:04 \sim 15:16$

### Control of An Exoskeleton Robot for Upper Limb Rehabilitation

Lin Liu
Institute of Forming Technology & Equipment, Shanghai Jiao Tong University, China
Yunyong Shi
School of Biomedical Engineering, Shanghai Jiao Tong University, China
Le Xie
School of Biomedical Engineering, Shanghai Jiao Tong University, China

- A multi-DOF exoskeleton robot is proposed for upper limb rehabilitation.
- Robust control method is adopted for the robot.
- Simulation and experiment results are compared.

$15:16 \sim 15:28$

### A Master-slave Control System for Lower Limb Rehabilitation Robot with Pedal-actuated Exoskeleton

Gao Huang, Jiameng Fan, Weimin Zhang, Fei Meng and Qiang Huang
School of Mechatronical Engineering, Beijing Institute of Technology, China
Marco Ceccarelli
Robotics and Mechatronics, University of Cassino and South Latium, Italy
Tony Xiao
College of Engineering at University of Illinois, Urbana, USA

- A master-slave control system is proposed for elders and patients.
- The rehabilitation system can enable users to walk around and exercise simultaneously.
- A leg cycling wheelchair prototype is used to verify the feasibility of the proposed method.
- The experiments show the method can help users to walk around and exercise their legs simultaneously and effectively.
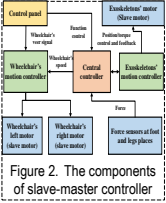
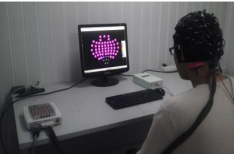Figure 2. The components of slave-master controller

$15:28 \sim 15:40$

### Effects of Transcranial Alternating Current Stimulation on Performance of SSVEP-based Brain-Computer Interface

Renquan Duan and Dingguo Zhang *
School of Mechanical Engineering, Shanghai Jiao Tong University, China
Email: dgzhang@sjtu.edu.cn

- Investigate the influence of Transcranial Alternating Current Stimulation (tACS) on the performance of SSVEP-based Brain-Computer Interface (BCI).
- We conduct the experiment on six healthy subjects in two groups, tACS group and sham (no tACS) group.
- The classification accuracy of BCI is improved significantly after intervention in tACS group, while there is no obvious change in sham group.

The experimental setup. The two electrodes (anode and cathode) of tACS are under the EEG cap (PO9 and PO10).
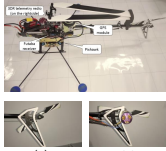
# WeC3: UAV

Chair: Chaoqun Wang     Co-chair: Hang Zhou
Apsara Room     Wednesday, 08-Jun-2016, 14:40-15:40

14 : 40 ∼ 14 : 52

### A Novel Direct Drive Tail for Miniature Flybarless Helicopters

Yuan Chang, Daibing Zhang and Tijiang Hu
College of Mechatronics and Automation, National University of Defense Technology, China

- The novel mechanism of direct drive tail employs a brushless motor mode.
- A nonlinear helicopter model based on first-principles is adopted for analysis.
- Control parameters are optimized by online testing and experience.
- Experiments demonstrate its advantage over torque tube tail for less vibration and prompter responses.



(a)          (b)
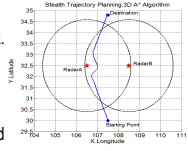
Replacement of a torque tube tail (a) with a direct drive tail (b)

14 : 52 ∼ 15 : 04

### A Fast Stealth Trajectory Planning algorithm for Stealth UAV to Fly in Multi-Radar Network

Zhe Zhao, Yifeng Niu, Zhaowei Ma, Xiaoting Ji
College of Mechatronic Engineering and Automation, National University of Defense Technology, China

- Individual RCS character of UAV must be considered when it flies in multi-radar network.
- Searching space with dynamic constrains of UAV can juggle computing speed and accessibility.
- Three times B-spline smooth algorithm is used to satisfy the differential constrains of trajectory.
- A simulation experiment is designed to verify the efficiency of our algorithm.



3D A* Stealth Trajectory Planning Algorithm

15 : 04 ∼ 15 : 16

### Variant Step Size RRT: An Efficient Path Planner for UAV in Complex Environments

Chaoqun Wang and Max Q.-H. Meng
Department of Electronic Engineering
The Chinese University of Hong Kong

- Proposed a RRT path planner with variant step size.
- Sample-saving method can save sampling time and can be used in replanning problems.
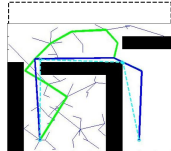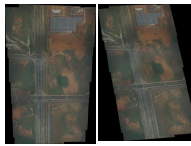- Post optimization algorithm without infinite sampling.



Fig.1 Path generation and optimization

15 : 16 ∼ 15 : 28

### Seamless stitching of large area UAV images using modified camera matrix

Hang Zhou, Dongxiang Zhou, Keju Peng, Ruibin Guo
JCISS, University of Defense Technology, China
Yunhui Liu
Department of Mechanical and Automation Engineering, The Chinese University of Hong Kong, China.

- Feature extraction and matching.
- Structure from motion.
- Registration using modified camera matrix.
- View selection.
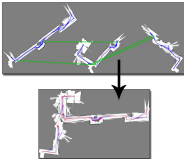- Multi-band blending based on graph-cut



stitching results before and after View selection

15 : 28 ∼ 15 : 40

### A Framework for Multi-Robot Pose Graph SLAM

Isaac Deutsch[1], Ming Liu[2] and Roland Siegwart[1]
[1]ETH Zurich, [2]City University of Hong Kong

- Create flexible multi-robot SLAM system from various *existing* single-robot SLAM software
- Framework provides feedback between robots which they can use to improve their effectiveness
- We also propose a graph correction and an image feature filtering scheme
- We demonstrate functionality of the framework with three robots in various indoor datasets

# WeD1: Innovative Design-II

Chair: He Huang    Co-chair: Shaokui Weng
Royal Ballroom    Wednesday, 08-Jun-2016, 16:00-17:00

$16:00 \sim 16:12$

### Design and Analysis of a Two-DOF Coupling Motion Robotic Joint

He Huang, Erbao Dong, Lin Zhou, Zhuo Duan, Chunshan Liu, Jin Luo, Min Xu and Jie Yang
Precision Machinery and Precision Instrumentation, University of Science and Technology of China, China

- A robotic joint with higher payload ability, power density and speed is proposed.
- The forward and inverse kinematics are solved for the path planning.
- A unique control strategy is proposed based on the two special motion modes.

The prototype of two-DOF coupling motion robotic joint

$16:12 \sim 16:24$

### Heavy-Payload Omnidirectional Robot

Long Han[1], Huihuan Qian[2], Kexin Xing[3] and Yangsheng Xu[2]
[1]The Chinese University of Hong Kong, Hong Kong
[2]The Chinese University of Hong Kong, Shenzhen, China
[3]Zhejiang University of Technology, China

- A Heavy-Payload Omnidirectional Robot (Hobot) that efficiently carries 2.13 tons of mass using only an average power of 646W on uneven indoor floors.
- Four qualitative design criteria: ground contact, energy efficiency, type of omnidirectionality and internal stress distribution.

Fig. 1: Steerable Differential-Geared Dual-Wheel (SDD).

- Two quantitative design criteria: Support Force Isotropy (SFI) and Critically Loaded Mass (CLM).

Fig. 2: Heavy-Payload Omnidirectional Robot (Hobot).
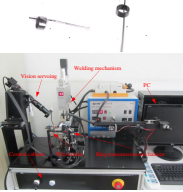
$16:24 \sim 16:36$

### System Development for Micro-electrode Assembly of Cochlear Implant

Shaokui Weng, Weibin Rong, Zeyang Xia*, Hao Deng, Yangzhou Gan, and Jing Xiong
Shenzhen Institutes of Advance Technology, Chinese Academy of Sciences, China

- This study developed an assembly system for Micro-electrode Assembly of Cochlear Implant;
- Several key mechanical mechanism for the micron level parts were designed, including a wire feeder, a ring transmission mechanism, and a welding mechanism;
- The overall performance of the assembly system was verified by experiments.

The assembly system

$16:36 \sim 16:48$

### Stability Analysis of A Mobile Health Care Robot

Diansheng Chen and Sitong Lu
The Robot institute, Beihang University, China
Xuanhai Luo
The Robot institute, Beihang University, China
Min Wang

- Analyze system stability based on a wheeled mobile health care robot;
- Use CG, ESM, ZMP to quantify the static and dynamic stability;
- Obtain the upper acceleration stabilizing the motion through Use 3 or 4 stimulation;
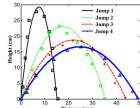- Validate the theoretical results with appropriate experiments.

The Wheeled Mobile Health Care Robot

$16:48 \sim 17:00$

### Locust-inspired jumping robot with the initial jumping posture control

Diansheng Chen, Kewei Chen, Ziqiang Zhang and Min Wang
Robot institute, School of Mechanical Engineering and Automation, Beihang University, China

- We presents a locust-inspired jumping robot with initial body posture adjustment and self-righting mechanisms.
- The robot with the size of 12 cm$\times$8 cm$\times$2.9 cm and 300 g weight can jump across the obstacle of about 30cm height with the controlled trajectory.
- The robot can recover its body from the upside down posture on the ground and simultaneously recover the jumping legs and store energy.

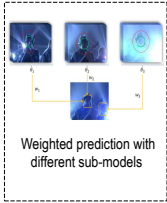Jumping robot which can adjust its initial jumping posture

# WeD2: Tracking

Chair: Zhe Liu     Co-chair: Lingyun Xu
Sunflower Room     Wednesday, 08-Jun-2016, 16:00-17:00

$16:00 \sim 16:12$

### Visual Tracking via an Ensemble of Random Classifiers

Yichun Shi
Department of Computer Science and Engineering, Shanghai Jiao Tong University, China
Hesheng Wang
Department of Automation, Shanghai Jiao Tong University, China

- Robust and Adaptive Tracking.
- An ensemble of random classifiers updated differently.
- Generative model for weighting the sub-models.
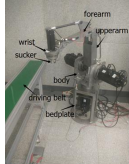- Good results on challenging datasets.


Weighted prediction with different sub-models

$16:12 \sim 16:24$

### Design of Palletizing Algorithm Based on Palletizing Robot Workstation

Yunjie Xu, Yumei Liu, Lina Hao, Hongtai Cheng
School of Mechanical Engineering and Automation
Northeastern University, Shenyang, China

- Based on four degrees of freedom articulated robot and workstation.
- Analysis of advantages and disadvantages of overlap stacking style and interlaced stacking style.
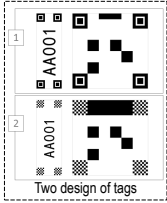- Design a kind of palletizing algorithm of palletizing robot workstation overlap stacking style.


The structure of palletizing robot workstation

$16:24 \sim 16:36$

### Real-time Tag Recognition Based on Morphology and Local Contrast

Zhiqin Chen
Department of Computer Science, Shanghai Jiao Tong University, China
Yufeng Zhang, Hesheng Wang, and Weidong Chen
Department of Automation, Shanghai Jiao Tong University, China

- Two new tags are designed.
- Two methods of tag recognition based on morphology and local contrast are developed.
- The two tag localization algorithms have some complementary characters in recognition distance.
- The new methods can quickly and accurately extract tags and their information under various conditions.
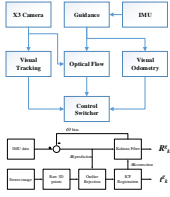

Two design of tags

$16:36 \sim 16:48$

### Towards Autonomous Tracking and Landing on Moving Target

Lingyun Xu* and Haibo Luo*
Shenyang Institute of Automation, Chinese Academy of Sciences, China
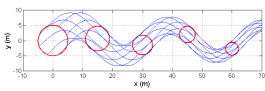
- This paper proposed a framework for autonomous tracking and landing on a moving target with a VTOL UAV. In our framework, we applied a particle filter based Visual Servo in the UAV vision system to detect and track the moving the target at real time.
- The control method used in this framework combined tracking and approaching base on the range distance.



$16:48 \sim 17:00$

### Synchronous Trajectory Tracking for Mobile Robot Network without velocity measurements between coupling robots

Zhe Liu, Weidong Chen, Junguo Lu, and Hesheng Wang
Department of Automation, Shanghai Jiao Tong University, China

- Synchronous Trajectory Tracking problem under time-varying communication delays is investigated in this work.
- Only position information (without velocity measurements) is used for achieving synchronization purpose.
- Distributed controller guarantees the convergences of both the trajectory tracking errors and synchronization errors.
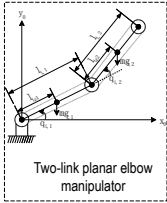
# WeD3: Adaptive Control-II

Chair: Chaoli Wang     Co-chair: Bohan Yang
Apsara Room     Wednesday, 08-Jun-2016, 16:00-17:00

$16:00 \sim 16:12$

### Distributed leaderless consensus control of multiple Euler-Lagrange systems with unknown control directions

Gang Wang and Chaoli Wang
University of Shanghai for Science and Technology, China

• Multiple Euler-Lagrange systems
• Distributed control
• Adaptive control
• Unknown control directions

Two-link planar elbow manipulator

$16:12 \sim 16:24$

### Optimal Path Planning for Mobile Manipulator based on Manipulability and Localizability

Chen Hu, Weidong Chen, Jingchuan Wang and Hesheng Wang
Department of Automation, Shanghai Jiao Tong University, China

• Optimal path planning for mobile manipulator to reduce the uncertainty of end-effector's pose.
• Using localizability as the optimization index.
• Keep manipulability greater than a threshold along path.
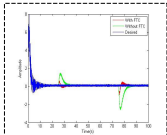• Generate a smooth path for mobile manipulator to track.

Initial path(black) and solution path(red)

$16:24 \sim 16:36$

### Fault Estimation and Active Fault Tolerant Control for Servo Systems

Fumin Guo and Xuemei Ren
School of Automation, Beijing Institute of Technology, China

• The servo systems are modeled as linear systems with unknown inputs and actuator faults.
• A robust fault estimator is designed to obtain the magnitude and characteristics of faults.
• An output feedback active fault tolerant controller is constructed to keep post-fault systems stable.
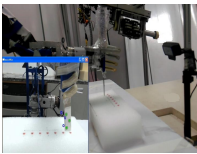
Responses of output y2(t)

$16:36 \sim 16:48$

### Vision-Based Cutting Control of Deformable Objects

Bohan Yang, Hesheng Wang, Weidong Chen and Zehui Wang
Department of Automation, Shanghai Jiao Tong University, China

• A novel vision-based cutting control method of deformable objects is proposed.
• The method predicts the object's deformation and plans cutting path online.
• A multi-points' visual tracking algorithm is designed to control the knife's motion .
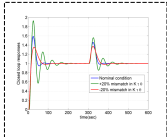• Unknown material parameters of the deformation model are visually estimated online.

Experiment of Cutting Control

$16:48 \sim 17:00$

### Optimal Input Load Disturbance Rejection Controller Design for Typical Integrating Processes Based on IMC

Wei Zhang, Lingyue Xia and Chaoli Wang
Automation, University of Shanghai for Sicence and Technology, China

• Optimal input load disturbance rejection controller design for three typical integrating processes.
• No-weight function design method and the designed controller is analytical.
• Easy tuning of the performance degree to trade off between the performance and robustness .

Output responses for ±20% disturbances in parameters