THE 2012 IEEE INTERNATIONAL CONFERENCE ON ROBOTICS AND AUTOMATION

ICRA 2012

Robots and Automation: Innovation for Tomorrow's Needs

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Foreword

It is a great honor to welcome you to the 2012 IEEE International Conference on Robotics and Automation (ICRA 2012), which is being held in the great city of Saint Paul, Minnesota. This year, ICRA 2012 continues to be the flagship conference in robotics and automation by focusing on technical excellence and innovation on many different fronts. The ICRA theme is "Robots and Automation: Innovation for Tomorrow's Needs." Robotics and automation are at the crossroads of new developments in algorithms, hardware, and software that pave new routes in technological innovation. Saint Paul is the vibrant capital of Minnesota, known as the "Land of 10,000 Lakes." St. Paul and Minneapolis constitute a large metropolitan area known as the "Twin Cities." Many companies like 3M, Cargill, Target, Best Buy are headquartered in the Twin Cities.

This year, we have received an unusually large number of submissions – 2032 papers from over 50 countries. Due to the record number of submissions, the Conference Editorial Board (CEB) and the Senior Program Committee were forced to make difficult decisions in selecting papers to maintain the quality and balance of the technical program. We regret that many excellent papers could not be accommodated. The use of iThenticate was introduced with the goal of reducing overlap with previous paper submissions. A very aggressive approach was followed in order for each paper to receive at least two meaningful and constructive reviews. A total of 818 papers were selected, which resulted in one of the lowest acceptance rates in the history of ICRA. Some of these papers are presented in interactive sessions, a first for an ICRA. All the presentations, with the author's approval, will be videotaped and archived, another first for our conferences. The objective is to create new methods for promoting our community and serving our members. Having the proceedings in a USB thumbdrive is another innovative step. The technical sessions are accompanied by special tutorials where we invited some world experts to share their knowledge. The tutorials are free to all the participants and cover various robotics/automation topics of current research interest. It should be noted that 18 workshops will be organized, all of them supported/proposed by the corresponding RAS Technical Committees (another first for our conferences). ICRA 2012 will have one of the largest exhibitions in our recent history with systems from industry, research institutions, and national laboratories. The video proceedings include 18 video submissions that cover topics ranging from ground robots to computer vision. Supplementing the technical presentations, the program is highlighted by plenary talks delivered by distinguished scholars – Professor Bradley Nelson on "Robotics in the Small," Professor Harry Asada on Bio-Bots, and Professor Jun-Ho Oh on the humanoid robot HUBO II.

We would like to express our sincere appreciation and thanks to the entire Organizing Committee, the CEB, the reviewers, and the local arrangements staff for their contributions and tireless efforts towards the success of ICRA 2012. In particular, we like to express our sincere thanks and appreciation to Lynne Parker for being the organizer of this long and intensive review process as the Editor-in-Chief of the CEB, Volkan Isler and his local staff for the smooth operation of the conference, and Max Meng for the digest creation. We also like to extend our sincere thanks to Raj Mahdavan for a superb exhibitions organization, Venkat Krovi who worked tirelessly to make sure that we are financially sound, and Bert Tanner who handled our registration. Numerous individuals, in particular Dan Lofaro, Alison Amundson, Kathy Colabaugh, Becky Helgeson and Keisha Carr

enabled us to execute such a complex process. Finally, our special thanks go to all the authors for contributing their research work, the participants and the exhibitors for making the 2012 IEEE International Conference on Robotics and Automation a memorable event. Enjoy Minnesota and its more than 10,000 lakes!!!

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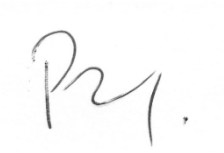

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Djoudi, Dalila
Djugash, Joseph
Do, Martin
Dobrokhodov, Vladimir
Dobson, Andrew
Dogar, Mehmet Remzi
Doh, Nakju
Doi, Miwako
Doitsidis, Lefteris
Dolan, John M.
Dolgov, Dmitri
Dombre, Etienne
Dominey, Peter Ford
Dong, Hao
Dong, Shuonan
Dong, Wei
Dong, Wenjie
Dong, Yongkun
Dong, Zhuxin
Doniec, Marek
Donlin, Regina Kathleen
Donzé, Alexandre
Dopfer, Andreas
Dornaika, Fadi
Doshi, Prashant
Dotoli, Mariagrazia
Douillard, Bertrand
Doulgeri, Zoe
Dragan, Anca
Drenner, Andrew
Drew, Benjamin
Drews Jr, Paulo
Droeschel, David
Drumwright, Evan
Druon, Sebastien
Dryanovski, Ivan
Du, Jingli
Du, Zhijiang
Du Toit, Noel E.
Duan, Feng
Dubey, Venketesh
Duchaine, Vincent
Duckett, Tom
Dudek, Gregory
Duff, Elliot
Dunbabin, Matthew David
Dune, Claire
Durfee, Ed
Durham, Joseph W.
Durrie, Jason
Duschau-Wicke, Alexander
Duvallet, Felix
Dzul, Alejandro
Earon, Ernest J. P.
Echigo, Tomio
Edan, Yael

Gayle, Russell
Gazi, Veysel
Ge, Shuzhi Sam
Ge, Yunjian
Gedikli, Suat
Gee, Andrew
Gehrig, Dirk
Geib, Christopher
Geiger, Andreas
Geraerts, Roland
Geyer, Christopher
Geyer, Hartmut
Ghaffari Toiserkan, Kamran
Gharpure, Chaitanya
Gherardi, Luca
Ghidoni, Stefano
Ghorbani, Reza
Ghose, Debasish
Ghrist, Robert
Giampaolo, Conte
Gielniak, Michael Joseph
Gienger, Michael
Giglio, Davide
Giguere, Philippe
Gil, Jorge Juan
Gil, Stephanie
Gillespie, Brent
Gillet, Denis
Gillula, Jeremy
Gimenez, Antonio
Gini, Giuseppina
Gini, Maria
Giralt, Xavier
Girdhar, Yogesh
Girgin, Sertan
Gitlin, Richard
Glas, Dylan F.
Glover, Arren
Gnemmi, Alberto
Gning, El Hadji Amadou
Gobbalipur Ranganath, Jayanth
Goedeme, Toon
Gofuku, Akio
Goldberg, Ken
Goldenberg, Andrew
Goldman, Roger E.
Gonçalves, Eder M.
Goncalves, Nelson
Gonzalez, David
Gonzalez, Felipe
Gonzalez, Javier
Gonzalez, Juan Pablo
Gonzalez de Santos, Pablo
Gonzalez Villagomez, Jesus
Gonzalez-Galvan, Emilio J.
Goo, Nam Seo
Goodin, Chris
Goodwine, Bill
Gorb, Stanislav N
Gorman, Jason
Gosline, Andrew
Gosselin, Clement
Gosselin, Frederick P.
Goswami, Ambarish
Gouaillier, David
Gould, Stephen
Goulette, François
Gouttefarde, Marc
Gowal, Sven
Grabe, Volker
Grady, Devin
Graham, Rishi
Grainger, Steven
Grand, Christophe
Granström, Karl
Grant, Edward
Grassi Junior, Valdir
Gray, Steven
Gregg, Robert D.
Greggio, Nicola
Greytak, Matthew
Gribovskaya, Elena
Gribovskiy, Alexey
Griffin, Brent Austin
Griffiths, Paul
Griffiths, Sascha
Grimes, Matthew Koichi
Grindle, Garrett
Grizzle, J.W
Groeger, Martin
Groff, Richard
Grollman, Daniel
Grosch, Patrick
Gross, Horst-Michael
Grossmann, Etienne
Groten, Raphaela
Grothues, Thomas
Grupen, Rod
Gruyer, Dominique
Grzes, Marek
Grzonka, Slawomir
Gräser, Axel
Gu, Hong
Gu, Jason
Guan, Yisheng
Guarnieri, Michele
Guerreiro, Bruno J. N.
Guerrero, J.J.
Guiochet, Jeremie
Guivant, Jose
Guizilini, Vitor
Gunes, Hatice
Guo, Chunzhao
Guo, Feng
Guo, Meng
Guo, Shuxiang
Guo, Yi
Gupta, Kamal
Gupta, Megha
Gupta, Nikhil
Gupta, Satyandra K.
Guralnik, Dan
Gustafson, Joakim
Gustafsson, Fredrik
Gutmann, Jens-Steffen
Guy, Stephen J.
Gyan, Philippe
Haar, Stefan
Hachiya, Hirotaka
Haddadin, Sami
Hadsell, Raia
Haffele, Celina
Hafner, Verena Vanessa
Hager, Gregory
Hagita, Norihiro
Hamel, Tarek
Hammer, Patrick
Hammer, Peter
Hammond III, Frank L.
Han, Chang-Soo
Han, Jeakweon
Han, Jianda
Han, Jonghui
Han, Kyung Min
Han, Li
Han, Long
Hanazawa, Yuta
Handroos, Heikki
Hanheide, Marc
Hansen, Peter
Hao, Lina
Harada, Kensuke
Harada, Tatsuya
Harata, Yuji
Harkins, Richard
Harrison, Alastair
Hart, Stephen
Hartley, Richard
Haschke, Robert
Hasegawa, Osamu
Hasegawa, Yasuhisa
Hashimoto, Kenji
Haslinger, Robert
Hatakeyama, Shoshiro
Hatton, Ross
Hauert, Sabine
Hauser, Kris
Havlena, Michal
Havoutis, Ioannis
Hawasly, Majd
Hayet, Jean-Bernard
Haynes, Galen Clark
Hayward, Vincent
He, Hu
Hebert, martial
Hebert, Paul
Heger, Frederik W.
Hehn, Markus
Heidarsson, Hordur K
Heidrich-Meisner, Verena
Heinen, Milton
Hemachandra, Sachithra Madhawa
Hemakumara, Madu Prasad
Hendrich, Norman
Hennes, Daniel
Henrich, Dominik
Henry, Peter
Herbst, Evan
Herder, Just
Herdt, Andrei
Herisse, Bruno
Hermans, Tucker
Herranz, Luis
Hershberger, Dave
Hertkorn, Katharina
Hertzberg, Christoph
Hesch, Joel
Hesselbach, Juergen
Hester, Todd
Heuer, Herbert
Heyneman, Barrett
Higashi, Toshimitsu
Higashimori, Mitsuru
Hill, Andrew John
Hillier, Nick
Hilsenstein, Volker
Hines, Lindsey
Hirai, Shinichi
Hirata, Yasuhisa
Hirose, Toshinori
Hirschmüller, Heiko
Hirzinger, Gerd
Ho, Van
Hoburg, Warren

Kapadia, Apoorva
Karaman, Sertac
Karayiannidis, Yiannis
Karimadini, Mohammad
Karnad, Nikhil
Karras, George
Karumanchi, Sisir
Katayama, Yasuhiro
Katic, Dusko
Katsiaris, Pantelis
Katz, Dov
Katz, Roman
Kavraki, Lydia
Kawahara, Tomohiro
Kawamoto, Junji
Kawamura, Atsuo
Kawamura, Sadao
Kawasaki, Haruhisa
Kawasaki, Hiroshi
Kawashima, Kenji
Kawewong, Aram
Kazakidi, Asimina
Kazemi, Moslem
Kearney, Michael
Keith, François
Keller, Thierry
Kelly, Jonathan
Kelouwani, Sousso
Kemper, Kevin
Kendoul, Farid
Kenyon, Robert
Kernbach, Serge
Kesner, Samuel B.
Khansari-Zadeh, Seyed Mohammad
Khorasani, Khashayar
Khwaja, Asim
Kiguchi, Kazuo
Kikuchi, Koki
Kikuchi, Takehito
Killpack, Marc
Kim, Bong Keun
Kim, Byeong-Sang
Kim, Chang Young
Kim, ChangHwan
Kim, Doik
Kim, Donghyeon
Kim, Gon-Woo
Kim, H. Jin
Kim, Hong Seok
Kim, Hwa Soo
Kim, Hyoung-Rock
Kim, Hyun-Jung
Kim, Jinhyun
Kim, Jiwoong
Kim, Jong-Hoon
Kim, Jong-Hwan
Kim, Jong-Wook
Kim, Jonghoek
Kim, Jonghyuk
Kim, Jung
Kim, Kangjin
Kim, Keehoon
Kim, Kwang
Kim, MinJun
Kim, Soohwan
Kim, Whee Kuk
Kim, Yeon-Ho
Kim, Young J.
Kim, Young-Suk
Kimball, Peter
Kimmel, Andrew
Kimura, Hiroshi
Kimura, Shinichi
King, H. Hawkeye
Kingston, Peter
Kino, Hitoshi
Kinsey, James
Kinugasa, Tetsuya
Kirby, Brian
Kirchner, Frank
Kirsch, Alexandra
Kita, Kahori
Kjellstrom, Hedvig
Klank, Ulrich
Klaptocz, Adam
Kleeman, Lindsay
Klein, Georg
Klein, Julius
Kleiner, Alexander
Klesh, Andrew
Klimentjew, Denis
Klingbeil, Ellen
Klodmann, Julian
Kloetzer, Marius
Klotzbuecher, Markus
Kneip, Laurent
Knepper, Ross A
Knoll, Alois
Knox, W. Bradley
Kobayashi, Etsuko
Kobayashi, Hiroaki
Kobayashi, Jun
Kobayashi, Ryo
Kobayashi, Yo
Kober, Jens
Kobilarov, Marin
Kobilarov, Marin
Kodagoda, Sarath
Koenig, Nathan
Koganezawa, Koichi
Koizumi, Norihiro
Kojima, Fumio
Kojima, Masaru
Koku, Bugra
Kollar, Thomas
Kolling, Andreas
Kolsch, Mathias
Kolter, J. Zico
Komma, Philippe
Komoriya, Kiyoshi
Komura, Taku
Kondo, Hideki
Kondo, Kazuaki
Konidaris, George Dimitri
Konietschke, Rainer
Konolige, Kurt
Kontolatis, Ioannis
Koo, Ja Choon
Kootstra, Gert
Koppula, Hema Swetha
Kormushev, Petar
Korrapati, Hemanth
Kortsmit, Jeroen
Kosa, Gabor
Kosecka, Jana
Koseki, Yoshihiko
Kosuge, Kazuhiro
Kotosaka, Shinya
Kottege, Navinda
Kouskoulas, Yanni
Kovac, Mirko
Kovacs, Gabor
Kovecses, Jozsef
Koziol, Scott
Kozlowski, Krzysztof R.
Kraft, Dirk
Kragic, Danica
Krainin, Michael
Kratochvil, Bradley
Krichmar, Jeffrey
Krishna, Madhava
Kristan, Matej
Kroeger, Torsten
Kroemer, Oliver
Krohs, Florian
Kronander, Klas
Krontiris, Athanasios
Krovi, Venkat
Krueger, Volker
Krug, Robert
Krupa, Alexandre
Krut, Sebastien
Kruusmaa, Maarja
Krüger, Norbert
Kubus, Daniel
Kucukyilmaz, Ayse
Kudoh, Shunsuke
Kuehnlenz, Kolja
Kuemmerle, Rainer
Kuffner, James
Kuhn, Juliane
Kuindersma, Scott
Kuipers, Benjamin
Kulchenko, Paul
Kulic, Dana
Kumagai, Masaaki
Kumar, Rajesh
Kumar, Vijay
Kummert, Franz
Kunii, Yasuharu
Kunz, Clayton
Kunz, Tobias
Kunze, Lars
Kurabayashi, Daisuke
Kuratate, Takaaki
Kurazume, Ryo
Kurita, Yuichi
Kurniawati, Hanna
Kurokawa, Haruhisa
Kushleyev, Aleksandr
Kuwata, Yoshiaki
Kwartowitz, David
Kweon, In So
Kwon, Dong-Soo
Kwon, Hyunki
Kwon, SangJoo
Kwon, Tae-Bum
Kühnlenz, Kolja
Kyriacou, Theocharis
Kyriakopoulos, Kostas
Kyrki, Ville
La, Hung
Labonte, Daniel
Lacevic, Bakir
Lacroix, Simon
Ladický, Lubor
Laffranchi, Matteo
Lahijanian, Morteza
Lahr, Derek
Lai, Chun C.
Lai, Kevin
Lakaemper, Rolf
Lakemeyer, Gerhard
Lakemond, Ruan

Ma, Shugen
Ma, Xianghong
MacDonald, Bruce
Machado, Luis
Macharet, Douglas Guimarães
Maciejewski, Anthony A.
Maddern, William
Maeda, Guilherme Jorge
Maeda, Yusuke
Magnenat, Stéphane
Magnusson, Martin
Mahdizadeh, Amin
Mahmud, Hassan
Mahony, Robert
Mahvash, Mohsen
Maier, Daniel
Mair, Elmar
Maire, Frederic
Maitin-Shepard, Jeremy
Majdik, Andras
Majoe, Dennis
Majumdar, Anirudha
Majumder, S
Majure, Lydia
Maki, Kevin
Maldonado, Alexis
Malek, Lukasz
Malhotra, Mark
Malmirchegini, Mehrzad
Malvezzi, Monica
Malysz, Pawel
Manchester, Ian
Mandel, Christian
Mann, George K. I.
Manocha, Dinesh
Manolakis, Dimitris
Manoonpong, Poramate
Mansley, Chris
Mao, Zhi-Hong
Marani, Giacomo
Marantos, Panos
Marble, James
Marchand, Eric
Marconi, Lorenzo
Marder-Eppstein, Eitan
Marfil, Rebeca
Marhamati, Nina
Marin, Raul
Marin-Hernandez, Antonio
Marin-Jimenez, Manuel J.
Marinakis, Dimitri
Marino, Alessandro
Mariottini, Gian Luca
Markdahl, Johan
Markelic, Irene
Marques, Jorge S.
Marques, Lino
Marra, Steven
Marshall, Joshua A.
Martel, Sylvain
Marthi, Bhaskara
Martin, Patrick
Martin, Philippe
Martin, Steven Colin
Martinelli, Francesco
Martinez, Jorge L.
Martinez, Sonia
Martinez Mozos, Oscar
Martinez Salazar, Harold Roberto
Martinez-Cantin, Ruben
Martinez-Carranza, Jose
Martinez-Gomez, Jesus
Martínez-Otzeta, José María
Martínez-Rosas, Juan C.
Martins, Ricardo
Marton, Zoltan-Csaba
Maruyama, Hisataka
Masamune, Ken
Mashimo, Tomoaki
Masia, Lorenzo
Mason, Julian
Masone, Carlo
Masory, Oren
Masoud, Ahmad A.
Mastrogiovanni, Fulvio
Masuda, Taisuke
Matabosch, Carles
Mather, T, William
Mathis, Frank
Matos, Vítor
Matsubara, Takamitsu
Matsuhira, Nobuto
Matsuno, Takayuki
Matsuura, Daisuke
Matteo Zoppi, zoppi
Matthews, Iain
Matuszek, Cynthia
Maufroy, Christophe
Maus, Horst Moritz
Mavroidis, Constantinos
Maxon, Sean
May, Stefan
Maycock, Jonathan
Maye, Jerome
Mayer, Christoph
Mayol, Walterio
Maza, Ivan
Mazurek, Gustaw
Mazza, Edoardo
Mazzolai, Barbara
McCarthy, Chris
McDermott, Erik
McGinnity, Martin
McInroy, John
McIsaac, Ken
McKee, Gerard
McKinnon, David
McLurkin, James
McManus, Colin
Medeiros, Adelardo
Medina Ayala, Ana Ivonne
Medrano-Cerda, Gustavo
Meeussen, Wim
Meger, David Paul
Meghjani, Malika
Mei, Christopher
Mei, Deqing
Mei, Jiangping
Mei, Tao
Meier, Franziska
Meier, Lorenz
Mejias, Luis
Mekonnen, Alhayat Ali
Melchiorri, Claudio
Mellinger, Daniel
Menciassi, Arianna
Mendoza Garcia, Ricardo Franco
Menegatti, Emanuele
Menezes, Paulo
Meng, Qing-Hao
Menon, Carlo
Mericli, Cetin
Mericli, Tekin
Merino, Luis
Merlet, Jean-Pierre
Mermoud, Gregory
Merryweather, Andrew
Mertz, Christoph
Merz, Torsten
Mettin, Uwe
Meyer, Wolfgang
Meyer-Delius, Daniel
Mezouar, Youcef
Micaelli, Alain
Micera, Silvestro
Michalek, Maciej, Marcin
Michael, Nathan
Michaud, Francois
Michel, Olivier
Migliore, Davide
Mihaylova, Lyudmila
Miklic, Damjan
Miksik, Ondrej
Miller, Stephen
Mills, James K.
Milner, Theodore Edgar
Milstein, Adam
Milutinovic, Dejan
Minato, Takashi
Minor, Mark
Miossec, Sylvain
Miranda Neto, Arthur, Arthur
Mirats Tur, Josep M.
Mirisola, Luiz Gustavo
Missura, Marcell
Mistry, Michael
Mita, Seiichi
Mitchell, Julie C.
Mitobe, Kazuhisa
Mitsou, Nikos
Mitsugami, Ikuhisa
Mitsukura, Yasue
Mitsunaga, Noriaki
Mittendorfer, Philipp
Miura, Jun
Miura, Kanako
Miwa, Hiroyasu
Miyake, Yoshihiro
Miyakoshi, Seiichi
Miyashita, Takahiro
Miyoshi, Takanori
Mizukawa, Makoto
Moberg, Stig
Modayil, Joseph
Mohan, San
Mohta, Kartik
Molfino, Rezia
Moll, Mark
Mombaur, Katja
Monin, Andre
Monroy, Raúl
Montambault, Serge
Montano, Luis
Montes, Hector
Montesano, Luis
Montijano, Eduardo
Moon, Chang-bae
Moon, Jae-Sung
Moore, Joseph
Moore, Richard James Donald
Mora, Andres

Palmer III, Luther R.
Palunko, Ivana
Pan, Jia
Pangercic, Dejan
Panin, Giorgio
Panousopoulou, Athanasia
Paoli, Andrea
Paolini, Robert
Papadopoulos, Evangelos
Papadopoulos, Georgios
Papageorgiou, Xanthi
Papaleo, Eugenia
Papanikolopoulos, Nikos
Paparoditis, Nicolas
Papazov, Chavdar
Paprotny, Igor
Park, Chung Hyuk
Park, Frank
Park, Hae Won
Park, Hae Won
Park, Hyungju Andy
Park, In-Won
Park, Jae Byung
Park, Jaeheung
Park, Jong Hyeon
Park, Jong Jin
Park, Wooram
Park, Yong-Jai
Park, Yong-Lae
Parker, Chris
Parker, Lonnie
Parra, Carlos
Parra Vega, Vicente
Parsley, Martin Peter
Pascoal, Antonio
Pashkevich, Anatol
Pasqualetti, Fabio
Passenberg, Carolina
Patel, Rajnikant V.
Pathak, Kaustubh
Patil, Sachin
Patoglu, Volkan
Patron-Perez, Alonso
Patronik, Nicholas
Paul, Rohan
Pavone, Marco
Paxman, Jonathan
Payandeh, Shahram
Payton, David
Paz, Lina María
PB, Sujit
Pchelkin, Stepan
Peijie, Zhang
Pellegrini, Stefano
Pelrine, Ron
Peltason, Julia
Pepy, Romain
Peralta Cabezas, José Luis
Perdereau, Véronique
Pereira, Fernando
Pereira, Guilherme
Perez, Patrick
Perez-del-Pulgar, Carlos
Perrin, Nicolas Yves
Perrollaz, Mathias
Peschel, Joshua
Pessin, Gustavo
Peters, Steven
Petillot, Yvan R.
Petit, Antoine
Petrick, Ron
Petrovskaya, Anna
Pettre, Julien
Pezzementi, Zachary
Pfaff, Patrick
Pham, Minh Tu
Pham, Quang-Cuong
Phee, Louis
Philippsen, Roland
Phillips, Mike
Phung, Tri Cong
Piater, Justus
Piccigallo, Marco
Pickup, Lyndsey
Pimenta, Luciano
Pinies, Pedro
Piovesan, Davide
Pipe, Tony
Pippin, Charles
Pitzer, Benjamin
Pivtoraiko, Mihail
Pizarro, Oscar
Plaku, Erion
Plank, Markus
Plante, Jean-Sebastien
Platt, Robert
Plonski, Patrick
Plöger, Paul G.
Pochyly, Ales
Poduri, Sameera
Poignet, Philippe
Polat, Ilhan
Pollard, Nancy S
Polushin, Ilia G.
Pomerleau, Francois
Pon, Aura
Ponda, Sameera
Popa, Dan
Popovic, Marko
Porez, Mathieu
Porfiri, Maurizio
Porta, Josep M
Posner, Ingmar
Possani Espinosa, Andre
Pott, Andreas
Poulakis, Pantelis
Pounds, Paul
Prabhakaran, B
Pradalier, Cedric
Prado, José Augusto
Prankl, Johann
Prasser, David
Prats, Mario
Pratt, Jerry
Prattichizzo, Domenico
Prestes, Edson
Pretto, Alberto
Prieto, José Carlos
Prime, Zebb
Prisacariu, Victor
Pronobis, Andrzej
Prorok, Amanda
Provancher, William
Provatidis, Christoforos
Provost, Julien
Pryor, Mitch
Przybylski, Markus
Puangmali, Pinyo
Pugeault, Nicolas
Puig, Luis
Putze, Felix
Qian, Huihuan
Qiu, Quan
Quadros, Alastair James
Quaglia, Davide
Quek, Boon Kiat
Quigley, Morgan
Quigley, Steven
Quinn, Roger, D.
Rabaud, Vincent
Raczkowsky, Joerg
Radkhah, Katayon
Raducanu, Bogdan
Rahn, Christopher
Rahwan, Talal
Rai, Piyush
Rakotondrabe, Micky
Ramachandran, Deepak
Raman, Vasumathi
Ramirez-Amaro, Karinne
Ramisa, Arnau
Ramos, Ander
Ramos, Fabio
Rand, Omri
Randelli, Gabriele
Ranganathan, Ananth
Rasmussen, Christopher
Rasolzadeh, Babak
Rastgaar, Mohammad
Ratliff, Nathan
Ravindran, Balaraman
Redon, Stephane
Reed, Brooks
Reed, Kyle Brandon
Reggiani, Monica
Régnier, Stéphane
Reina, Giulio
Reishus, Dustin
Reiter, Austin
Reitmayr, Gerhard
Rekleitis, Georgios
Rekleitis, Ioannis
Remy, C. David
Remy, Sekou
Ren, Hongliang
Ren, Lei
Ren, Ping
Ren, Wei
Ren, Xiaofeng
Rentschler, Mark
Reynolds, Matthew
Ribnick, Evan
Richa, Rogerio
Richtsfeld, Andreas
Richtsfeld, Mario
Ridao, Pere
Rieffel, John
Riek, Laurel D.
Riener, Robert
Rigatos, Gerasimos
Righetti, Ludovic
Rimon, Elon
Ringwood, John
Riskowski, Jody L.
Ristic-Durrant, Danijela
Ritter, Helge Joachim
Riviere, Cameron
Rizzi, Alfred
Roa, Maximo A.
Roberti, Flavio
Roberts, Jonathan
Robertsson, Anders
Robuffo Giordano, Paolo
Rocchi, Fabrizio
Rocha, Rui Paulo
Rocon, Eduardo

Shin, Jiwon
Shirinzadeh, Bijan
Shkolnik, Alexander
Shkurti, Florian
Shoaei, Mohammad Reza
Short, Elaine
Shvalb, Nir
Si, Yulin
Sibley, Gabe
Sidobre, Daniel
Silva, Filipe
Simaan, Nabil
Simeon, Thierry
Simeon, Thierry
Simetti, Enrico
Simões, Eduardo do Valle
Simon, Dan
Simonetto, Andrea
Simonin, Olivier
Simpkins, Alex
Sinapov, Jivko
Singh, Amarjeet
Singh, Arjun
Singh, Gautam
Singh, Sanjiv
Singh, Surya
Sinibaldi, Edoardo
Sintov, Avishai
Siqueira, Adriano
Sira-Ramírez, Hebertt
Siri, Silvia
Sitte, Joaquin
Sitti, Metin
Sivic, Josef
Skocaj, Danijel
Skonieczny, Krzysztof
Skotheim, Øystein
Skrzypczynski, Piotr
Slocum, Alexander
Smith, Christopher
Smith, James
Smith, Joshua R.
Smith, Stephen L.
Smith, Stuart
Snape, Jamie
Soccol, Dean
Solà, Joan
Solea, Razvan
Solis, Jorge
Sommerlade, Eric
Son, Hyoung Il
Song, Dan
Song, Jae-Bok
Song, Kai-Tai
Song, Xuan
Song, Yang
Song, Yimin
Song, Yun Seong
Sorbello, Rosario
Sorrenti, Domenico G.
Sotzing, Christopher
Spenko, Matthew
Spinello, Luciano
Spletzer, John
Spong, Mark
Sproewitz, Alexander
Sprunk, Christoph
Sreenath, Koushil
Sridhar, Muralikrishna
Sridharan, Mohan
Srinivasa, Siddhartha
Srinivasan, Manoj
Stachniss, Cyrill
Stachura, Maciej
Stampfer, Dennis
Stan, Sergiu-Dan
Stankovic, Milos
Stasse, Olivier
Steder, Bastian
Steedman, Mark
Steinbach, Eckehard
Steinbauer, Gerald
Steinfeld, Aaron
Stenger, Björn
Stepp, Cara
Stergiopoulos, Yiannis
Stetten, George
Stewart, Robert
Stiefelhagen, Rainer
Stienen, Arno H.A.
Stiffler, Nicholas
Stilwell, Daniel
Stinckwich, Serge
Stingu, Emanuel
Stocco, Leo
Stoianovici, Dan
Stojmenovic, Ivan
Stolkin, Rustam
Stoy, Kasper
Stoyanov, Danail
Stoyanov, Todor
Stramigioli, Stefano
Strasdat, Hauke
Strobl, Klaus H.
Stroupe, Ashley W.
Stulp, Freek
Stump, Ethan
Sturm, Jürgen
Stückler, Jörg
Su, Hao
Su, Jianbo
Su, Yuxin
Suarez, Raul
Suárez-Ruiz, Francisco
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Yip, Wai-Kuan
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Yoshida, Eiichi
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Zefran, Milos
Zelenika, Saša
Zell, Andreas
Zendjebil, Iman Mayssa
Zenou, Emmanuel
Zerbato, Davide
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Zhang, George
Zhang, Hai-Tao
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Plenary Sessions

Robotics in the Small

Tuesday May 15, 2012, 13:15-14:15, Ballrooms A, B, C, E, F, and G
Chair: Shigeki Sugano, Waseda University

Professor Brad Nelson

Department of Robotics and Intelligent Systems,

ETH-Zürich, Zürich, Swiss

Abstract

While the futuristic vision of micro and nanorobotics is of intelligent machines that navigate throughout our bodies searching for and destroying disease, we have a long way to go to get there. Progress is being made, though, and the past decade has seen impressive advances in the fabrication, powering, and control of tiny motile devices. Much of our work focuses on creating systems for controlling micro and nanorobots in liquid as well as pursuing applications of these devices. Larger scale microrobots for delivering drugs to the retina to treat eye diseases such as age related macular degeneration and retinal vein and artery occlusion are moving towards clinical trials. As size decreases to the nanoscale, we have been inspired by motile bacteria, such as E. coli, and have developed nanorobots that swim with a similar technique. Applications we pursue at these scales are for the treatment of breast cancer and cerebral infarctions.

The potential impact of this technology on society is high, particularly for biomedical applications, though many challenges remain in developing micro and nano robots that will be useful to society. An overarching requirement for achieving breakthroughs in this area is the need to bring together expertise from a wide variety of science and engineering disciplines. Robotics brings expertise in the planning and control of mechanisms with many degrees of freedom in uncertain environments. Nanotechnology teaches innovative approaches to fabricating nanoscale machines. In addition, biomedical imaging advances are needed, as is fundamental insight into the nature of fluid dynamics at very small scales. Medical professionals must be tightly integrated into the development cycle, and experts in developing business models and intellectual property must be closely consulted.

As systems such as these enter clinical trials, and as commercial applications of this new technology are realized, radically new therapies and uses will result that have yet to be envisioned.

Biography

Brad Nelson is the Professor of Robotics and Intelligent Systems at ETH Zürich. His primary research focus is on microrobotics and nanorobotics with an emphasis on applications in biology and medicine. He received a B.S.M.E. from the University of Illinois at Urbana-Champaign and an M.S.M.E. from the University of Minnesota. He has worked as an engineer at Honeywell and Motorola and served as a United States Peace Corps Volunteer in Botswana, Africa, before obtaining a Ph.D. in Robotics from Carnegie Mellon University in 1995. He was an Assistant Professor at the University of Illinois at Chicago (1995-1998) and an Associate Professor at the University of Minnesota (1998-2002). He became a Full Professor at ETH Zürich in 2002.

Prof. Nelson has received a number of awards including more than a dozen Best Paper Awards and Award Finalists at major robotics conferences and journals. He was named to the 2005 “Scientific American 50,” Scientific American magazine’s annual list recognizing fifty outstanding acts of leadership in science and technology from the past year for his efforts in nanotube manufacturing. His laboratory won the 2007 and 2009 RoboCup Nanogram Competition, both times the event has been held. His lab appears in the 2012 Guinness Book of World Records for the "Most Advanced Mini Robot for Medical Use." He serves on the editorial boards of several journals, has chaired several international workshops and conferences, has served as the head of the ETH Department of Mechanical and Process Engineering, the Chairman of the ETH Electron Microscopy Center (EMEZ), and is a member of the Research Council of the Swiss National Science Foundation.

Bio-Bots: Bio-Integrated Robotics Using Live Cells As Components

Wednesday May 16, 2012, 13:15-14:15, Ballrooms A, B, C, E, F, and G
Chair: Rüdiger Dillmann, The Karlsruhe Institute of Technology

Professor H. Harry Asada

Department of Mechanical Engineering,

Massachusetts Institute of Technology (MIT), Cambridge, MA, USA

Abstract

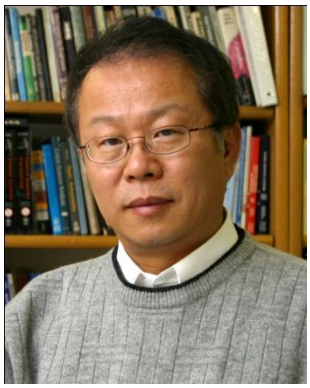
Live cells and tissues cultured in microfluidic in vitro environment can be used as components of a robot. Skeletal muscles, for example, have the potential to be effective actuators for powering a micro-robot or an artificial "animal". Muscle strips can be formed from their precursory cells, myoblasts, by guiding them through multi-stage myogenic process. Muscle strips self-assembled together with a robotic structure can activate a high DOF micro mechanism, for which there is no actuator technology currently available. Such live biological materials will be a game-changing technology in designing robotic systems and extending their applications to broader fields. This talk will introduce the state-of-the-art of bio-artificial muscles and other key biological components, and address potentials and challenges of bio-integrated robots. Three thrusts of bioengineering and control technologies will be highlighted. First, skeletal muscle cells are genetically altered so that each muscle strip can be controlled individually with high spatiotemporal resolution: Optogenetics. When exposed to a light beam, a group of light-sensitive muscle strips contract locally and dynamically, creating multi DOF motion in a compact body. Second, a new culturing technique is developed for creating 3-D fascicle-like muscle constructs, which is a key step for scaling up the bio-artificial muscles to a large-scale functional muscle. Finally, a new stochastic control method for controlling a population of cells and micro-tissues will be discussed. While individual cells and tissues are inevitably heterogeneous and stochastic, their population behaviors are stable and functional in a wide range. A new approach is needed for in vitro control of cells and tissues to assure robust, reliable behaviors. The talk will conclude with future research agenda on Bio-Bots at the NSF Science and Technology Center, Emergent Behaviors of Integrative Cellular Systems, where the speaker's group has been participating.

Biography

H. Harry Asada is Ford Professor of Engineering and Director of the Brit and Alex d'Arbeloff Laboratory for Information Systems and Technology in the Department of Mechanical Engineering, Massachusetts Institute of Technology (MIT), Cambridge, MA. He received the B.S., M.S., and Ph.D. degrees in precision engineering in 1973, 1975, and 1979, respectively, all from Kyoto University, Japan. He specializes in robotics, biological engineering, and system dynamics and control. His current research in the biological engineering area includes bio-artificial muscles, angiogenesis, modeling and control of cell migration, and cell tracking image processing. His current robotics research includes wireless micro underwater robots for direct inspection of nuclear reactors, aircraft manufacturing robotics, wearable supernumerary robotic limbs for assisting factory workers and astronauts, and cellular PZT actuators. He won the Best Conference Paper Award at the IEEE International Conference on Robotics and Automation in 1993 and 1999, its Best Automation Paper Award in 1997, and 2010, the O. Hugo Schuck Best Paper Award from the American Control Council in 1985, and Best Journal Paper Awards from the Society of Instrument and Control Engineers in 1979, 1984, and 1990. He received the Rufus Oldenburger Medal from ASME in 2011, and the Henry Paynter Outstanding Researcher Award from ASME Dynamic Systems and Control in 1998. He also received the Ruth and Joel Spira Award for Distinguished Teaching from the School of Engineering, MIT, for his contribution to robotics education. Dr. Asada is a Fellow of ASME.

Development Outline of the Humanoid Robot: HUBO II

Thursday May 17, 2012, 13:15-14:15, Ballrooms A, B, C, E, F, and G
Chair: Henrik Iskov Christensen, Georgia Institute of Technology



Professor Jun Ho Oh

Department of Mechanical Engineering,

Korea Advanced Institute of Science and Technology (KAIST), Korea

Abstract

Hubo II is a 40-DOF full size Humanoid Robot with 1.3m of height and 45Kg of weight. Hubo II which was originally developed at KAIST is now in commercial production stage by Rainbow Co., an enterprise licensed by KAIST. Nine Hubo II have successfully been delivered to universities and research institutes in Singapore and the US.

The full size humanoid robot differs from the toy size small ones in many aspects. It should have a very stable and well-designed structure with little uncertainties. It must be strong enough to move its body weight, but not so heavy to minimize the torques to drive the body parts. All the electrical parts and sensors including force/torque sensors, inertia sensors, the driver circuits, and decentralized control must be designed and fabricated compact enough to be fit in the enclosure of the body.

Another important task is to design a walking algorithm. The walking algorithm is composed with two parts: off-line gait pattern design and real time stabilization control. Gait pattern design is to find a periodic function for each joint of leg such that humanoid robot is to walk with desired velocity keeping a certain level of stability. We suggested a simple function connected with cubic spline and sine functions with minimal number of parameters. This approach simplifies the parameter adjustment procedure. Play back of gait pattern found from the former process, however, does not guarantee the robot walks in real practice since there are number of uncertainties involved in real situations. The uncertainties include ground inclination, friction, and un-modeled vibration of the body. The stabilization algorithm should deal with these kinds of problems. Hubo's walk algorithm has eight levels of hierarchical control architecture to cope with the general circumstances in the walking environment.

The general issues mentioned above will be presented.

Biography

Professor Jun Ho Oh (57) received his B.S. and M.S. degree from Yonsei University, Seoul, Korea in 1977 and 1979, respectively. After working at Korea Atomic Energy Research Institute as a researcher from 1979 to 1981, he received Ph.D. degree in mechanical engineering in the field of automatic control at U.C., Berkeley in 1985. He is now a distinguished professor of mechanical engineering and the director of Humanoid robot research center (Hubo Lab) at Korea Advanced Institute of Science and Technology (KAIST).

He has performed many industry and government research projects in motion control, sensors, microprocessor applications, robotics, etc. He is especially interested in mechatronics and system integration. In the past ten years, he completed unique humanoid robot series KHR-1, KHR-2, Hubo and Hubo 2 and he also developed Albert Hubo and Hubo FX-1. He is currently studying to improve the performance of humanoid robot for faster and more stable walking, robust robot system integration and light weight design. He is a member of ASME and IEEE. He is also a member of the National Academy of Engineering of Korea.

Workshops and Tutorials

The workshops and tutorials are scheduled on Monday and Friday of the conference week. They are listed here for your consideration. More detailed information and all workshops and tutorials proceedings can be found on the conference website http://www.icra2012.org/program/workshop.php and http://www.icra2012.org/program/tutorials.php . All events take place in the RiverCentre meeting rooms 1-12.

Monday May 14, 2012 Workshops/Tutorials (08:30-17:30)

Room	ID	Title	Organizers
1	Workshop 1	**Variable Impedance Actuators Moving the Robots of Tomorrow**	Raffaella Carloni, Bram Vanderborght, Alin Albu-Schäffer, Antonio Bicchi
2	Workshop 2	**Bio-Bots**	H. Harry Asada
3	Workshop 3	**Many-Robot Systems: Crossing the Reality Gap**	Donald Sofge, Volkan Isler, Ani Hsieh, Frank Ehlers
4	Workshop 4	**New Design Principles and Frontiers for Wearable Robotics**	Maria Chiara Carrozza Dino Accoto
5	Workshop 5	**Seventh Full-day Workshop on Software Development and Integration in Robotics (SDIR-VII)**	Davide Brugali Bruce A. Mac Donald Issa A.D. Nesnas
6	Workshop 6	**Haptic Teleoperation of Mobile Robots: Theory, Applications and Perspectives**	Cristian Secchi, Domenico Prattichizzo, Antonio Franchi, Paolo Robuffo Giordano
7	Workshop 7	**Robotics and Performing Arts: Reciprocal influences**	Pericle Salvini Daniela Rus
8	Workshop 8	**Robotic Satellite Servicing**	Craig Carignan Giacomo Marani Wendell Chun
9	Workshop 9	**2nd Workshop on Semantic Perception, Mapping and Exploration (SPME)**	Dirk Holz, Zoltan-Csaba Marton, Andreas Nuechter, Andrzej Pronobis, Radu Bogdan Rusu
10-11	Tutorial 1	**Motion Planning for Dynamic Environments**	Steve LaValle
12	Tutorial 2	**Industry Track**	Bonnie Yue Carlos Osorio

Friday May 18, 2012 Workshops/Tutorials (08:30-17:30)

Room	ID	Title	Organizers
1	Workshop 10	**The Future of HRI - Paving the Way to Next Generation of HRI**	Pericle Salvini Monica Nicolescu Iroshi Hishiguro
2	Workshop 11	**Bio Assembler for 3D Cellular System Innovation**	Tatsuo Arai
3	Workshop 12	**Conditions for Replicable Experiments and Performance Comparison in Robotics Research**	Fabio P. Bonsignorio, Angel P. Del Pobil, John Hallam, Raj Madhavan,
4	Workshop 13	**Workshop on Long-term Autonomy II**	Paul Furgale Gabe Sibley Tim Barfoot
5	Workshop 14	**Pathways to Clinical Needle Steering: Recent Advances and Future Applications**	Cameron Riviere Robert Webster
6	Workshop 15	**Stochastic Geometry in SLAM**	Martin Adams Ba-Ngu Vo
7	Workshop 16	**Modular Surgical Robotics: How Can We Make It Possible?**	Paolo Fiorini Giancarlo Ferrigno Elena De Momi
8	Workshop 17	**Industry-Academia Collaboration in the ECHORD Project: a Bridge for European Robotic Innovation**	Alois Knoll Bruno Siciliano Norberto Pires
9	Workshop 18	**Semantic Perception and Mapping for Knowledge-enabled Service Robotics**	Michael Beetz, Patric Jensfelt, Alper Aydemi, Dejan Pangercic, Ben Pitzer, Bhaskara Marthi
10	Tutorial 3	**Advanced 3D Point Cloud Processing with Point Cloud Library (PCL)**	Radu Rusu
11	Tutorial 4	**Reinforcement Learning for Robotics and Control**	Pieter Abbeel Jan Peters
12	Tutorial 5	**Robot Operating System (ROS): Core and Advanced Topics**	Christopher Crick

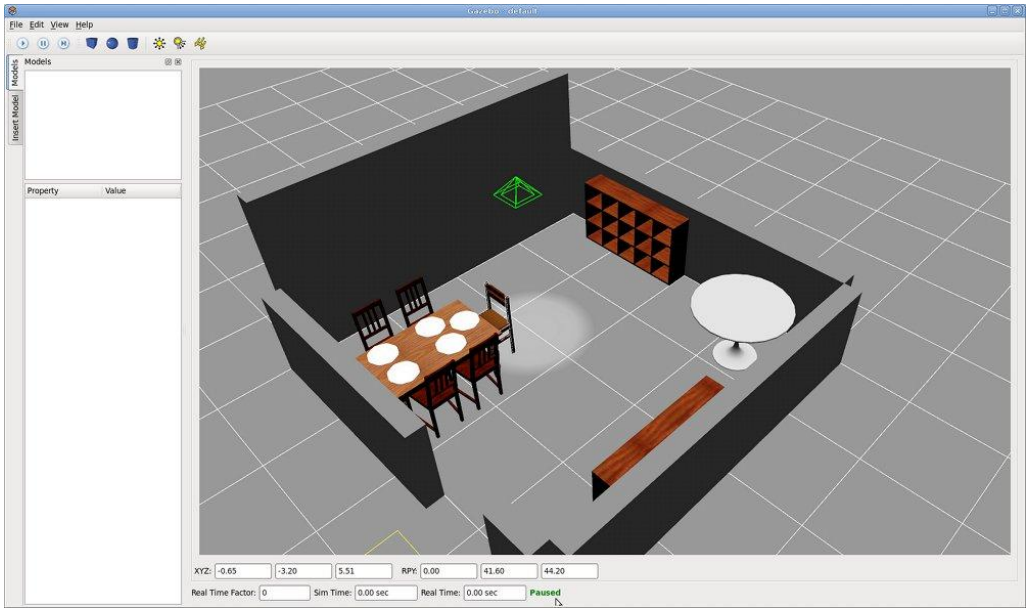
ICRA Robot Challenge 2012

This year's ICRA Robot Challenge will be held at ICRA 2012. Our goal is to make the Challenge accessible to all members of the ICRA community, to integrate it tightly with the technical aspects of the conference, and to encourage as many participants as possible to bring their teams and participate. This year's challenge will consist of six events:

- The Mobile Manipulation Challenge
- The Modular Robotic Challenge
- The Mobile Microrobotics Challenge
- The DARwIn-OP Humanoid Application Challenge
- The Manufacturing Challenge

Each challenge is organized individually, but all will be co-located at the conference. The Robotic Challenges are being held in the Roy Wilkins Auditorium of RiverCentre in Saint Paul. To participate in any of the challenges, use the contact information below.

The Mobile Manipulation Challenge (AKA Sushi Boat Challenge)



This year a new Mobile Manipulation Challenge will show off the state of the art in integrated perception and manipulation. The challenge models a set of "sushi boat" restaurant tasks: clearing a table, setting a table, and serving from a rotating table.

We will run this challenge at two scales: human and mini. The human scale will use real tables and chairs and dishes. The mini scale will be suited for smaller robots.

Participants are welcome to bring their own robots and software, or to make use of Willow Garage's PR2 robots (human scale) or Kuka's YouBot robots (mini scale) for the challenge. Simulations of the space at both scales will be available in advance.

More information will be available at MobileManipulationChallenge.org.

Indoor Robotic Contingency (formerly Planetary Robotic Contingency, AKA the modular robot competition)

This challenge simulates an unexpected problem where a robotic solution must be quickly developed and deployed, using only existing resources. The intent of this event is to develop versatile robotic systems and software that can be adapted quickly to address unexpected events. Since humans are present, a natural solution to realistic unexpected events would exploit human creativity and human-robot interaction.

The competition drives not only the development of versatile robotic hardware and on-board software, but also the design and development of programming and assembly tools capable of rapidly implementing a wide variety of capabilities. Since tele-operation is not precluded for this event, the development of effective user interfaces is another expected outcome.

The Environment and Event Parameters

The environment for this event will consist of two areas: a green zone and a red zone. The green zone will represent the human-occupied area from which the robots will be "launched" onto the red zone (where humans may not enter). Robots must be placed in an airlock chamber and drive (or be driven) out onto the red zone. If a robot needs to return to the green zone, it must do so through the airlock chamber. The airlock will be 1.5m long, 1m wide, and 1m tall, with 1m by 1m doors at each end of the long dimension.

Teams will be allowed to use only what they can carry within one airline suitcase. This may be any container that weighs less than 50lbs (23kg) and with outside dimensions summing to less than 62 inches (157cm), and weighing 25kg or less. For example, a container 70cm long, 50cm wide and 30cm tall has a total dimension of 70+50+30 = 150cm, and would be within the size limits. For convenience, we will also allow access to six standard domestic AC power outlets (United States standard NEMA 5-15, 110v, 15A, 60Hz).

The actual unexpected problem to be solved will be announced on the day of the competition. The problems will be constrained to have likely robotic solution that fit the spirit of the competition. For example, you will not be required to have the robot travel 100km to the site of the problem, or to construct a 10-person emergency habitat from freshly-mined regolith. The scope of the task might vary from a short 10 minute task, to one taking several hours. Specific tasks will be announced to all teams simultaneously, and they will work on their solutions independently.

Example Scenarios

To give an idea of the sorts of tasks, here are a few examples. In the past the competition had a space theme where tasks simulated Martian or lunar habitat emergencies. See: http://modlabupenn.org/icra/.

Antenna recovery

An antenna outside the habitat has been knocked over during a Martian storm. The antenna is crucial to the guidance of a resupply transport, which is scheduled to arrive in 4 hours and an EVA is not safe. The team must develop a robot that can reach the antenna, grasp it and reattach it to its receptacle. The antenna is 10 m from the habitat, sitting on top of a 1m by 2m rectangular base that is 1m tall. The base is visible from the habitat. The antenna is a 1cm cylindrical rod 1m long that fits as a peg into a hole 2cm deep in the base. You have a spare antenna and base in the habitat that can be used for testing purposes.

Base station repair

Sensors have discovered a tear in a thermal covering on the top of a storage shed which contains the habitat's store of liquid nitrogen. The team has 4 hours before the Martian morning arrives and starts to dangerously heat the nitrogen. The team must develop a robot that can crawl on top of the structure, use the supplied patching material, and patch the hole by dispensing a supplied glue. Unfortunately, the structure was not designed to support heavy weights, so the robot must weigh less than 5kg or risk collapsing the structure, with disastrous consequences.

Nuclear power plant repair

You must send a robot into a nuclear power plant and shut off a valve before the power plant explodes. The valve is standard 1/2" pipe ball valve shut off by rotating a 3" lever 90 degrees. The amount of torque required to shut off the valve is not trivial. Access to the critical areas has size constraints - e.g. going through pipes or small channels to reach the lever.

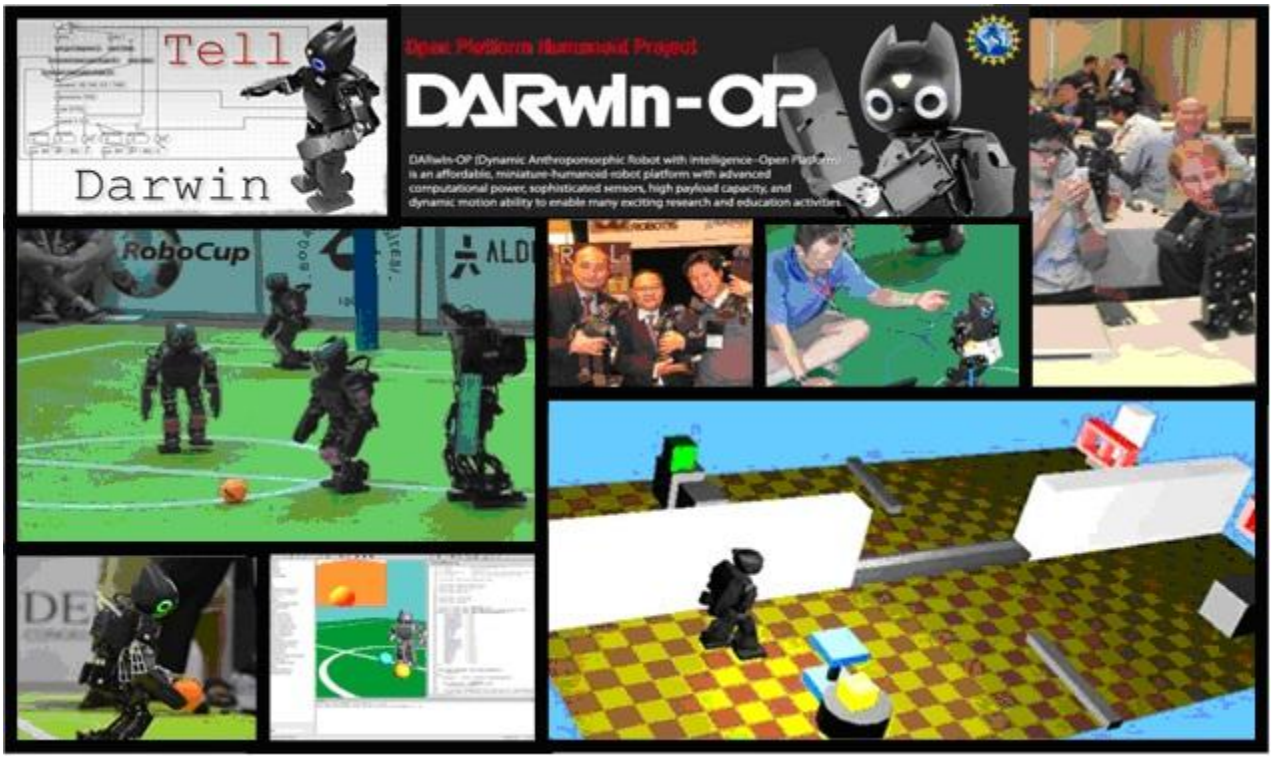
For more details, please contact Mark Yim (yim@grasp.upenn.edu).

Mobile Microrobotics Challenge

Recent advances in the design and fabrication of microelectromechanical systems (MEMS) have enabled the development of mobile microrobots that can autonomously navigate and manipulate in controlled environments. It is expected that this technology will be critical in applications as varied as intelligent sensor networks, in vivo medical diagnosis and treatment, and adaptive microelectronics. However, many challenges remain, particularly with respect to locomotion, power storage, embedded intelligence, and motion measurement. As a result, NIST has organized performance-based competitions for mobile microrobots that are designed to: 1) motivate researchers to accelerate microrobot development, 2) reveal the most pressing technical challenges, and 3) evaluate the most successful methods for locomotion and manipulation at the microscale (e.g., actuation techniques for crawling). This year’s event will include two challenge tasks (mobility and micro assembly), a freestyle demo, and a poster session.

More details can be found at http://www.nist.gov/el/isd/mmc or by contacting Jason Gorman (jason.gorman@nist.gov).

DARwIn-OP Humanoid Application Challenge



Objectives

DARwin-OP is an open platform humanoid project supported by NSF. DAR-win-OP is a vision-capable humanoid with full functionality and scalability. Researchers are strongly encouraged to join an open source community for cooperative research to encourage creative applications from around the globe and maximize contribution for humanoid research. For more information, see: www.robotsource.org.

Registration

Teams (1-4 members) who use DARwin-OP robot to develop their own application are eligible. Projects using customized hardware or simulation only are also welcome.

Participants required to deliver

1 minute video demonstration (for online registration and review)

All participants are entitled to receive Webots Pro 90 day License (1 each)

Please contact info@robotsource.org to get license.

For Finalists selected to make presentation at ICRA

5 minutes free-style demonstration (within 1 meter x 1 meter square table)

5 minutes presentation of project (PPT explanation of robot's functions and technologies)

All necessary equipment and items must be prepared by each participating team.

Judging Criteria

Creative Idea - 40%

Technical Skills - 30%

Overall Completion - 30%

Judging Committee

Professor Dennis Hong (Virginia Tech)

Professor Daniel Lee (University of Pennsylvania)

For more details, please visit www.robotsource.org or contact Kayla Kim (info@robotsource.org)

The Manufacturing Challenge

This will be the fourth year of this simulation-based challenge which is designed to stimulate research in robotics dealing with problems related to mixed-palletizing and intra-factory package delivery and logistics.

CHALLENGE EVENTS

This year's events will include two challenges. Each challenge will have multiple events and teams can participate in one or more events.

(1) Mixed Palletizing Challenge:

This challenge is designed to explore algorithms and techniques to address the three dimensional cutting stock problem, a variant of the combinatorial non-deterministic polynomial-time hard (NP-hard) knapsack problem. Teams will create and evaluate pallet optimal packing plans using XML schemas, a Pallet Viewer application and the USARSim simulation framework.

(2) Mobility & Task Completion Challenge:

The events of this challenge are designed to address the need for one or more factory robots to operate in unstructured environments amongst dynamic obstacles. Teams will use the USARSim simulation framework to deliver completed pallets throughout a simulated warehouse environment.

TEAMS

Teams of one or more researchers, students and faculty may participate in the competition. Teams have the option to be physically present for the challenge events or, participate remotely from their home institution. New and multi-disciplinary teams that foster collaboration and include researchers from other disciplines (ex. operations research, systems engineering, applied mathematics) are especially encouraged to participate.

If you have any questions, contact George Dimitoglou (dimitoglou@hood.edu).

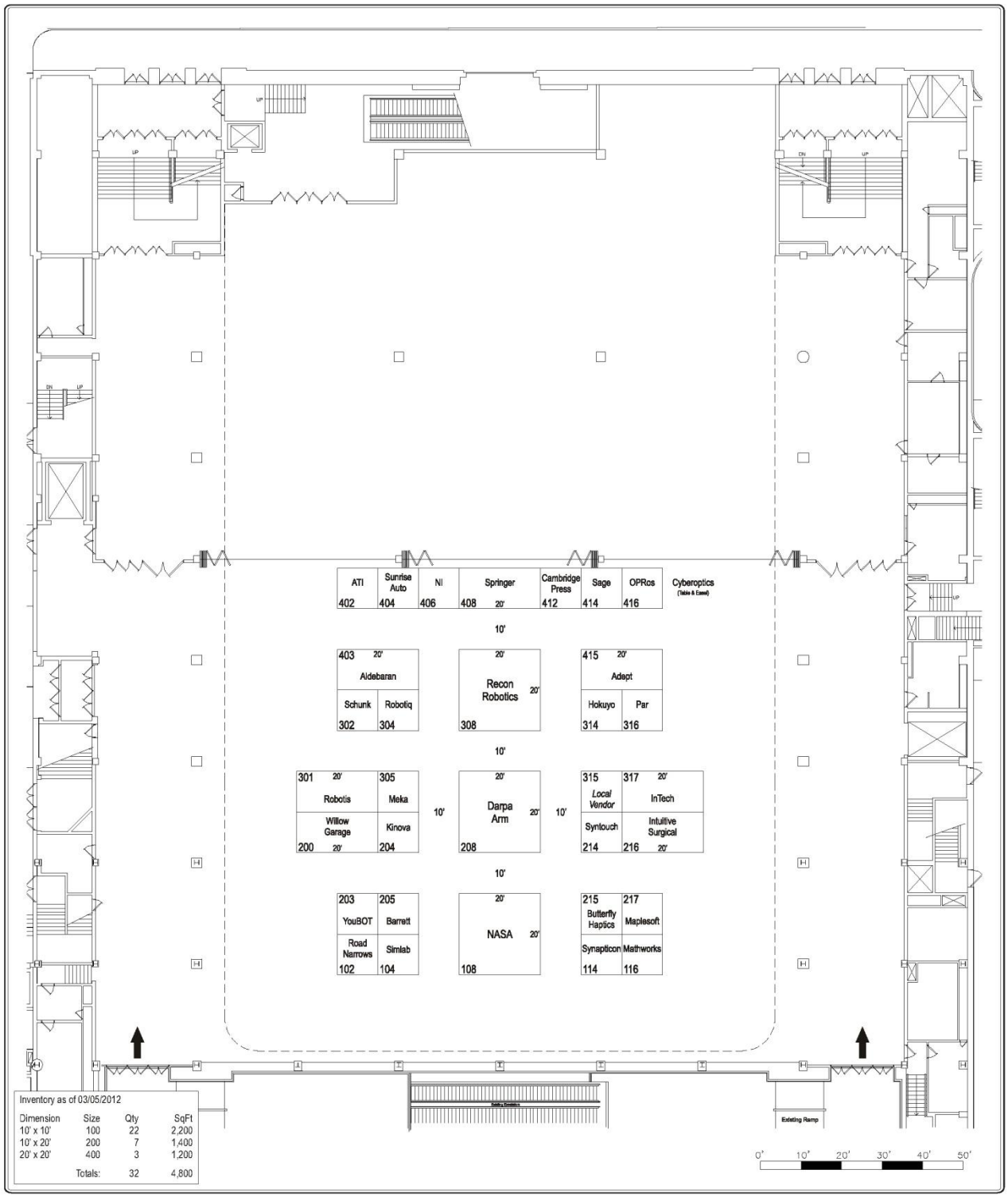
Schedule

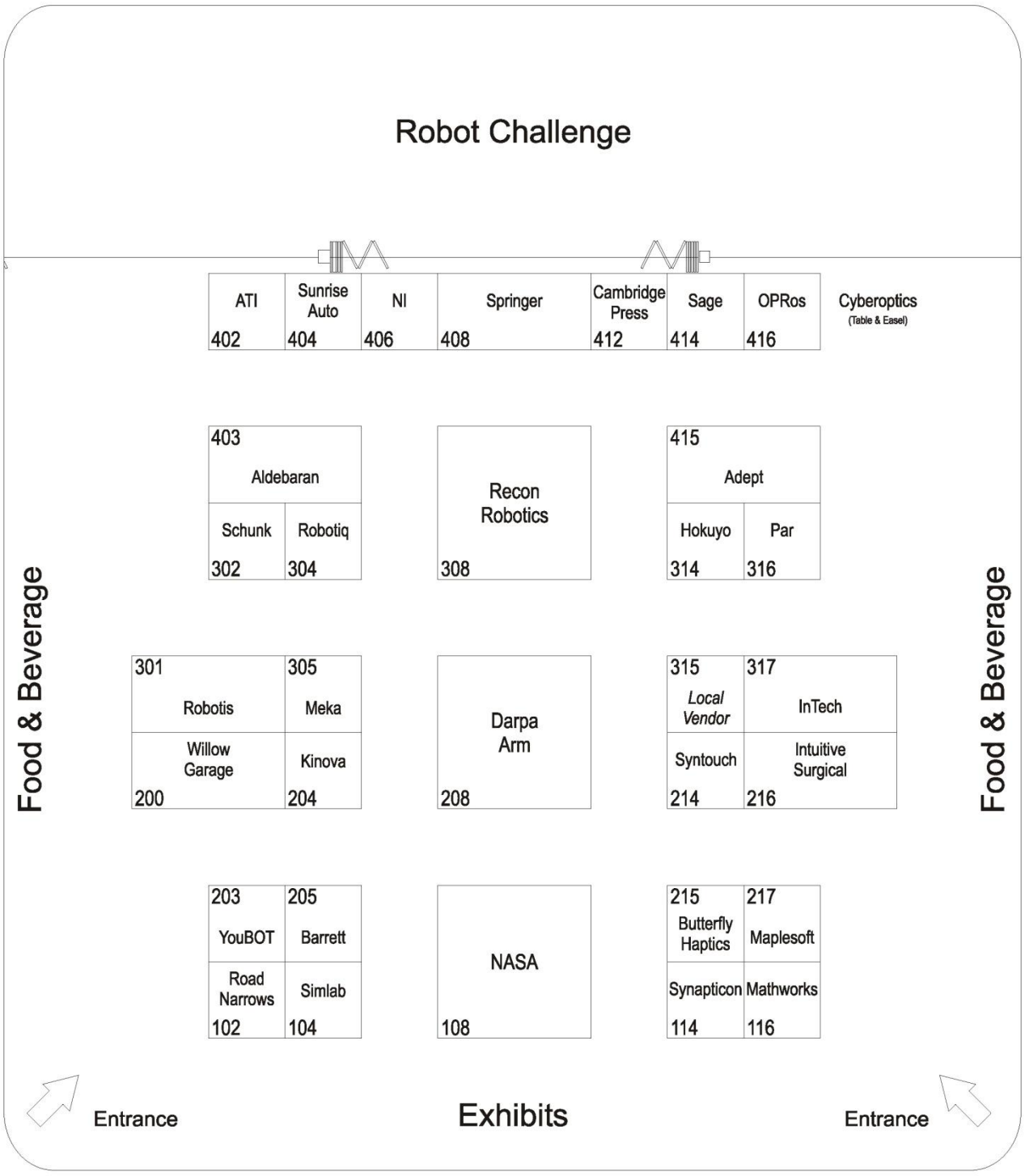
Tuesday May 15	12:00 - 13:30 14:30 - 18:00	Indoor Robotic Contingency
	14:30 - 18:00	Mobile Microrobotics Task 1
Wednesday May 16	8:30 - 13:30 14:30 – 18:00	DARwin-OP
	8:30 - 13:30 14:30 - 18:00	Manufacturing
	8:30 - 12:00 14:30 - 15:30	Mobile Microrobotics Task 2
	12:00 - 13:30 14:30 - 18:00	Mobile Manipulation
Thursday May 17	8:30 - 11:30	Mobile Manipulation
	9:30 - 11:00	Mobile Microrobotics Demos
	14:30 - 15:30	Robot Challenge Summaries

Exhibitions

Floorplan

The exhibitions and Robotic Challenges are being held in the Roy Wilkins Auditorium of RiverCentre in Saint Paul.





GES Global Experience Specialists

2012 IEEE International Conference on Robotics & Automation

St. Paul, Minnesota, USA May 14-18, 2012

Schedule

Tuesday May 15	12:00-18:00
Wednesday May 16	08:00-18:00
Thursday May 17	08:00-18:00
Friday May 18	08:00-12:00

Exhibitors

Aldebaran www.aldebaran-robotics.com

ATI www.ati-ia.com

Adept www.adept.com

Barrett Technology Inc. www.barrett.com

Butterfly Haptics butterflyhaptics.com

Cambridge Press www.cambridge.org

Cyberbotics www.cyberbotics.com

ARM Autonomous Robotic Manipulation	**DARPA ARM**	www.theARMrobot.com
HOKUYO	**Hokuyo Automatic Co., Ltd.**	www.hokuyo-aut.jp
kinova	**Kinova, Inc.**	www.kinovarobotics.com
meka	**MEKA**	www.mekabot.com
NASA • JSC • GM R2 • ISS ROBONAUT	**NASA**	robonaut.jsc.nasa.gov
NATIONAL INSTRUMENTS	**National Instruments**	www.ni.com
OPRoS	**OPRos**	www.opros.or.kr
PAR SYSTEMS	**PaR Systems**	www.par.com
RECON ROBOTICS WORLD LEADER IN TACTICAL MICRO-ROBOT SYSTEMS	**Recon Robotics**	www.reconrobotics.com
RoadNarrows Robotics	**Road Narrows LLC**	www.roadnarrows.com

	**Robotis**	www.robotis.com
	**ROBOTIQ**	www.robotiq.com
	**SAGE Publications Ltd.**	www.sagepub.co.uk
	**Schunk**	www.schunk.com
	**SimLab. Co. Ltd.**	www.rlab.co.kr
	**Springer Publishers**	www.springer.com
	**Synapticon, Inc.**	www.synapticon.com
	**Syntouch LLC**	www.syntouchllc.com
	**Sunrise Auto**	www.dummysensor.com
	**youBot**	www.youbot-store.com

ICRA 2012 Awards

Best Automation Paper Award (sponsored by United Technologies Research Center)

The IEEE International Conference on Robotics and Automation (ICRA 2012) encourages research in automation by annually recognizing the Best Automation Paper for systems that operate autonomously in predictable environments over extended periods, or the explicit structuring of such environments.

Factors that will be considered are originality, depth, quality, presentation, and significance as related to automation, emphasizing efficiency, productivity, quality, and reliability, focusing on systems that operate autonomously in predictable environments over extended periods, or the explicit structuring of such environments.

Best Cognitive Robotics Paper Award (sponsored by CoTeSys)

This award is established to promote interdisciplinary research on cognition for technical systems and advancements of cognitive robotics in industry, home applications, and daily life.

Factors to be considered are: the significance of cognitive behavior and cognitive capabilities, interdisciplinary work, creativity, technical merits, originality, potential impact in applications in industry and at home, and clarity of presentation.

Best Manipulation Paper Award (sponsored by Ben Wegbreit)

The award wants to highlight innovative efforts in the planning and execution of manipulation tasks which take place in dynamic environments. The integration of humans is also critical. Numerous challenges need to be overcome and new applications are also highly sought after.

Best Medical Robotics Paper Award (sponsored by Intuitive Surgical)

This award will recognize outstanding work in the area of medical robotics and computer-assisted interventional devices and systems. Relevant topics may include the design and development of novel devices and robotic systems, and their integration with navigation and imaging technologies for enhanced clinical efficacy.

Best Service Robotics Paper Award (sponsored by KUKA)

This award promotes between robotics science research and industry R&D advancement in the area of service robotics applications (both professional and domestic).

Factors to be considered are: the significance of the new applications, technical merits, originality, potential impact on the field, and clarity of presentation.

Best Vision Paper Award (sponsored by Ben Wegbreit)

For the best paper relating to Vision presented at the IEEE International Conference on Robotics and Automation.

Best Video Award

This award recognizes the most outstanding video in the Video Proceedings of the annual IEEE International Conference on Robotics and Automation.

Factors to be considered are: Technical merit, originality, potential impact on the field, practical significance for applications, and clarity of the video presentation.

Best Student Paper Award (sponsored by United Technologies Research Center)

To recognize the most outstanding paper authored primarily by a student at the annual IEEE International Conference on Robotics and Automation.

Factors to be considered are: Technical merit, originality, potential impact on the field, practical significance of the applications, clarity of the written presentation in the proceedings, and quality of the oral presentation at the conference.

Best Conference Paper Award

The Best Conference Paper award recognizes the most outstanding paper in the Proceedings of the annual IEEE International Conference on Robotics and Automation.

Factors to be considered are: Technical merit, originality, potential impact on the field, clarity of the written paper, and quality of the oral or other presentation.

Industry Forum

Bridging the Gap between Academia, Industry, and Government to Benefit End-Users

Tuesday May 15, 2012, 08:30-17:30, RiverCentre Rooms 10-11

Organizers: Raj Madhavan (University of Maryland, College Park & National Institute of Standards and Technology, USA) & Rainer Bischoff (KUKA Laboratories, Germany)

The ICRA 2012 industrial forum will focus on bridging the gap between academia, industry and government by bringing together experts, leaders, and practitioners from diverse domains and from across the world to provide a truly global perspective. Similar efforts have been undertaken in the United States, Europe, and Asia with mixed results. You will hear from researchers, vendors, and funding agencies on their experiences and the roadblocks they have encountered. A panel discussion will conclude the forum to foster dialog between participants and speakers. Based on the discussions stemming from the entire day, a white paper will be published with an action plan to go from where we are to where we can. The target audience of the forum is end-users, developers, vendors, and anyone who is interested in robotics and automation technologies.

In addition to the main theme, the following topics will be addressed during the forum:

- How can industry and academia work together by actively collaborating and acknowledging differences in practices, implementations, and mindset?
- What can government agencies do to foster such collaboration and facilitate innovation and technology transfer?
- How can the end-users and the community at-large benefit from the above three groups working as a cohesive whole?
- What are known (and hidden) and not-so-widely discussed barriers and roadblocks?
- What is the role of standardization and ad-hoc standards and best practices?
- Can the support of entrepreneurship address some of the aforementioned problems?
- How can we leverage existing know-how and target the low-hanging fruit as well as long-term issues in a collaborative fashion?

Agenda

The final list of speakers is yet to be confirmed. Please check the ICRA 2012 website (http://www.icra2012.org) and IEEE-RAS IAB website (http://www.ieee-ras.org/industrial) for an updated final agenda.

08:30-08:40	Introduction & Welcome: Dr. Raj Madhavan & Dr. Rainer Bischoff
08:40-09:00	Opening Remarks: IEEE-RAS President, Prof. David Orin & IEEE President-Elect, Dr. Peter Staecker

09:00-10:30	Invited Talks (1)
10:30-10:45	Coffee Break
10:45-11:45	Invited Talks (2)
12:00-14:30	Lunch & ICRA 2012 Plenary
14:30-16:00	Invited Talks (3)
16:00-16:15	Coffee Break
16:15-17:15	Panel Discussion
17:30	Adjourn

NSF Presentation

Entrepreneurship and Innovation: The Next Decade NSF's Innovation Corps and the Future of Entrepreneurial Education

Wednesday May 16, 2012, 15:00-17:00, RiverCentre Rooms 10-11
Organizer: Richard Voyles (National Science Foundation, USA)

In the United States, the National Science Foundation (NSF) is developing a new program to reinvigorate entrepreneurship tied to federally-sponsored research. The Innovation Corps is an aggressive new program to train students and principal investigators in the subtleties of commercializing output of basic research. Researchers with NSF-sponsored research ideas that they believe are nearing commercial potential can apply for funding to help determine the business potential of ground-breaking ideas. To qualify for funding and make a go/no-go decision on commercialization potential, PIs must do two things: assemble an entrepreneurial team and commit the team to enroll in an NSF-supported entrepreneurship course tailored for engineers and scientists.

Education is a key pillar of the NSF mission and entrepreneurship and innovation are key drivers of the United States' and world economies. However, some believe entrepreneurial education has failed to deliver substantive changes in the success rate of technology-based start-up businesses in the United States. NSF has adopted an emerging new curriculum being championed at select universities that formulates business creation as a methodology familiar to engineers and scientists: hypothesis testing. By capturing this methodology and introducing it to educators, engineers and scientists, the Innovation Corps endeavors to construct an innovation ecosystem that more efficiently captures the fruits of government investment in long-term research for job creation and economic development. This bold new program has been garnering deep interest from government agencies and entrepreneurial educators around the world. In an economic climate that presents increasing challenges due to the accelerating pace of technological change, dwindling natural resources, rising unemployment, and spiraling populations, greater efficiency in translating academic advances into meaningful impact on society is relevant to all.

In this presentation, the NSF Innovation Corps for U.S. researchers will be described, as well as personal perspectives on how the program has shaped PI plans.

http://www.nsf.gov/news/special_reports/i-corps/

Social Events

Monday, May 14

Two parallel gatherings will take place at the Crowne Plaza.

- **Student Social:** Students pre-registered for this welcome party will be treated to local food from the MN State Fair, and enjoy a presentation by Jorge Cham.
  Location: Minnesota Ballroom, Lower Level (18:00 – 20:00)
- **ICRA 2012 Reception:** An opportunity for workshop attendees and early arrivals to socialize and network before the start of the conference
  Location: Great River Ballroom, First Level (18:00 – 20:00)

Tuesday, May 15

- **Women in Engineering Luncheon:** This event is organized by the IEEE Women in Engineering (WIE) and Membership Activity Board (MAB), and sponsored by IEEE. The ICRA "Birds of a Feather" Women Luncheons offer the opportunity to young female researchers to discuss informally with senior faculty members around a free lunch. "Birds of a Feather" Women Luncheon has been held as one of social events during ICRA since 2007, and will be held as part of services served by WIE and MAB since 2011. Free lunch will be available on a first-come, first-served basis to ICRA women attendees.
  Location: Crowne Plaza, Great River Ballroom (12:00 – 13:00)
- **Welcome Reception.**
  Location: Minnesota Science Museum (19:30 – 21:30)

Wednesday, May 16

- **GOLD Lunch:** A lunch for all Graduates of the Last Decade (GOLD) will be organized at the Continental Ballroom level. This luncheon was initiated within the RAS Technical Activities Board (TAB) as a means to let graduates be aware of what the society has to offer, and to network with each other. The opportunity is also used to present the structure of the society, and introduce the various Technical Committees forming TAB. RAS members will have first priority. If you are not yet a member, you can sign up now at www.ieee-ras.org. Pre-registration required.
  Location: Crowne Plaza, Great River Ballroom (12:00 – 13:00)
- **Lunch with the Leaders:** (for 100 RAS student members) This event is organized by the IEEE Robotics and Automation Society (RAS) . Lunch with Leaders (LwL) was initiated by the Student Activities Committee with the aim to provide students with an opportunity to get in contact with leaders and get advice and mentoring on their career and research. Leaders in attendance will include: **Antal Bejczy, T. C. Steve Hsia, Paolo Dario, David Orin, Vincenzo Piuri, Kazuhiro Kosuge, Bruno Siciliano**. Note that this activity is

intended for current students. RAS members will be prioritized. Pre-registration required.
Location: Crowne Plaza, Windows on the River (12:00 – 13:00)

- **Banquet:**
  Location: RiverCentre Grand Ballrooms (19:00 – 21:30)

Thursday, May 17

- **Awards Lunch:**
  Location: RiverCentre Grand Ballrooms (12:00 – 13:00)
- **Farewell Reception:**
  Location: RiverCentre Roy Wilkins Auditorium (18:30 – 20:30)

Conference Locations

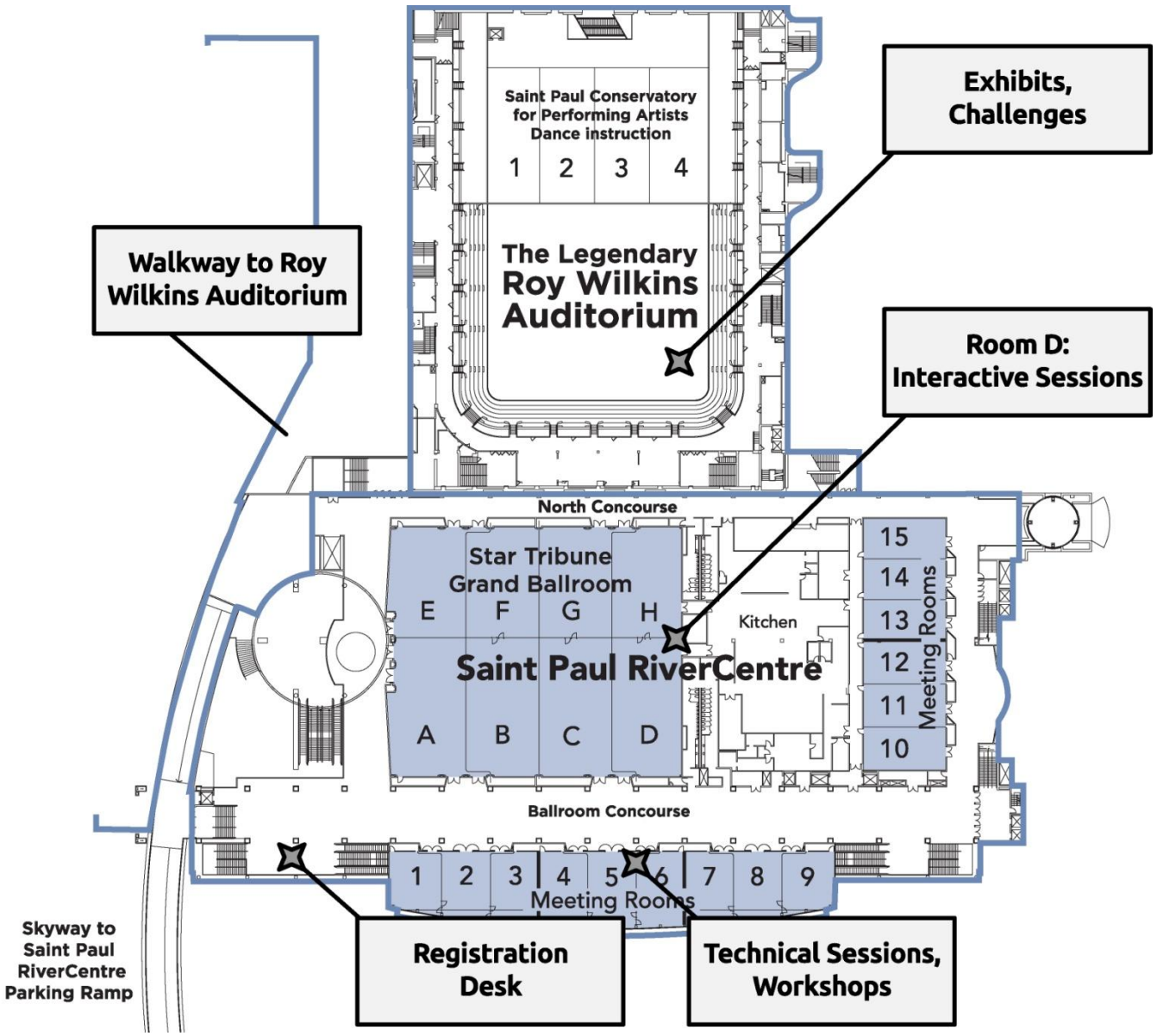
The IEEE International Conference on Robotics and Automation (ICRA) 2012 will kick off on May 14. From May 14 to May 18, the conference will showcase technical sessions, workshops, tutorials, and exhibits reflecting advances in our rapidly developing field.

ICRA 2012 will take place at the RiverCentre in Saint Paul, Minnesota, USA. The convention center is located in downtown Saint Paul overlooking the Mississippi River. The walk from RiverCentre to Crowne Plaza, the main conference hotel, takes about eight minutes along Kellogg Boulevard.

All workshops, technical sessions, exhibits and robotics challenges will be held at the RiverCentre. The Crowne Plaza will host the Robotics and Automation Society (RAS) meetings, as well as some of the social events. On Monday, Tuesday, Wednesday and Friday, lunchboxes will be available for purchase at the Ordway Center.

Minneapolis and Saint Paul constitute a vibrant metro area known as the Twin Cities. The Cities are home to a number of Fortune 500 companies including Target, Best Buy, 3M, Medtronic, and Xcel Energy. The area is also a major hub for arts, sports, education and entertainment. Together with its numerous parks, lakes, biking and hiking trails, the Twin Cities have something fun and exciting for any taste. As the ICRA 2012 Organization Team, we hope that you enjoy your time in the Land of 10,000 Lakes!

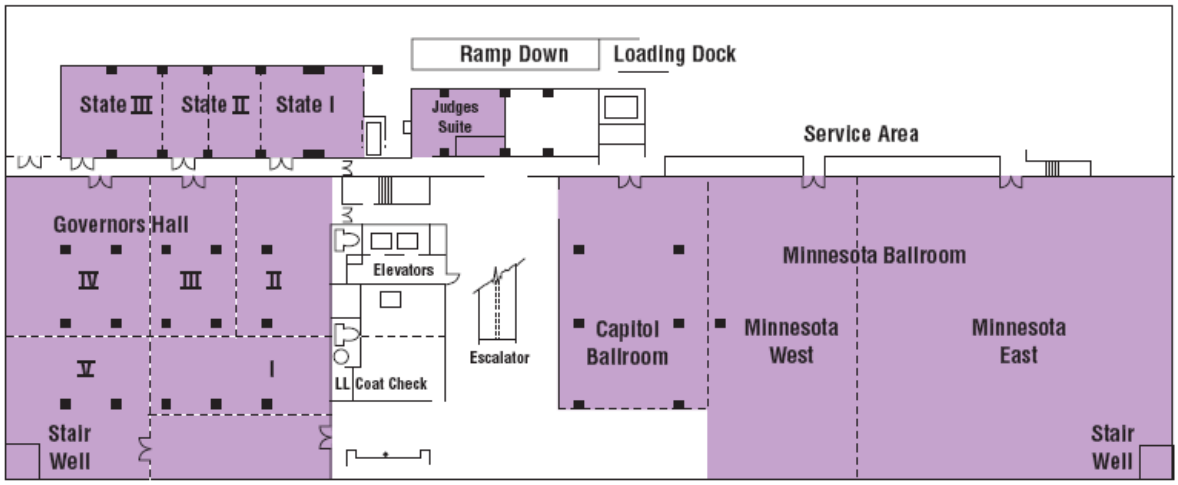
Conference Venue: Saint Paul RiverCentre



Meeting Locations at the Crowne Plaza

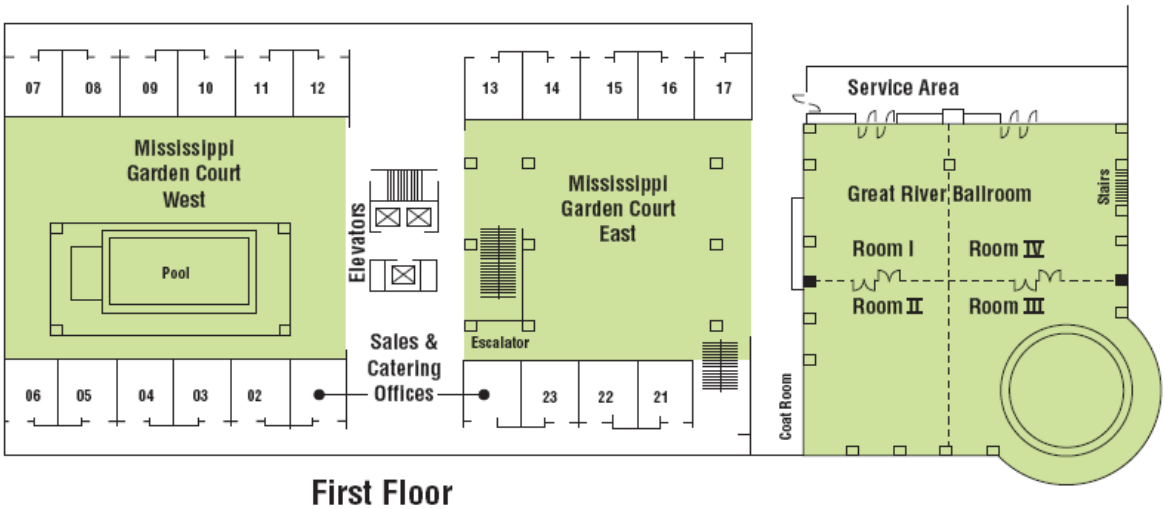
The events will be spread out across the Lower Level, Lobby Level and the First Floor.

- Lower Level: Minnesota Ballrooms, Governors Hall, State Rooms



Lower Level

- Lobby Level: Kellogg I, II, II (layout not shown)
- First Floor: Great River Ballroom

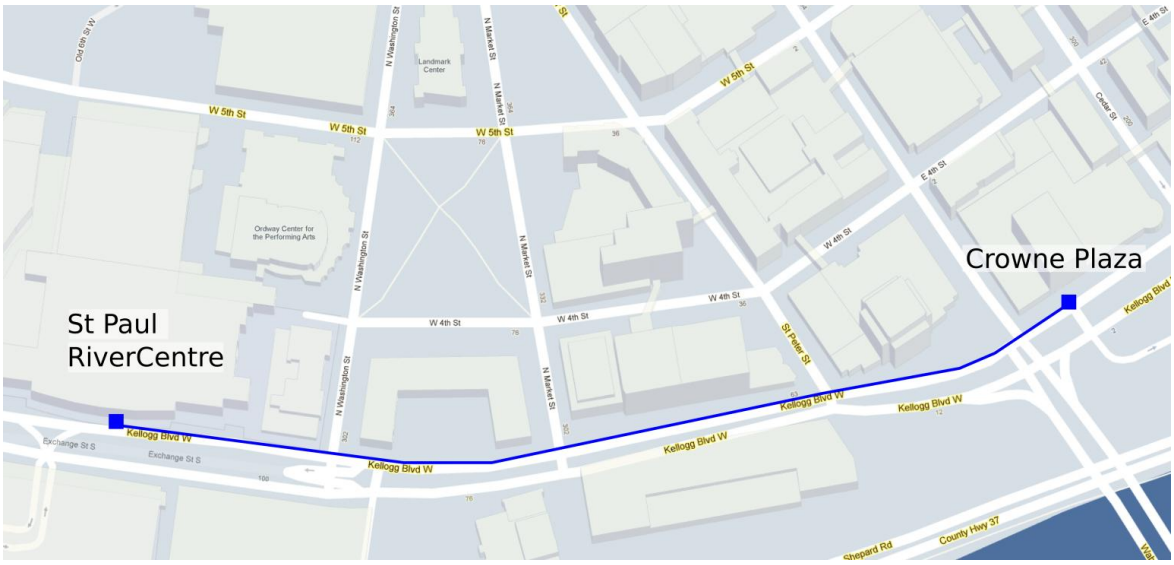


First Floor

Accommodations

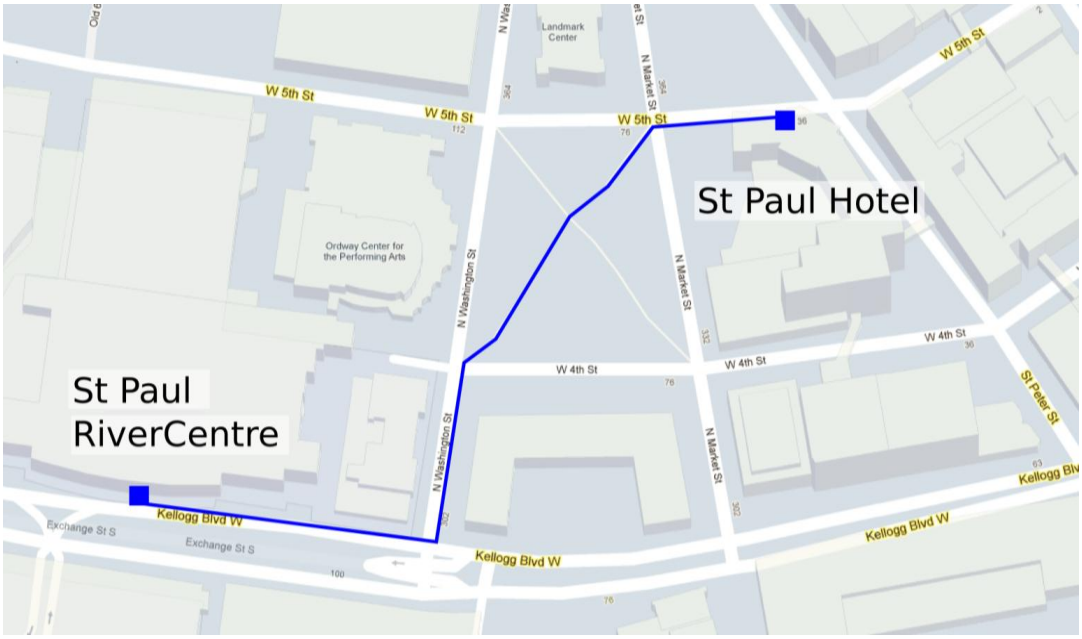
Crowne Plaza St. Paul Riverfront Hotel

Distance from Venue (Walking): ~8min (0.4mi / 0.6km)



St. Paul Hotel

Distance from Venue (Walking): ~5min (0.3mi / 0.5km)



In case that you have problems with the online reservation system of the Saint Paul hotel, please call or email the hotel and mention the IEEE code 486144.

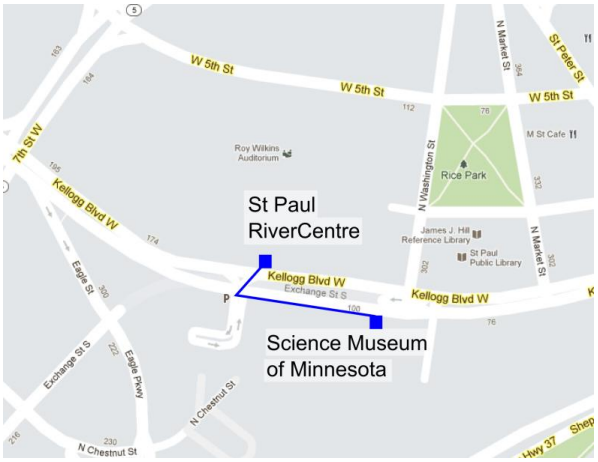
Phone (Toll Free): 1-800-292-9292 Email: reservations@saintpaulhotel.com

The Science Museum of Minnesota

On Tuesday May 15, the ICRA 2012 Welcome Reception will take place at the Science Museum of Minnesota. Located on Kellogg Boulevard and overlooking the Mississippi River, the Science Museum of Minnesota offers guests a unique opportunity to explore all kinds of science learning. With nearly nine acres of indoor space devoted to hands-on science activities, a state-of-the-art giant screen theater, and an outdoor exhibit gallery featuring science-themed mini-golf and a 17,000 square-foot prairie maze, the Science Museum of Minnesota has something for visitors of all ages and backgrounds to enjoy.

In the Science Museum of Minnesota's Experiment Gallery, visitors can carry out simple experiments and find the joy of discovery as they uncover the fundamental properties of physical events. They can explore energy transformation, weather, air dynamics, light, waves and resonance, and more. The Science Museum of Minnesota's Cell Lab offers visitors an opportunity to don a lab coat and gloves to explore the world of cells through creative experiments.

One of the highlights of the museum's Dinosaurs and Fossils Gallery is an 82-foot-long ***Diplodocus***, a plant-eating dinosaur from the Jurassic period. With St. Paul's roots originating from the Mighty Mississippi, the Science Museum of Minnesota's authentic towboat, the *Charles E.*, serves as a viewing platform overlooking the river that gave the city its life. A perennial summer visitor favorite, the Big Back Yard features a science-style mini-golf course, a 17,000-square foot prairie maze, gardens, and an award-winning solar-powered building. During the conference, SMM will also feature a Pirates exhibit!



Local Attractions: Sample Itineraries

Have some time to spare? Try out one of these sample itineraries, as recommended by our volunteers!

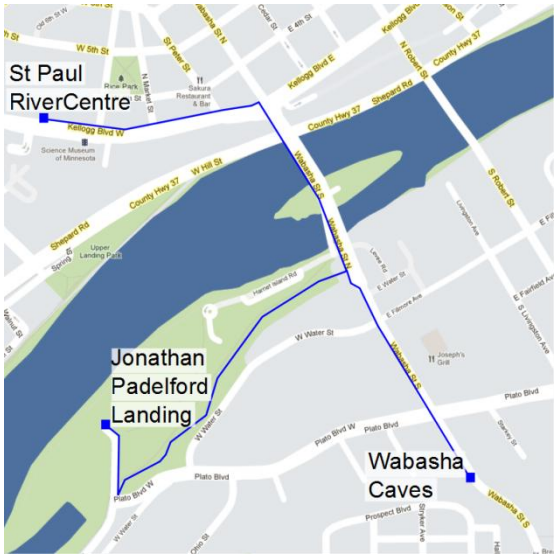
Downtown Saint Paul

If you will miss the welcome reception, you can visit the **Science Museum of Minnesota** (http://www.smm.org/) which is right across from the RiverCentre (be sure to see the pirate exhibit). Alternatively, you can visit the Minnesota History Center: http://www.minnesotahistorycenter.org/.

The **Minnesota History Center**, which opened in October of 1992, is home to the Minnesota Historical Society's collections and provides a place for visitors to discover their connections to the past. This landmark building houses a museum, library, classrooms, and conference rooms, the 314-seat 3M Auditorium, two museum stores and a café.

During the conference, a new exhibit featuring a rare, early published version of the U.S. Constitution and an even more rare draft of the Bill of Rights, along with the original editions of the two state of Minnesota Constitutions, will be on display.

How to get there: The walk from the RiverCentre takes about ten minutes. We recommend taking the following path which is slightly longer, but includes **Mickey's Dining Car**. Listed on the national register of historic places and featured in several movies, the Food Network and travel TV programs, Mickey's is an authentic 1930's Art Deco diner. The diner has been serving up breakfast, lunch and dinner 24 hours a day for nearly 70 years. For more see www.mickeysdiningcar.com.



Other Saint Paul Activities

Cathedral of St. Paul: Take a fifteen minute walk from the RiverCentre to see one of the most prominent attractions of St. Paul.

Jonathan Padelford: Enjoy the splendor of the Mississippi with a ride on the Jonathan Padelford, an authentic sternwheeler riverboat. A historically narrated public sightseeing excursion departs at 2P.M. on Saturdays and Sundays beginning May 12. The tour runs for 90 minutes. Sights on the way include: the St. Paul High Bridge, Fountain Cave, Pike Island, and Fort Snelling. Tours depart from Harriet Island, which is directly across the river from the Science Museum. The Jonathan Padelford is a twenty minute walk from the Crowne Plaza (twenty-five from the RiverCentre). Visit http://www.riverrides.com/pages/public/sightseeing.html.

Wabasha Street Caves: These manmade caves have historically been used for growing mushrooms and for the storage of food. In the 1920s, they were converted into a nightclub, and frequented by gangsters such as John Dillinger (OK, it's just a rumor). The caves are said to be haunted (this one is definitely true). The walk is about fifteen minutes from the Crowne Plaza, and twenty from the RiverCentre.

Summit & Grand Avenues: In the mid-1800s, St. Paul was transitioning from a town to a city, and the business leaders of the day used their newfound wealth to build themselves mansions on the hill overlooking their empire. Many of these mansions are still standing today, under the shade of broad trees, stretching from the Cathedral of St. Paul down Summit Avenue for 4 1/2 miles. This is the longest stretch of Victorian houses in the

US. Highlights include the James J. Hill House, the Minnesota Governor's Mansion, and the row house where the author F. Scott Fitzgerald lived. If you get tired of houses and trees you can stop for a bite to eat on Selby Avenue near the Cathedral, or alternatively near the intersection of Grand Avenue and Victoria (a block south of Summit Ave). Both areas were once streetcar stops which allowed commercial districts to build up in mostly residential areas. Though the street car is long gone, the commercial areas remain, and they are popular local destinations.

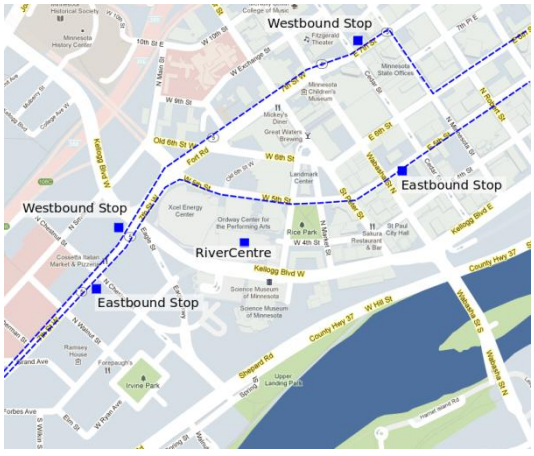
Mall of America & Summit Brewery

The **Mall of America** features a wide range of dining and entertainment options including an indoor theme park, a water park, a 1.2 million gallon aquarium, 4.3 miles of store fronts, and over 50 restaurants. Visit www.mallofamerica.com for more information.

How to get there: The conference is planning to provide shuttles to MoA. Please check the information booth by the registration area in RiverCentre for departure information. You can also take Bus 54 Express Route on 5th Avenue. The trip there is about half an hour.

Summit Brewery: If you are taking public transportation, you can stop by the Summit Brewery along the way. Summit is a uniquely Minnesotan beer, and a local favorite. The Brewery offers free tours and free samples, and has a gift shop on site. Book the tour in advance at: http://www.summitbrewing.com/culture/tours.

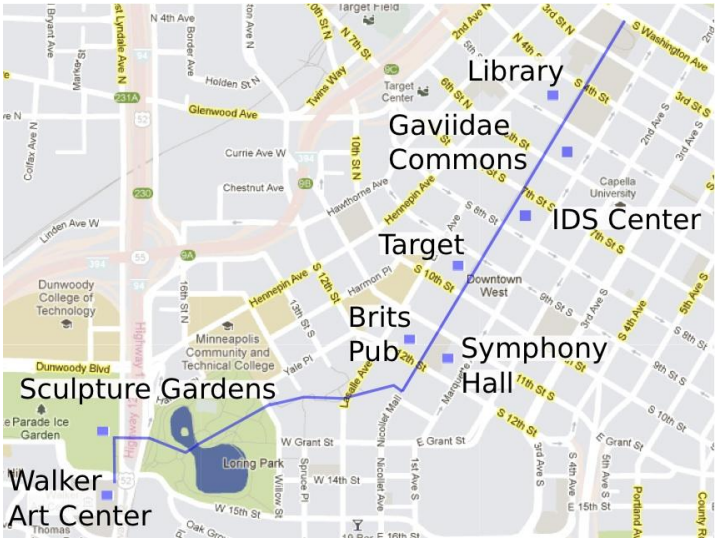
How to get there: Route 54 takes 20 minutes from the Saint Paul River Centre. Disembark on Otto Avenue.



Minneapolis

Our suggested itinerary for Minneapolis starts from the Minneapolis Central Library (make sure to peek inside!) and ends at the Minneapolis Sculpture Gardens and Walker Art Center. The walk takes about thirty minutes. Our starting point, the Minneapolis Public Library, marks the north end of Nicollet Mall – a pedestrian mall lined with restaurants and shops. You can walk outside or indoors, through the skyways – a complex web of tunnels used by Minnesotans in the winter.

The best place to enter the skyway system is through the Gaviidae Commons home to Nieman Marcus, the premium outlet Saks Off 5th, and other upscale shopping and dining areas. Continuing down the mall you'll encounter the IDS center, the tallest skyscraper in the Twin Cities. The Center is home to a nice indoor plaza and to more affordable lunch options. Between the IDS center and Target flagship store, you can stop by Barnes and Noble (bookstore), go to Panera for quick sandwich, or enjoy Zelo; an upscale restaurant featuring American and Italian fusion cuisine. The next block features the Target flagship store along with a rich selection of bars and restaurants including: The News Room, an American pub and restaurant with decor showcasing news events in Minneapolis' history; Barrio, a tequila bar with Mexican appetizers; and The Local, a famous Irish pub. The Local is a great spot to catch the latest European soccer match on TV. In the following blocks, there is the Minneapolis Symphony Hall, which is separated from the street by a large open plaza, and Brit's Pub, a classic English watering hole complete with the largest rooftop patio in the city and its own lawn bowling pitch. In the middle of the next block, Loring Greenway leads away from the street to the west. The Greenway provides a quick, shady path to Loring Park and the pedestrian bridge over Highway 94 to the Minneapolis Sculpture Garden and Walker Art Center.

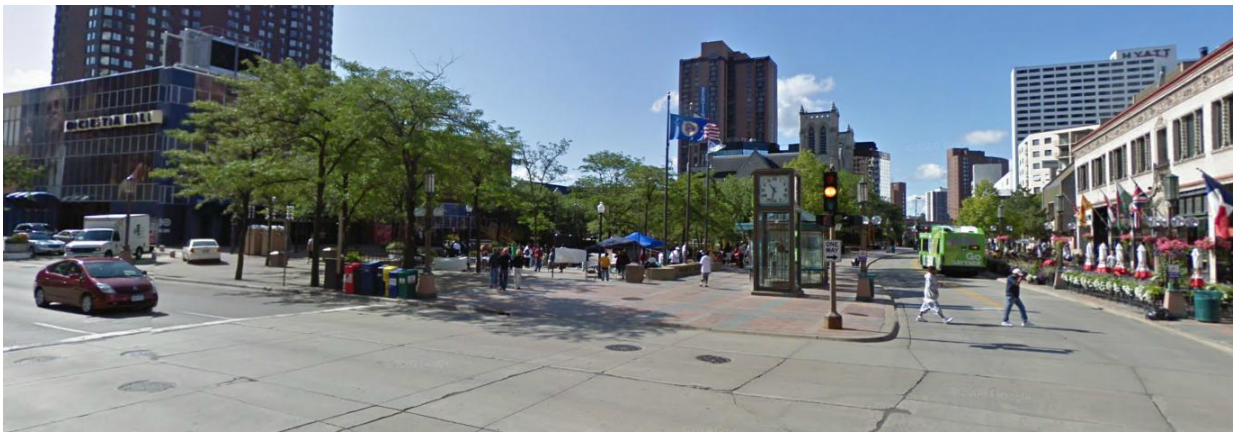


Featuring over 40 permanent art installations, the Minneapolis Sculpture Garden is one of the largest urban sculpture gardens in America. The Walker Art Center is one of the nation's five biggest museums showcasing modern art. It features work by Georgia O'Keeffe, Andy Warhol, Cindy Sherman, and Frank Gaard. The Museum Shop is worth a visit, as is the restaurant 'Gather,' with its inventive, locally-sourced American cuisine. For more information see www.walkerart.org.

How to get there: In the evening take one of the conference-provided shuttles (planned – please check the info desk), or catch the 94 bus on the corner of Minnesota and 6th Street. From the Crowne Plaza, walk east along Kellogg Blvd to Minnesota St. (two blocks), then walk along Minnesota St. to 6th (three blocks). There are many other direct buses from Downtown Saint Paul to Downtown Minneapolis (e.g. Route 16 and 50), but 94 is the fastest.

Other Minneapolis Activities near the Nicollet Mall:

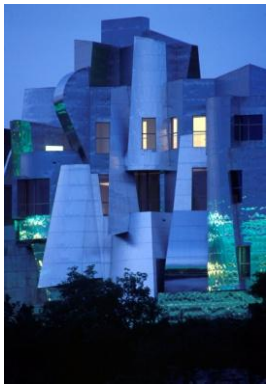
- Baseball fans can catch a Minnesota Twins game at the new Target Center in Minneapolis:
  May 13 (1:10pm) against the Blue Jays
  May 14 (7:10pm) and 15 (12:10pm) against the Indians
- The Twin Cities support more live theater per capita than any other city in the U.S. with the exception of New York City. There are about one hundred theaters in the Twin Cities. Most are located on Hennepin Avenue in downtown Minneapolis
- **The Minnesota Orchestra**, now in its second century and led by Music Director Osmo Vänskä, ranks among America's top symphonic ensembles, with a distinguished history of acclaimed performances. During the conference, you can catch:
  - Romeo and Juliet - Sat May 12, 2012 8P.M.
  - Vänskä, Sudbin and Mozart -
    Thu May 17, 11A.M.; Fri May 18, 8P.M.; Sat May 19, 8P.M.; Sun May 20, 2P.M.



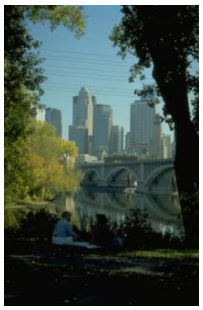
University of Minnesota Campus & Riverfront District (Minneapolis)

The Mississippi river runs through the University of Minnesota's Minneapolis campus dividing the campus into the East Bank and West Bank. The Washington Avenue Bridge connects the two banks with dedicated pedestrian and bike lanes. The bridge provides excellent views of the Mississippi and of downtown Minneapolis.

The Northrop Mall is the heart of the campus, with the Northrop Memorial Auditorium on one end, and the Coffman Memorial Union at the other. The Union is a hub of recreational student activities. The campus is also home to the **Weisman Art Museum** and the **Bell Museum of Natural History**, both on the East Bank. Notable architecture on campus includes the Weisman building (picture below) and the Armory building. Visit http://www.umn.edu/ to learn more.

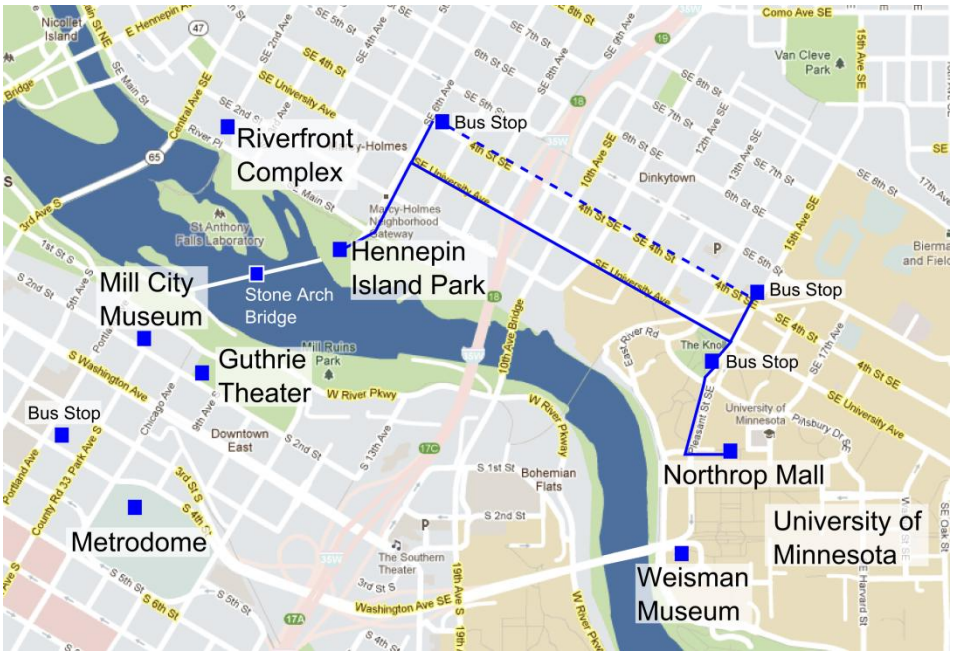


How to get there: You can join the campus tours organized by the ICRA committee. You can also take buses Route 3, 16, and 50 from the Crowne Plaza Hotel to the campus (about 55 minutes). Pleasant Street and Eddy Hall (East Bank) is the stop you want. The University operates a regular, free shuttle service around the campus.



Riverfront District: Close to the University of Minnesota is the historic Riverfront district featuring a museum, observation decks, restaurants with live outdoor music, jogging and biking trails. The **Guthrie Theater** building features a cantilevered lobby open to all visitors, dubbed "the endless bridge", with an observation site overlooking the Mississippi River and the Minneapolis skyline. The **Mill City Museum**, built into the ruins of what was once the world's largest flour mill, features multimedia shows, movies and self-guided exhibits about the intertwined histories of the flour industry, the river, and the city. The **Saint Anthony Riverfront complex** situated next to the Hennepin Island Park offers numerous sports restaurants and bars with live outdoor music in the summer. Biking trails run across both banks of Mississippi, and rental bikes are available at nearby locations from **Nice Ride MN**. Visit http://stanthonymain.com/.

How to get there: From St. Paul, you can take Bus Route 94 and get off the bus at 4th Street S and Portland Avenue (about 35 minutes). If you are coming from the university campus, you can walk directly (about 15 minutes), or take bus route 6 at the 4th Street and 15th Avenue SE bus stop and get off at the 4th Street and 4th Avenue SE bus stop (this takes about six minutes).



Don’t want to walk?

- From the St. Anthony Main (near the Riverfront complex above) you can rent bikes, or take a guided Segway tour:
  - https://www.niceridemn.org
  - http://www.humanonastick.com
- Minneapolis was recently named America's most bike friendly city by Bicycling Magazine

Other Local Information/Activities

Conference Registration

A conference registration desk will be set up and opened at the RiverCentre during the following hours:

Monday May 14	07:30-18:00
Tuesday May 15	07:30-18:00
Wednesday May 16	07:30-17:00
Thursday May 17	07:30-17:00
Friday May 18	07:30-13:00

Conference Hot-Line

During the registration hours, you can reach our information desks by calling +1-651-726-1802

Wireless Network Access

Wireless network access will be provided for all participants during the conference. There will be two SSIDs (secure and open access):

- ICRA2012 - SSID for open authentication
- ICRA2012-secure - SSID for WPA2 with PSK

To ensure excellent quality of service, we will support 2400 connections in meeting rooms 1-15 and the hall outside these rooms.

Technical Tours

Technical tours will take place at the University of Minnesota Digital Technology Center (DTC) on the morning of Monday, May 14 and on Friday, May 18 in the morning and afternoon. The tours will give participants the opportunity to visit research exhibits and attend robotics and computer vision demonstrations from the research groups of faculty at the UMN including, among others: Maria Gini, Volkan Isler, Bernice Mettler, Nikos Papanikolopoulos, and Stergios Roumeliotis. The tours are free and include transportation. Pre-registration is required. Please view the conference website for more information after May 1st.

Children

Minnesota offers some wonderful activity options for families with kids. Both the Science Museum (across from the conference venue) and the Children's Museum (a couple of blocks North) provide all day fun and learning. The Mall of America is a must-see. You might also consider visiting Como Park. Once there, be sure to see the Como Ordway Memorial Japanese Garden – a living symbol of the peace and friendship between Saint Paul and its sister city Nagasaki, Japan. Como Park also houses a small zoo, which is free and open every day of the week. You can catch Bus 3 from downtown Saint Paul to Como Park.

The main zoo is the Minnesota Zoo which is ~20 miles south of the Cities, and has lots of fun exhibits and activities.

Weather/Time Information

The average temperature for St. Paul in the middle of May is a high of 70°F (21°C) and a low of 49°F (9.4°C). The weather is highly variable. Temperatures in the mid-80s or the 30s are not unheard of for this time of the year. Most days are sunny but intense rainstorms can arrive with little warning. Humidity ranges from medium to high. Dressing in layers is advisable.

Saint Paul is in the US Central Daylight Time zone (GMT -5).

The North Country

Metro Connections will offer tours to Northern Minnesota:
http://www.metroconnections.com/transportation/tours/

Check out the information booth at the conference for details.

More Saint Paul Information

The City of Saint Paul (http://www.visitsaintpaul.com/) will staff an information booth located in the RiverCentre lobby during the core conference hours to answer questions about Saint Paul activities.

Shuttles

The conference is planning to provide shuttles to downtown Minneapolis in the evening and the Mall of America during the day. The shuttles will pick up and drop off from the RiverCentre on Kellogg Boulevard. A shuttle to the Minneapolis/St. Paul International Airport is available for a fee (please see below for discount information).

Discount on SuperShuttle and ExecuCar MSP Airport Transfers

Online Group Discount Code: QT4QC valid for travel 5/9-5/22, 2012)

To receive your group's discounted rate:

- Make your roundtrip reservation by following this link: https://www.supershuttle.com/default.aspx?GC=QT4QC
- Provide the requested information your name, flight details (from and to the airport), and your local contact phone number.
- Select your hotel/landmark from the drop-down listing of hotels (type 3-5 letters of name in search box)
- Choose your preferred service and pricing: (additional $1 per person fuel surcharge may apply)
  - SuperShuttle Shared-Ride ($13 one way, $22 round trip per person) savings of $1 or $6 RT
  - Exclusive Van Save on Service, up to 10 passengers ($85 plus 18% gratuity)
  - ExecuCar Sedan Service ($49 plus 18% gratuity per direction for up to 4 passengers)
  - ExecuCar baggage claim "Meet and Greet" additional $25
- Provide a credit card for payment and print your confirmation page [or e-mail it to yourself]

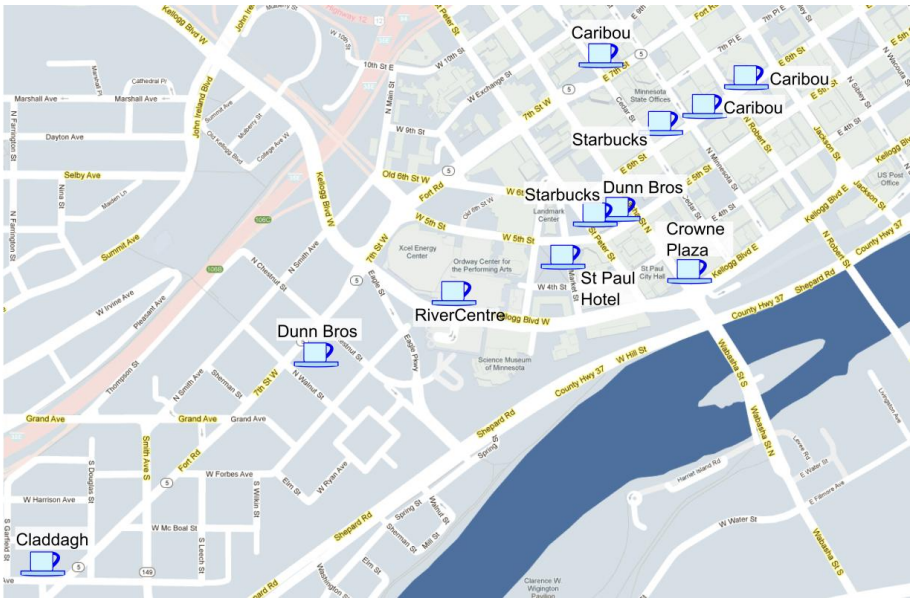
Reservations from MSP are not required for SuperShuttle service, but are recommended. ExecuCar must be reserved and pre-paid in advance.

Terminal #1: Upon arrival to MSP International airport, claim your luggage at Baggage Claim. From “Baggage” follow the signs for Hotel Shuttles and Scheduled Vans to the Ground Transportation Atrium. The SuperShuttle service desk is centrally located and open 24/7.

Terminal #2 (Southwest, Sun Country, Air Tran): Proceed across the street from the terminal; the ground transportation center is located on the ground floor of the parking ramp. Pick up the courtesy phone at the blue and yellow SuperShuttle Kiosk and you will be automatically connected to a local agent.

Please note, these are non-commissionable discount rates. A $2 fee may be assessed for 1-800# reservations.

Coffee



Dunn Bros Coffee
367 Wabasha St
St Paul, MN 55102
(651) 767-0567

Caribou Coffee
56 6th St E
St Paul, MN 55101
(651) 225-0844

Starbucks
411 Cedar Street
St Paul, MN 55101
(651) 292-5187

Caribou Coffee
444 Cedar Street
St Paul, MN 55101
(651) 222-3130

Dunn Bros Coffee
242 7th St W
St Paul, MN 55102
(651) 222-3445

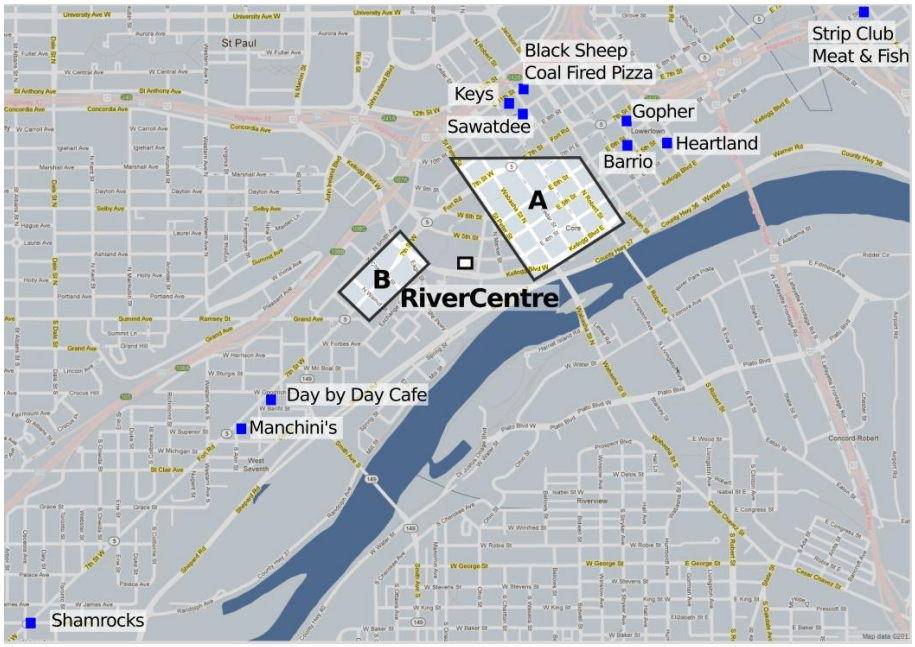
Caribou Coffee
401 Robert Street
St Paul, MN 55101
(651) 295-8686

Starbucks
380 St Peter St
St Paul, MN 55101
(651) 222-7118

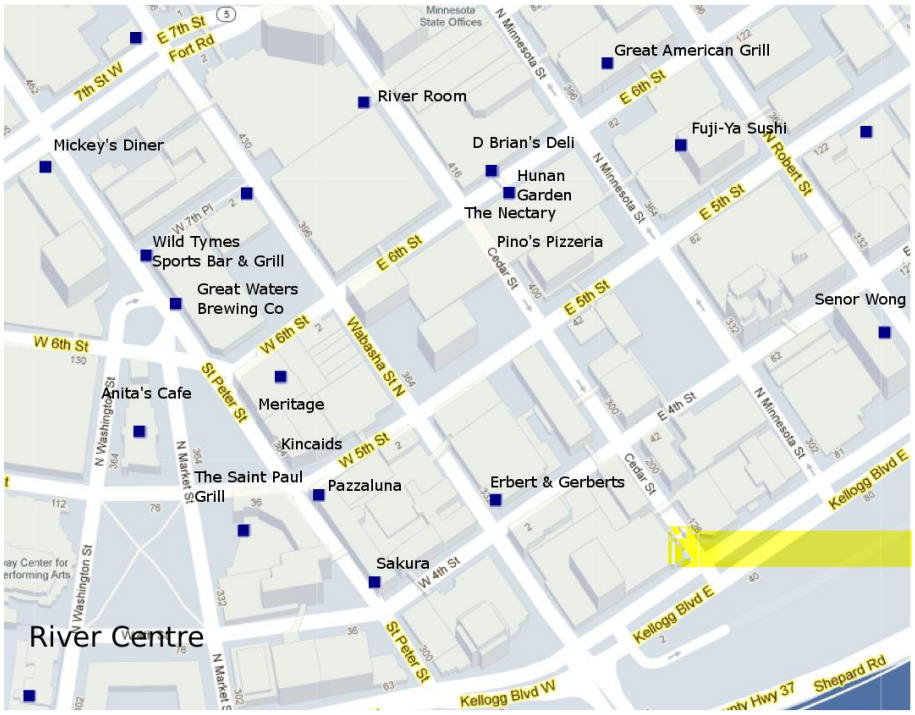
Claddagh Coffee
459 7th St W
St Paul, MN 55102
(651) 600-3400

Other places to get a cup of Joe: St Paul RiverCentre, Crowne Plaza Riverfront Hotel (has a Starbucks on site), St Paul Hotel

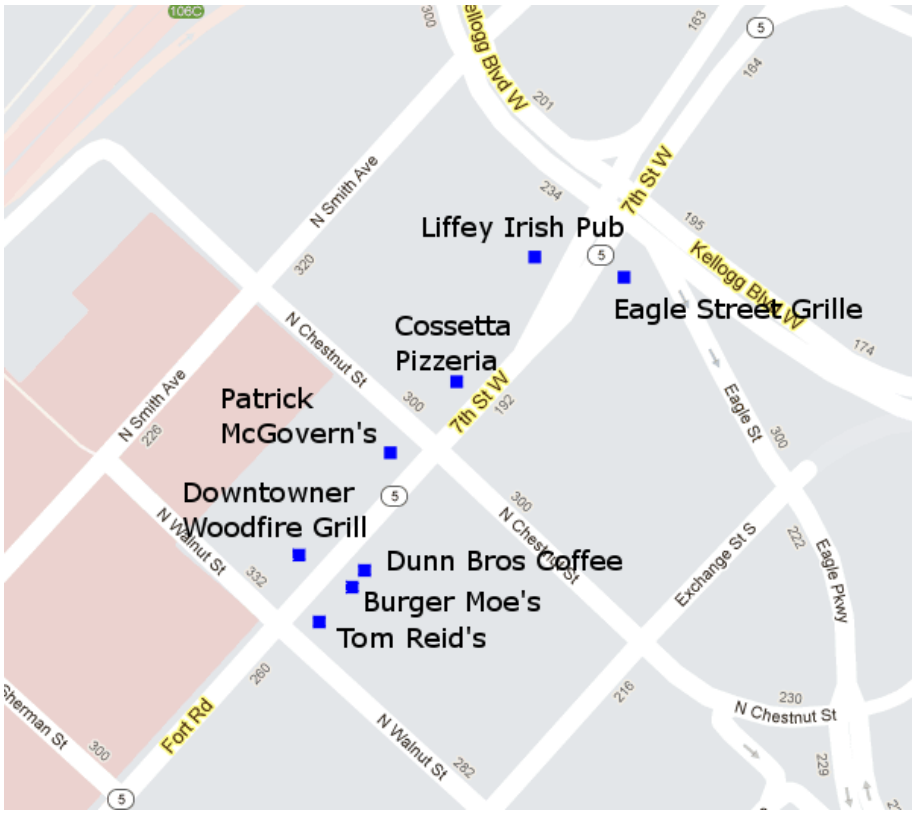
A Map of Area Restaurants (Locations Approximate)



Area A Close-Up



Area B Close-Up



Where to eat in Saint Paul ($)

The Twin Cities are home to many great restaurants, theaters, and bars. This is just a small sampling of what Saint Paul has to offer. The places listed below are perfect for those on a student budget:

American Cajun Grill
56 6th Street East, Suite 210
(651) 222-3738
Cajun/Creole; Open for lunch on weekdays.

Anita's Cafe
75 5th Street West, Suite 101
(651) 292-4160
For $7.25, Anita's offers lunch in a box: a deli sandwich, and homemade side salad. Dine-ins are also welcome.

Black Sheep Coal Fired Pizza
512 North Robert Street
(651) 227-4337
Minnesota's first coal fired pizza place. Simple, good food.

Burger Moe's
242 West 7th Street
(651) 222 - 3100
Patio seating. Sixty beers from around the world - forty of them on tap. Just two blocks from the Xcel Energy Center.

Cossetta's Italian Market & Pizzeria
211 7th Street West
(651) 222-3476
Generous portions. Kid-friendly. Cafeteria-style Italian deli and pizzeria. Rooftop seating offered.

D. Brian's Deli
444 Cedar Street
(651) 223-7979
Fast service. Across the street from Bruegger's Bagels and Potbelly Sandwich Shop. Emphasis on healthy, natural ingredients.

Day by Day Cafe
477 7th Street West
(651) 227-0654
Locally renowned breakfast served until close at 3PM. Patio seating. Soups/sandwiches/salads.

Erberts & Gerberts
334 Wabasha Street North
(651) 298-1919
Soups and sandwiches. Erberts is a Wisconsin-based chain.

The Four Inns
101 East 5th Street, Suite 220
(651) 291-7939
Skyway diner. Around since 1970. Lots of character.

Gastrotruck
(763) 607-6055
A food truck, serving pub-style treats including sliders, crudo, and tacos. Call to find out where they are parked!

Jimmy John's
5 7th Place West
(651) 291-5000
Sandwich chain, headquartered in Champaign, Illinois.

Maison Darras
401 Robert Street North
(651) 379-2770
Open Monday - Friday until 2P.M. A French bistro in the sky(way)! All sandwiches are under $6.

Meritage Crepe Stand
410 St. Peter Street
(651) 222-5670
Check Twitter (@meritage_stpaul) daily to see what's on the menu. The Stand is open Tuesdays - Fridays, 11A.M. to 2 P.M. Both sweet and savory crepes are available.

Mickey's Diner
36 7th Street West
(651) 222-5633
Serving St. Paul around-the-clock since 1939. A classic diner experience.

The Nectary
56 E 6th Street, Suite 211
(651) 292-9963
Skyway location. Quick service. The salads are recommended.

Pinos Pizzeria
55 E 5th Street, Suite 1400
(651) 228-0673
NY-style pizza. Food court location.

Potter's Pasties and Pies
(612) 819-3107
Parks weekdaily in downtown St. Paul. Both sweet and savory pies offered.

Where to eat in Saint Paul ($$)

The eateries listed here are perfect for those looking for a fine dining experience that won't break the bank.

Barrio
235 6th Street East
(651) 222-3250
Latin American street food. Small plates. Great bar. Lively atmosphere.

Mancini's
531 7th Street West
(651) 224-7345
Char house and lounge.

Downtowner Woodfire Grill
253 West 7th Street
(651) 228-9500
American bistro. Signature dishes include fire-roasted meats, fish cooked in the Persian tradition.

Eagle Street Grille
174 W 7th Street
(651) 225-1382
Across the street from the Xcel Energy Center. American fare. Free wireless. Sixteen TV screens.

Fuji Ya Japanese Restaurant
465 Wabasha Street
(651) 310-0111
Full bar. Most award-winning sushi restaurant in the Twin Cities.

Great Waters Brewery
Hamm Building
426 St. Peter Street
(651)221-BREW
Brewpub. Handcrafted beer. Patio dining. Very close to Xcel Energy Center.

Keys Cafe & Bakery
500 Robert Street North
(651) 222-4083
One of nine Twin Cities locations. "Created-from-scratch" recipes that "you grew up with."

Meritage (for lunch)
410 Saint Peter Street
(651) 222-5670
Open for lunch Tuesday - Friday with Happy Hour 3-6 on those days. Urban bistro. French.

Pazzaluna Urban Italian Restaurant & Bar
360 Saint Peter Street
(651)223-7000
Trattoria. Dinner Only.

Sakura Restaurant & Sushi Bar
350 Saint Peter Street, Suite 195
(651) 224-0185
Can get crowded on weekend nights. Newly remodeled. Full-length sushi bar.

Sawatdee
486 Robert Street North
(651) 528-7106
Voted "Best Thai 2011" by MPLS St Paul Magazine Readers' Poll. Happy Hour everyday, 4-6P.M.

Senor Wong
111 East Kellogg Boulevard
(651) 224-2019
Asian/Latin fusion.

The St. Paul Grill
350 Market Street
(651)224-7455
Exceptional bar. New American. Grill.

Where to eat in Saint Paul ($$$)

For a memorable Saint Paul-fine dining experience try:

Heartland Restaurant
289 E 5th Street
(651) 699-3536
Sustainable, locally raised and grown ingredients used. Organic. Menu changes nightly. Two pre fixe options. Dining room opens at 5P.M., with last seating at 9:30P.M. Closed Mondays. Executive chef is a 2010/2011 James Beard Award nominee. Reservations are recommended.

Kincaid's Fish, Chop & Steak House
380 Saint Peter Street
(651) 602-9000
Steak (USDA prime-aged), seafood, and chop house. Classic American dining.

The Strip Club (It's not what you think!)
378 Maria Avenue
(651) 793-6247
Specializing in seasonal fare (especially meats), they boast excellent service and a cozy atmosphere. Open for dinner only, reservations recommended.

Meritage (for dinner)
410 Saint Peter Street
Open for lunch Tuesday - Friday with Happy Hour 3-6 on those days. Urban bistro. French.

Pubs and Bars in Saint Paul

Eagle Street Grille
174 7th Street West
(651) 225-1382
Located right across from the RiverCentre. Traditional American. Full bar. Outdoor seating.

Shamrocks
995 7th Street West
(651) 228-9925
Live music. Great burgers.

The Artist Quarter
408 Saint Peter Street
(651) 292-1359
A favorite for local and professional musicians. They specialize in jazz, and have a small cover charge, but the 7P.M. shows on Monday, Tuesday

and Wednesday are free. Located in the heart of downtown Saint Paul.

Gopher Bar
241 7th Street East
(651) 291-9638
Cheap beer, Coney dogs, and a dive bar-crowd. A Red State-bar in a state that is Blue!

The Hat Trick Lounge
134 E 5th Street
(651) 228-1347
Inexpensive bar food. A true Saint Paul 'dive' bar. Drinks are cheap. Service is not fussy.

Where to eat in Minneapolis

A nightly shuttle service will be offered to transport ICRA participants to downtown Minneapolis. The shuttle will pick up and drop off on Nicollet Mall and 9th Street. This is a very small sampling of what Minneapolis has to offer:

Hell's Kitchen
80 South 9th Street
(612) 332-4700

Unique underground, chef-owned restaurant. Open for breakfast, lunch, dinner and drinks 7 days a week. Live (free) music most evenings and during brunch on weekends. Late night "rock-the-house" shows offered on Thursdays, Fridays and Saturdays until 2A.M.

MASA
1070 Nicollet Mall
(612) 338-6272
Contemporary Mexican. Voted Best Mexican Restaurant by Minneapolis St. Paul Magazine for two years running.

Solera
900 Hennepin Avenue
(612) 338-0062
Spanish. Locally-sourced ingredients. One of the largest collections of Spanish wine in the U.S. Solera is in the heart of the Minneapolis Theater District.

Vincent A
1100 Nicollet Mall
(612) 630-1189
New American. Tasting menus offered. Reservations recommended.

Zelo
831 Nicollet Mall
(612) 333-7000
Neo-Italian. Offers late-night seating. White linen. Large and small plates. Emphasis on sustainable ingredients.

Saffron
123 N 3rd Street
(612) 746-5533
A contemporary presentation of Mediterranean cuisine, inspired by Moroccan, Spanish, and French flavors.

112 Eatery
112 N 3rd Street
(612) 343-7696
New American. Winner: Best Chef, Midwest (James Beard Award). Late night dining.

Fogo de Chao
645 Hennepin Avenue
(612) 338-1344
Brazilian steakhouse chain.

Acknowledgments and Credits

- **Cover Art:** Nikhil Karnad
- **Digest Volunteer**: Jimmy Chen
- **Images:** City of Saint Paul ("Visit Saint Paul"), City of Minneapolis ("Meet Minneapolis"), Google Maps and Street View, Paul Robertson, Dan Anderson; Crowne Plaza, Hotel Saint Paul, RiverCentre and the Science Museum of Minnesota

Program at A Glance

ICRA 2012 Technical Program
Monday May 14, 2012

	Room 1	Room 2	Room 3	Room 4	Room 5	Room 6	Room 7	Room 8	Room 9	Room 10-11	Room 12
08:30 - 17:30	Workshop 1 Variable Impedance Actuators	Workshop 2 Bio-Bots	Workshop 3 Many-Robot Systems	Workshop 4 Wearable Robotics	Workshop 5 Software Development SDIR-VII	Workshop 6 Haptic Teleoperation	Workshop 7 Robotics and Performing Arts	Workshop 8 Robotic Satellite Servicing	Workshop 9 Semantic Perception - Service	Tutorial 1 Motion Planning	Tutorial 2 Industry Issues
18:00 - 20:00	**ICRA 2012 Reception**			**Crowne Plaza Great River Ballroom First Level**		**Student Social**				**Crowne Plaza Minnesota Ballroom, Lower Level**	

ICRA 2012 Technical Program
Tuesday May 15, 2012

	Room 1	Room 2	Room 3	Room 4	Room 5	Room 6	Room 7	Room 8	Room 9	Room 10-11	Ballroom D	Auditorium
08:30 - 10:00	TuA01 Estimation and Control for UAVs	TuA02 Bipedal Robot Control	TuA03 Learning and Adaptive Control of Robotic Systems	TuA04 Under-actuated Robots	TuA05 Path Planning and Navigation	TuA06 Applied Machine Learning	TuA07 Robust and Adaptive Control of Robotic Systems	TuA08 Redundant Robots	TuA09 Collision	Industry Forum	TuA10 Interactive Session	
Coffee Break												
10:30 - 12:00	TuB01 Control and Planning for UAVs	TuB02 Human Like Biped Locomotion	TuB03 Grasp Planning	TuB04 Pose Estimation	TuB05 Sensor Networks	TuB06 Minimally Invasive Interventions	TuB07 Micro and Nano Robots	TuB08 3D Surface Models, Point Cloud Processing	TuB09 Localization	Industry Forum	TuB10 Interactive Session	
12:00 - 13:00	**Women in Engineering Luncheon** — **Crowne Plaza Great River Ballroom**											
13:15 - 14:15	**Plenary Lecture: Robotics in the Small** **Professor Brad Nelson**, ETH-Zürich, Swiss Chair: Shigeki Sugano — **RiverCentre Ballrooms A, B, C, E, F, and G**											
14:30 - 16:00	TuC01 Autonomy and Vision for UAVs	TuC02 Planning and Navigation of Biped Walking	TuC03 Haptics	TuC04 Micro - Nanoscale Automation	TuC05 Multi-Robot Systems I	TuC06 Biologically Inspired Robotics	TuC07 Climbing Robots	TuC08 Human Detection and Tracking	TuC09 Mapping	Industry Forum	TuC10 Interactive Session	**12:00 - 18:00** ***Exhibits And Challenges***
Coffee Break												
16:30 - 18:00	TuD01 Force & Tactile Sensors	TuD02 Humanoid Motion Planning and Control	TuD03 Cable-Driven Mechanisms	TuD04 Force, Torque and Contacts in Grasping and Assembly	TuD05 Multi-Robot Systems II	TuD06 Needle Steering	TuD07 Perception for Autonomous Vehicles	TuD08 RGB-D Localization and Mapping	TuD09 Sensing for Manipulation	Industry Forum	TuD10 Interactive Session	
19:30 - 21:30	**Welcome Reception** — **Minnesota Science Museum**											

ICRA 2012 Technical Program
Wednesday May 16, 2012

	Room 1	Room 2	Room 3	Room 4	Room 5	Room 6	Room 7	Room 8	Room 9	Room 10-11	Ballroom D	Auditorium
08:30 - 10:00	WeA01 Learning and Adaptation Control of Robotic Systems II	WeA02 Multi-Legged Robots	WeA03 Medical Robotics I	WeA04 Novel Robot Designs	WeA05 Embodied Inteligence - Icub	WeA06 Trajectory Planning and Generation	WeA07 SLAM I	WeA08 Motion Path Planning I	WeA09 Surveillance		WeA10 Interactive Session	
Coffee Break												
10:30 - 12:00	WeB01 Parallel Robots	WeB02 Hybrid Legged Robots	WeB03 Grasping: Learning and Estimation	WeB04 Networked Robots	WeB05 Rehabilitation Robotics	WeB06 Micro and Nano Robots II	WeB07 Sampling Based Motion Planning	WeB08 Parts Handling and Manipulation	WeB09 Localization II		WeB10 Interactive Session	
12:00 - 13:00	**GOLD Lunch** — Crowne Plaza Great River Ballroom					**Lunch with the Leaders** — Crowne Plaza Windows on the River						**08:00 - 18:00** *Exhibits And Challenges*
13:15 - 14:15	**Plenary Lecture: Bio-Bots: Bio-Integrated Robotics Using Live Cells As Components** — **Professor Harry Asada**, Massachusetts Institute of Technology (MIT), USA — Chair: Rüdiger Dillmann — RiverCentre Ballrooms A, B, C, E, F, and G											
14:30 - 16:00	WeC01 Micro/ Nanoscale Automation II	WeC02 Compliance Devices and Control	WeC03 Underactuated Grasping	WeC04 Stochastic Motion Planning	WeC05 Image-Guided Interventions	WeC06 Mobile Manipulation: Planning & Control	WeC07 Environment Mapping	WeC08 SLAM II	WeC09 Visual Tracking	**15:00-17:00** NSF Presentation	WeC10 Interactive Session	
Coffee Break												
16:30 - 18:00	WeD01 Non-Holonomic Motion Planning	WeD02 Grasping and Manipulation	WeD03 Modular Robots & Multi-Agent Systems	WeD04 Embodied Intelligence - Complient Actuators	WeD05 Minimally Invasive Interventions II	WeD06 Space Robotics	WeD07 Results of ICRA 2011 Robot Challenge	WeD08 Visual Learning	WeD09 Video Session	NSF Presentation	WeD10 Interactive Session	
19:00 - 21:30	**Conference Banquet** — RiverCentre Ballrooms A, B, C, E, F, and G											

ICRA 2012 Technical Program
Thursday May 17, 2012

	Room 1	Room 2	Room 3	Room 4	Room 5	Room 6	Room 7	Room 8	Room 9	Room 10	Room12	Ballroom D	Auditorium
08:30 - 10:00	ThA01 Data Based Learning	ThA02 Medical Robotics II	ThA03 Novel Actuation Technologies	ThA04 Simulation and Search in Grasping	ThA05 Octopus-Inspired Robotics	ThA06 Intelligent Manipulation Grasping	ThA07 Physical Human-Robot Interaction	ThA08 Calibration and Identification	ThA09 Motion Planning II	Youth Outreach		ThA10 Interactive Session	
Coffee Break													
10:30 - 12:00	ThB01 Mechanism Design of Mobile Robots	ThB02 Grasping: Modeling, Analysis and Planning	ThB03 Biologically Inspired Robotics II	ThB04 Stochastic in Robotics and Biological Systems	ThB05 Teleoperation	ThB06 Continuum Robots	ThB07 AI Reasoning Methods	ThB08 Range Imaging	ThB09 Vision-Based Attention and Interaction	Youth Outreach		ThB10 Interactive Session	
12:00 - 13:00	**Awards Lunch**									**RiverCentre Ballrooms A, B, C, E, F, and G**			**08:00 - 18:00**
13:15 - 14:15	**Plenary Lecture: Development Outline of the Humanoid Robot: HUBO II** **Professor Jun Ho Oh**, Korea Advanced Institute of Science and Technology (KAIST), Korea Chair: Henrik Iskov Christensen									**RiverCentre Ballrooms A, B, C, E, F, and G**			***Exhibits And Challenges***
14:30 - 16:00	ThC01 Micro/ Nanoscale Automation III	ThC02 Control of UAVs	ThC03 Soft Tissue Interaction	ThC04 Formal Methods	ThC05 Robotic Software, Programming Environments, and Frameworks	ThC06 Compliant Nano-positioning	ThC07 Multi Robots: Task Allocation	ThC08 Navigation and Visual Sensing	ThC09 Marine Robotics I	Youth Outreach	**14:30 - 15:30** Challenge Summaries	ThC10 Interactive Session	
Coffee Break													
16:30 - 18:00	ThD01 Animation & Simulation	ThD02 Semiconductor Manufacturing	ThD03 Biomimetics	ThD04 Hand Modeling and Control	ThD05 High Level Robot Behaviors	ThD06 Localization and Mapping	ThD07 Industrial Robotics	ThD08 Embodied Soft Robots	ThD09 Marine Robotics II	Youth Outreach		ThD10 Interactive Session	
18:30 - 20:30	**Farewell Reception**										**RiverCentre Roy Wilkins Auditorium**		

ICRA 2012 Technical Program
Friday May 18, 2012

	Room 1	Room 2	Room 3	Room 4	Room 5	Room 6	Room 7	Room 8	Room 9	Room 10	Room 11	Room 12	Ballroom D	Auditorium
08:30 - 17:30	Workshop 10 Future of HRI	Workshop 11 Bio Assembler	Workshop 12 Replicable Experi-ments	Workshop 13 Long-term Autonomy	Workshop 14 Clinical Needle Steering	Workshop 15 Stochastic Geometry in SLAM	Workshop 16 Modular Surgical Robotics	Workshop 17 ECHORD Project	Workshop 18 Semantic Perception Exploration	Tutorial 3 Point Cloud Processing	Tutorial 4 Reinforce-ment Learning	Tutorial 5 Robot Operating System	**13:00 - 15:30** Fukushima Workshop	**08:00 - 12:00** ***Exhibits And Challenges***