UNIVERSITÀ DEGLI STUDI DI NAPOLI FEDERICO II

DIPARTIMENTO DI INGEGNERIA ELETTRICA E TECNOLOGIE DELL'INFORMAZIONE

PROF. BRUNO SICILIANO

prisma LAB

COLLOQUIUM ON ROBOTICS

WHO: **PROF. OUSSAMA KHATIB**
PROF. TAMIM ASFOUR
PROF. RON LUMIA
PROF. GIOVANNI INDIVERI
PROF. KOSTAS KYRIAKOPOULOS
DR. RAJ MADHAVAN

WHEN: **Tuesday, 21 April 2015, 09:00–13:00**

WHERE: Aula SofTel, via Claudio, building 3/A, floor 1

09:00–09:10	Welcome (Bruno Siciliano)
09:10–10:00	**Working with the New Robots (OUSSAMA KHATIB)**
10:00–10:30	**Humanoid Robotics: From Household Assistants to Personalized Robot Suits (TAMIM ASFOUR)**
10:30–11:00	**Impedance Control for Robotic Assembly (RON LUMIA)**
11:00–11:10	Coffee Break
11:10–11:40	**A Glimpse at the H2020 WiMUST Project and One of Its Bits: Outlier Robust State Estimation in Marine Robotics Applications (GIOVANNI INDIVERI)**
11:40–12:10	**Towards Persistent Autonomy of Underwater Robotic Vehicles: Robust Control Strategies for Efficient Positioning and Interaction (KOSTAS KYRIAKOPOULOS)**
12:10–12:40	**Humanitarian Robotics and Automation Technologies: Improving the Quality of Life for Humanity (RAJ MADHAVAN)**
12:40–13:00	Discussion

PROF. OUSSAMA KHATIB
Artificial Intelligence Lab
Stanford University
http://cs.stanford.edu/groups/manips/index.html

Working with the New Robots

Exploring, working, and interacting with humans, the new generation of robots being developed will increasingly touch people and their lives, in homes and workplaces, in challenging field domains and new production systems.
These emerging robots will provide support in services, health care, manufacturing, entertainment, education, assistance, and intervention. While full autonomy for the performance of advanced tasks in complex environments remains challenging, the simple intervention of a human would tremendously facilitate reliable real-time robot operations. Two basic modalities of haptically mediated interaction and direct physical contact are being conceived. Human–robot interaction greatly benefits from combining the experience and cognitive abilities of the human with the strength, dependability, competence, reach, and endurance of robots. Moving beyond conventional teleoperation, the new paradigm places the human at the highest level of task abstraction, relying on highly skilled robots with the requisite competence for advanced task behavior capabilities. The discussion focuses on robot design concepts, robot perception and control architectures, and task strategies that bring human modeling, motion, and skill understanding to the development of safe, easy to use, and competent robotic systems. The presentation will highlight interactions with a novel underwater robot Ocean One, O2, being developed at Stanford in collaboration with Meka Robotics, and KAUST. The motivation for this robot is to help marine biologists to safely explore the Red Sea's fragile and previously inaccessible underwater environment. Live interactions will illustrate how bimanual haptic devices can be used to interact with the entire robot. A 3D graphic and haptic interface allows non-expert users to intuitively operate the robot while feeling contact forces when performing dexterous tasks. While the operator can fully focus on the robot's task, the robot controller autonomously handles constraints, multiple contacts, disturbances, obstacles, and robot posture, so that the robot task can be optimally performed in the deep sea. This robot illustrates the new emerging paradigm in other challenging areas of underwater robotics, such as archeology, inspection, and maintenance of pipelines and other structures. Connecting humans to increasingly competent robots will certainly fuel a wide range of new robotic applications in challenging environments.

OUSSAMA KHATIB *received his Doctorate degree in Electrical Engineering from Sup'Aero, Toulouse, France, in 1980. He is Professor of Computer Science at Stanford University. His work on advanced robotics focuses on methodologies and technologies in human-centered robotics including humanoid control architectures, human motion synthesis, interactive dynamic simulation, haptics, and human-friendly robot design. He is Co-Editor of the Springer Tracts in Advanced Robotics series, and has served on the Editorial Boards of several journals as well as the Chair or Co-Chair of numerous international conferences. He co-edited the Springer Handbook of Robotics, which received the PROSE Award. He is a Fellow of IEEE and has served as a Distinguished Lecturer. He is the President of the International Foundation of Robotics Research (IFRR). Professor Khatib is a recipient of the Japan Robot Association (JARA) Award in Research and Development. In 2010 he received the IEEE RAS Pioneer Award in Robotics and Automation for his fundamental pioneering contributions in robotics research, visionary leadership, and life-long commitment to the field. Professor Khatib received the 2013 IEEE RAS Distinguished Service Award in recognition of his vision and leadership for the Robotics and Automation Society, in establishing and sustaining conferences in robotics and related areas, publishing influential monographs and handbooks and training and mentoring the next generation of leaders in robotics education and research. In 2014, Professor Khatib received the 2014 IEEE RAS George Saridis Leadership Award in Robotics and Automation.*

PROF. TAMIM ASFOUR
Karlsruhe Institute of Technology (KIT)
Institute for Anthropomatics and Robotics (IAR)
High Performance Humanoid Technologies (H2T)
http://www.humanoids.kit.edu

Humanoid Robotics: From Household Assistants to Personalized Robot Suits

Ambitious goals have been set for humanoid robots: They are expected to be companions and assistants for people in different ages and environments, helpers in man-made and natural disasters, and winners against the world soccer champion in 2050. The talk will first address recent progress towards building integrated 24/7 humanoid robots able to perform complex grasping and manipulation tasks in daily environments, to autonomously acquire object knowledge through active visual and haptic exploration and to learn whole-body actions from human observation and to imitate actions in a goal-directed manner. In the second part of the talk I will discuss the vision of robot suits for every body and the transformative impact of humanoid robotic on other research areas and application fields, where humanoid robots become 24/7 wearable companions for augmentation or replacing of human performance in daily and working environments and humanoid technologies contribute to personalized rehabilitation in medicine, human support and protection in human-made and natural disasters.

TAMIM ASFOUR *is Professor at the Institute for Anthropomatics and Robotics at the Karlsruhe Institute of Technology (KIT). He is Chair of Humanoid Robotics Systems and Head of the High Performance Humanoid Technologies Lab (H2T). His major current research interest is high performance 24/7 humanoid robotics. Specifically, his research topics include humanoid mechano-informatics and design, grasping and dexterous manipulation, goal-directed imitation learning, active vision and active touch, modeling and analysis of human motion, software and hardware architectures and system integration. He is developer of the ARMAR humanoid robot family and is leading the Humanoid Research Group at KIT since 2003. He is Editor-in-Chief of the IEEE-RAS conference on Humanoid Robots, was European Chair of the IEEE RAS Technical Committee on Humanoid Robots (2010–2014), Associate Editor of Transactions on Robotics (2010–2014). He is member the Executive Board of the German Association of Robotics (DGR) and member of the Board of Directors of euRobotics (2013–2015). He is principle investigator in several national projects (SFB 588, Autonomous Learning, Invasive Computing) and Integrated European Cognitive Systems projects (PACO-PLUS, Xperience, GRASP, WALK-MAN, KoroiBot, SecondHands, TimeStorm, I-Support).*

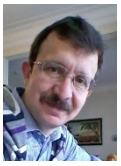
PROF. RON LUMIA
Department of Mechanical Engineering
University of New Mexico
http://www.me.unm.edu/~lumia/

Impedance Control for Robotic Assembly

This talk will provide an overview of UNM's efforts in impedance control and its application to assembly. A control system changes the impedance of the robot carrying a peg in real time to perform an insertion operation. This real time change prevents wedging or jamming. A number of demonstrations will be shown with varying insertion times. DARPA sponsored a competition several years ago where impedance control was the main concern. Although UNM did not apply for this funding, we implemented a few of these demos, which will be shown. In addition, some position based controller demos will be shown where multiple pendulums are moved in a swing free motion. Given the length of each pendulum, the system modifies a desired trajectory so as to avoid motions that excite any pendulum. Then the robot can move the load with nearly no residual swing.

RON LUMIA *received the BS degree in electrical engineering from Cornell University, Ithaca, NY, in 1972. He received the MS and PhD, both in electrical engineering, from the University of Virginia, Charlottesville, VA, in 1977 and 1979, respectively. His technical interests include computer vision, microrobotics, robot control, professional software development, and manufacturing. He has been a Professor in the Mechanical Engineering Department at the University of New Mexico, Albuquerque, NM since 1994. From 1986-94, he was Group Leader of the Intelligent Control Group at the National Institute of Standards and Technology (NIST). Previously, he held academic positions at Ecole Superieure d'Ingenieurs en Electrotechnique et Electronique (ESIEE) in Paris, France, Virginia Tech in Blacksburg, VA, and the National University of Singapore. He was a Fulbright Scholar at the Indian Institute of Science in Bangalore during Fall 2008. He will spend the 2015–2016 Academic Year on sabbatical at Chulalongkorn University, Bangkok, Thailand, also as a Fulbright Scholar. Professor Lumia remains active in IEEE Conference organization, serving IROS 2003 as Chair of Special Sessions, IROS 2007 as Finance Chair, ICRA1997 and 2006 as Exhibits Chair and ICRA 2010 as Finance Chair. He is currently Treasurer of the IEEE Robotics and Automation Society.*

PROF. GIOVANNI INDIVERI
Department of Innovation Engineering
University of Salento
http://persone.dii.unile.it/indiveri/



A Glimpse at the H2020 WiMUST Project and One of Its Bits: Outlier Robust State Estimation in Marine Robotics Applications

The talk will briefly describe the recently started Widely scalable Mobile Underwater Sonar Technology (WiMUST) project of H2020. The project aims at expanding and improving the functionalities of current cooperative marine robotic systems, effectively enabling distributed acoustic array technologies for geophysical surveying with a view to exploration and geotechnical applications. In particular, the second part of the talk will focus on recent results in the area of outlier robust state estimation and its potential applications in the framework of underwater robot navigation. Single range localization issues and the use of a least entropy-like based filter for underwater navigation will be addressed.

GIOVANNI INDIVERI *was born in Genova, Italy, in 1970. He holds a Laurea degree in Physics since 1995 and a Dottorato di Ricerca (Ph.D.) in Electronic Engineering and Computer Science since 1998 (both from the University of Genova, Italy). From 1999 to 2001 he was a post-doc Researcher at the Fraunhofer (formerly GMD) Institute for Intelligent Autonomous Systems FhG - AiS of Sankt Augustin, Germany. From December 2001 to January 2011 he was Ricercatore (Assistant Professor) at the School of Engineering of the University of Salento in Lecce, Italy. Since February 2011 he is Associate Professor in Systems and Control Engineering at the same University. His research interests are in the area of autonomous robotics and, in particular, of navigation, guidance and motion control for marine and underactuated robotic systems. Specific research topics include modeling and identification of marine robots, pose regulation, trajectory tracking and path following for underactuated kinematic robot models, marine robot navigation, outlier robust parameter identification and outlier robust state estimation. He has published over 90 paper in international journals and proceedings of international conferences on these subjects. From August 2011 to August 2014 he was Chair of the IFAC Technical Committee 7.5 on Intelligent Autonomous Vehicles (IAV) that he is currently serving as Vice-Chair. He is scientific responsible of the ISME network (inter-university center on Integrated Systems for the Marine Environment) at the University of Salento. He has contributed to numerous national and international research projects. Under the European FP7 and H2020 frameworks he has contributed to CHAT, Co3AUVs, DexROV and WiMUST (H2020 RIA project started on February 1st, 2015) that he is Coordinating on behalf of ISME. Since 2000 he has served as International Program Committee (IPC) member of over 30 international conferences in the area of Robotics, Systems and Control Engineering. He regularly servers as a reviewer for Journals in the same areas. He was the IPC co-chair and main organizer of the IFAC IAV 2010 Symposium in Lecce, Italy and Editor of the IFAC IAV 2013 Symposium in Gold Coast, Australia.*

PROF. KOSTAS KYRIAKOPOULOS
Control Systems Lab (CSL)
Mechanical Engineering Department
National Technical University of Athens (NTUA)
http://www.controlsystemslab.gr/kkyria/

Towards Persistent Autonomy of Underwater Robotic Vehicles: Robust Control Strategies for Efficient Positioning and Interaction

A common and important prerequisite for Persistent Autonomy of Unmanned Underwater Vehicles (UUVs) is advanced, platform-level, motion planning and control to efficiently handle most of the UUV platform-level motion issues in such a way as to allow motion to be perceived from higher levels (Learning, Task Planning, etc.) as a simple modality. At the same time the sought control scheme should handle complex task missions and be robust enough to parameter uncertainties and disturbances due to real sea conditions. In order to handle UUV specific needs such as limited energy and computational resources dictating low complexity motion control, model-free position and image-based visual servoing schemes are presented. They do not require the vehicle parameters and guarantee prescribed, transient and steady state, performance despite external disturbances. We proceed with a Vision-based Nonlinear Model Predictive Control (NMPC) scheme where the control loop does not close periodically, but instead a self-triggering mechanism decides when to provide the next control update. This leads to a significantly smaller number of measurements from vision and less frequent computation of the control law, thus reducing processing time and energy consumption. Complex real-time tasks, such as inspection and surveillance, often require high pitch angle configurations that may cause divergence of the navigation filters due to acoustic sensor limitations (DVL). Thus we propose visual servo control for UUV autonomous navigation and stabilization relative to an unknown visual target while achieving high pitch and yaw configurations. In the case of autonomous surveillance at low visibility, multi-beam imaging sonars replace traditional vision and model-based sonar servo control is adopted. The proposed controller is robust to UUV external disturbances and parametric uncertainties. Inspection and surveillance can be enhanced when employing multiple cooperating UUVs. Results on energy efficient coordinated motion control of multi-agent UUVs is presented. A self-triggering scheme for multi-agent systems control is developed where operational factors such as disturbances induced by sea currents as well as communication delays in underwater acoustic positioning systems (e.g. USBL) are considered. In addition to free motion (e.g. inspection/surveillance), underwater missions often require a level of interaction (e.g. valve/lever manipulation, tool grasping/carrying, etc.) that can be accomplished by Underwater Vehicle Manipulation Systems (UVMS). If a certain performance criterion is adopted (e.g. optimal configuration of the end-effector according to the required task) a motion control algorithm is developed for UVMS optimal pose configuration to efficiently interact with the environment. The presentation is concluded with immediate future directions towards cooperative motion and (physical) interaction control of multi-agent UVMS.

KOSTAS KYRIAKOPOULOS *received a Diploma in Mechanical Enginnering (Honors) from NTUA (1985) and the MS (1987) and Ph.D. (1991) in Electrical, Computer & Systems Eng. (ECSE) from Rensselaer Polytechnic Institute (RPI), Troy, NY. Between 1988–1991 he did research at the NASA Center for Intelligent Robotic Systems for Space Exploration. Between 1991–1993 he was an Assistant Professor at ECSE, RPI and the New York State Center for Advanced Technology in Automation & Robotics. Since 1994 he has been with the Control Systems Laboratory (CSL) of the Mechanical Engineering Department at NTUA, where he served as Associate Department Head while currently serves as a Professor & Director of: i) CSL, ii) the Mechanical Design & Control Systems Division, and iii) the Departmental Computation Lab. His current interests are in the area of Embedded Control Systems applications in Sensor-based Motion Planning and Control of Multi-robot Systems (Mobile, Underwater and Aerial Vehicles/Manipulators). He has been awarded a number of fellowships including the Alexander von Humboldt Foundation Fellowship. He has published more than 270 papers in journals and fully refereed international conferences. He has contributed to 31 projects funded by the European Commission and Greek Sources with a total budget of about 5M€. He served in the editorial committees of a number of IEEE publications and in the high-level administrative committees of a number of international conferences.*

DR. RAJ MADHAVAN
Institute for Systems Research
Maryland Robotics Center
University of Maryland
http://robotics.umd.edu/faculty/gateways/madhavan.php

Humanitarian Robotics and Automation Technologies: Improving the Quality of Life for Humanity

Robotics and Automation Technologies hold immense promise in transforming people's lives across various communities around the globe. It is quite easy to get the public's interest stoked when 'robots' are mentioned as robotics is seen as something sexy while evoking sci-fi type images. Consequently, there exists a huge disconnect between what is possible from an engineering and scientific viewpoint and what the expectations of the general public are. While the source of this disconnect can be conveniently blamed on Hollywood movies, the robotics community also can be held accountable, at least partly, for some of these confusions and exaggerations. It is my opinion that the academic and research entities have not done enough to educate the masses on what is realistic and what the limitations are. More fundamentally, the problem lies in the fact that we have not seen practical solutions that can be deployed in a truly useful and effective fashion towards making a difference in the quality of lives of people. In this talk, I will describe my current work focusing on the applied use of robotics and automation technologies for the benefit of under-served and under-developed communities by working closely with them to sustain developed solutions. This is made possible by bringing together researchers, practitioners from industry, academia, and government and various entities such as the IEEE Robotics Automation Society's Special Interest Group on Humanitarian Technology (RAS-SIGHT), NGOs, NPOs and other organizations and governments across the globe. I will share some of my efforts and thoughts on urban search and rescue, and disaster prevention, recovery, and response efforts, using Unmanned Ground Vehicles (UGVs) and Unmanned Aerial Vehicles (UAVs), respectively. I will provide an overview and describe the goals of RAS-SIGHT, its activities, and associated efforts. I will also discuss a recently held demining challenge that I co-organized with the intent of producing an open-source solution for detecting and classifying unexploded ordnance buried in minefields. A set of videos from several appropriate domains focusing on humanitarian applications will be featured.

RAJ MADHAVAN is a research scientist with the Institute for Systems Research, and a member of the Maryland Robotics Center at the University of Maryland, College Park. Currently he is on leave working on applying robotics and automation technologies for the benefit of humanity in a variety of domains. He has held appointments with the National Institute of Standards and Technology (March 2002–June 2013) and the Oak Ridge National Laboratory (March 2001–January 2010). He received a Ph.D. in Field Robotics from the University of Sydney, an ME (Research) in Systems Engineering from the Australian National University, and a BEEE from the College of Engineering, Anna University, India. Over the last 19 years, he has contributed to topics in field robotics, and systems and control theory. His current research interests include autonomous ground vehicle navigation in unstructured environments, performance evaluation and testing, benchmarking, and standardization of intelligent systems, and humanitarian robotics, particularly the development of applied robotics and automation technologies systems that are cost effective, reliable, efficient and geared towards improving the quality of lives of people in under-served and under-developed communities around the globe. Dr. Madhavan has published and edited three books and four journal special issues, and over 170 papers in archival journals, conferences, and magazines. He has served as an invited independent judge for robotics competitions, has given numerous invited presentations in research organizations in several countries, has served on editorial boards and program committees of premier robotics, automation, and control conferences, and on several national and international panels and review boards. He has been serving as the Vice President of the Industrial Activities Board (2013–2016), Chair of the Standing Committee for Standards Activities (2011–2016), and since 2012 as the Chair of the Special Interest Group on Humanitarian Technology (SIGHT), all within the IEEE Robotics and Automation Society.