NUI MAYNOOTH
Ollscoil na hÉireann Má Nuad

Half-day workshop on

Autonomous Robotics

9th August 2011, NUI Maynooth

http://www.nuim.ie/robocup

ISCC
Irish Systems and Control Committee

sfi
Fondúireacht Eolaíochta Éireann
Science Foundation Ireland

Hosted by the Electronic Engineering and Computer Science Departments and the Hamilton Institute at NUI Maynooth under their **Science Foundation Ireland** funded UREKA programme - Summer Internships in Autonomous Robotics (SIAR) . The event is technically co-sponsored by the **Irish Systems and Control Committee** (www.iscc-ifac.ie) and **RoboEireann** (www.nuim.ie/robocup).

Workshop on Autonomous Robotics

9th August, NUI Maynooth

Venue: Hamilton Institute Seminar Room, North Campus, NUI Maynooth
Poster session and light lunch: Foyer, Electronic Engineering building

Schedule

11.00 – 12.00 **Keynote Lecture: Humanoid Robot Soccer 101**
Dr. Thomas Röfer, German Research Center for Artificial Intelligence, Bremen

12.00 – 12.30 **Robot Soccer Demonstration by RoboEireann**

12.30 – 13.00 **Elevator Pitches by SIAR students**

13.00 – 14.00 **Poster Session and Light Lunch (Foyer, EE building)**
SIAR students and workshop participants

14.00 – 15.00 **Keynote Lecture: Robot Navigation and Mapping**
Prof. John Leonard, MIT Department of Mechanical Engineering and MIT CSAIL

15.00 – 16.00 **Invited talks by Irish Robotics researchers**

Mauro Dragone, UCD	Robotics UBIquitous COgnitive Network (RUBICON)
Tom Whelan, NUIM	Efficient Localization For Robot Soccer Using Pattern Matching
Edin Omerdic, UL	Future of ROV Piloting: Next Generation Smart ROVs

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Keynote 1: Humanoid Robot Soccer 101

Dr. Thomas Röfer, German Research Center for Artificial Intelligence, Bremen

Abstract: Building the software for a competitive robot soccer team is a challenging task. The robots have to perceive their environment, estimate where they and the other relevant object are located on the field, decide what to do, and execute those decisions. All this has to happen in real-time, on-board the robots, with limited computing power, and not only for a single robot, but for the whole team. The lecture will give a survey of these tasks, using the methods used by the team B-Human in the RoboCup Standard Platform League as an example.

Biography: Dr. Thomas Röfer received a Diploma in computer science and Dr. Ing. from Universität Bremen, Germany, in 1993 and 1998, respectively. He is a member of the Transregional Collaborative Research Center SFB/TR 8 “Spatial Cognition” at Bremen, funded by the Deutsche Forschungsgemeinschaft (DFG), and of the Executive Committee of the RoboCup Federation. He is currently Senior Researcher at the German Research Center for Artificial Intelligence (DFKI) in the Research Department on Safe and Secure Cognitive Systems at Bremen, Germany. He was the speaker of the GermanTeam in the RoboCup Four-legged League and is now the team leader of the team B-Human in the RoboCup Standard Platform League. Both teams won the world championship three times. His research interests include robot soccer, real-time computer vision, probabilistic world modeling, humanoid motion, and rehabilitation robotics.

Keynote 2: Robot Navigation and Mapping

Prof. John Leonard, MIT Department of Mechanical Engineering and MIT CSAIL

Abstract: This talk will have two parts. In part one, we will review recent progress in mobile robotics, focusing on the problems of simultaneous mapping and localization (SLAM) and cooperative navigation of mobile sensor networks. The problem of SLAM is stated as follows: starting from an initial position, a mobile robot travels through a sequence of positions and obtains a set of sensor measurements at each position. The goal is for the mobile robot to process the sensor data to compute an estimate of its position while concurrently building a map of the environment. We will present SLAM results for several scenarios including land robot mapping of large-scale environments and undersea mapping using optical imaging sensors. We will also describe work on cooperative navigation for networks of autonomous underwater vehicles (AUVs) and autonomous sea-surface vehicles (ASVs).

In the second part of the talk, we will provide an overview of MIT's entry in the 2007 DARPA Urban Challenge. The goal of this effort was to produce a car that can drive autonomously in traffic. Our team developed a novel strategy for using a large number of many inexpensive sensors, mounted on the vehicle periphery, and calibrated with a new cross-modal calibration technique. Lidar, camera, and radar data streams are processed using an innovative, locally smooth state representation that provides robust perception for real-time autonomous control. A resilient planning and control architecture has been developed for driving in traffic, comprised of an innovative combination of well- proven algorithms for mission planning, situational planning, situational interpretation, and trajectory control. The performance of our system in the NQE and race events will be reviewed, and ideas for future research will be discussed.

For more information, see http://grandchallenge.mit.edu

Joint work with Seth Teller, Michael Bosse, Paul Newman, Ryan Eustice, Matthew Walter, Hanumant Singh, Henrik Schmidt, Mike Benjamin, Alexander Bahr, Joseph Curcio, Andrew Patrikalakis, Matt Antone, David Barrett, Mitch Berger, Ryan Buckley, Stefan Campbell, Alexander Epstein, Gaston Fiore, Luke Fletcher, Emilio Frazzoli, Robert Galejs, Jonathan How, Albert Huang, Karl Iagnemma, Troy Jones, Sertac Karaman, Olivier Koch, Siddhartha Krishnamurthy, Yoshi Kuwata, Keoni Maheloni, David Moore, Katy Moyer, Edwin Olson, Andrew Patrikalakis, Steve Peters, Stephen Proulx, Nicholas Roy, Daniela Rus, Chris Sanders, Seth Teller, Justin Teo, Robert Truax, Matthew Walter, and Jonathan Williams.

Biography: John J. Leonard is Professor of Mechanical and Ocean Engineering at MIT and a member of the MIT Computer Science and Artificial Intelligence Laboratory (CSAIL). His research addresses the problems of navigation and mapping for autonomous mobile robots. He holds the degrees of B.S.E.E. in Electrical Engineering and Science from the University of Pennsylvania (1987) and D.Phil. in Engineering Science from the University of Oxford (1994). He studied at Oxford under a Thouron Fellowship and Research Assistantship funded by the ESPRIT program of the European Community. Prof. Leonard joined the MIT faculty in 1996, after five years as a Post-Doctoral Fellow and Research Scientist in the MIT Sea Grant Autonomous Underwater Vehicle (AUV) Laboratory. He has participated in numerous field deployments of AUVs, including under-ice operations in the Arctic and several major experiments in the Mediterranean. He has served an associate editor of the IEEE Journal of Oceanic Engineering and of the IEEE Transactions on Robotics and Automation. He is the recipient of an NSF Career Award (1998), an E.T.S. Walton Visitor Award from Science Foundation Ireland (2004), and the King-Sun Fu Memorial Best Transactions on Robotics Paper Award (2006).

Invited talks

Robotics UBIquitous COgnitive Network (RUBICON)

Dr. Mauro Dragone, CLARITY Centre for SensorWeb Technologies,

Abstract: This talk will introduce the new European project Rubicon - funded by the European Community's Framework Programme Seven (FP7) and co-ordinated by University College Dublin (UCD). This project aims to create a self-learning robotic ecology, called RUBICON (for Robotic UBIquitous COgnitive Network), consisting of a network of sensors, effectors and mobile robot devices. Enabling robots to seamlessly operate as part of these ecologies is an important challenge for robotics R&D, in order to support applications such as ambient assisted living, security, etc. Current approaches heavily rely on models of the environment and on human configuration and supervision and lack the ability to smoothly adapt to evolving situations. These limitations make these systems hard and costly to deploy and maintain in real world applications, as they must be tailored to the specific environment and constantly updated to suit changes in both the environments and in the applications where they are deployed. A RUBICON ecology will be able to teach itself about its environment and learn to improve the way it carries out different tasks. The ecology will act as a persistent memory and source of intelligence for all its participants and it will exploit the mobility and the better sensing capabilities of the robots to verify and provide the feedback on its own performance. As the nodes of a RUBICON ecology will mutually support one another's learning, the ecology will identify, commission and fulfill tasks more effectively and efficiently."

Efficient Localization For Robot Soccer Using Pattern Matching

Thomas Whelan, RoboEireann, NUI Maynooth

Abstract: One of the biggest challenges in the RoboCup Soccer Standard Platform League (SPL) is autonomously achieving and maintaining an accurate estimate of a robot's position and orientation on the field. Many robust systems already exist for robot localisation such as visual simultaneous localisation and mapping (SLAM) and LIDAR based SLAM. These approaches either require special hardware or are very computationally intense. The hardware on the Nao robot, the current robot of choice for the SPL, is quite low powered and as a result novel approaches to localisation in the RoboCup environment must be taken. In this talk a new approach to localisation in the SPL is presented which relies primarily on the information contained within white field markings while being computationally efficient enough to run in real time on board a Nao robot.

Title: Future of ROV Piloting: Next Generation Smart ROVs

Dr. Edin Omerdic, Mobile & Marine Robotics Research Centre, University of Limerick

Abstract: According to Richard Vandervoort, chief of ROV operation & underwater robotics, Marine Institute, Newfoundland, Canada, "the only real automatic controls present on modern work-class ROVs, used in offshore oil and gas exploration, are auto heading, auto depth and auto altitude. It really depends on pilot skills to do good piloting." Challenges faced by ROV pilots during deep water operations include pure visibility, time-varying ocean currents and umbilical drag effects. The Research team at Mobile and Marine Robotics Research Centre, University of Limerick, has developed ROV Upgrade Kit, a set of hardware/software components (MPPT Ring), that should be installed on an ROV and inside the Control Cabin, in order to increase level of automation, to make ROV operations easier and save expensive ship time by 20% or more. Smart ROV Latis has been designed & developed as a prototype platform to prove new technologies. System validation and technology demonstration was performed through a series of test trials with different support vessels off the west coast of Ireland, in Galway Bay and in the Shannon Estuary. Research outputs of the project are applicable to the growing international off-shore oil and gas sector, and also for future deployment, monitoring, and maintenance of ocean energy devices (in particular - wave energy converters and tidal turbines).