BREAKING THE SURFACE 2014 – List of tutorials

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Tutorial 1: 3D Mapping in Marine Environments
Andreas Birk, Jacobs University (Germany)

Marine robots are increasingly used in complex applications taking place in complex environmental settings under descreasing human supervision, i.e. with increasing autonomy. Good internal representations of the environment, i.e., maps, are in these cases not only interesting as mission deliverables but they are also essential for the vehicle's operation. e talk gives an overview of recent advances in the field of robotic 3D mapping with a particular focus on underwater applications. Bathymetric maps are sometimes denoted as 3D - but they can only represent elevation of terrain, i.e., a 2D manifold in 3D space which is also known as 2.5D. Techniques for full 3D representation and processing are in contrast needed for mapping complex natural environments like cliffs or reefs as well as man-made structures. e presentation includes a coverage of the core elements in 3D mapping, i.e., an overview of the state of the art with respect to underwater sensors, 3D representations, 6 degrees of freedom (6-dof) registration methods, and 6-dof Simultaneous Localization and Mapping (SLAM). e talk is completed by a hands-on tutorial where software for 3D mapping from the Jacobs Robotics group is used to demonstrate the different components and steps needed to generate 3D underwater maps.

Prof. Andreas Birk, PhD is since Nov. 2011 a full professor in Electrical Engineering and Computer Science at Jacobs University Bremen where he leads the robotics group. He started at Jacobs University in fall 2001 as associate professor while rejecting an offer for a professorship (C3) at the University of Rostock. Before he joined Jacobs University, he held a research-mandate of the Flemish Society for Applied Research, IWT. He was in addition from October 1997 on appointed as visiting professor (docent) at the Vrije Universiteit Brussel (VUB). He also worked as a visiting professor (C3) at the Universitat Koblenz-Landau in the winter-semester of 1999/2000. During the almost six years at the VUB, Andreas Birk was a member of the Artificial Intelligence Lab, which he joined as Postdoc in April 1996. In 1995 he received his doctorate from the Universitat des Saarlandes, Saarbrucken, where he previously studied Computer Science from fall 1989 to spring 1993.

Tutorial 2: Hovering AUVs for inspection and intervention
Marc Carreras, University of Girona (Spain)

AUVs have been traditionally being used for survey applications. Advances in sensors and algorithms for perceiving the underwater environment will extent the range of AUV applications to autonomous inspection or even autonomous intervention. is talk summarizes the work that for more than 10 years the University of Girona has been conducting on AUVs with hovering capabilities for inspection and intervention. Several AUVs have been developed in the laboratory, being “Girona 500” and “Sparus II” the current operative platforms. e first one is able to integrate big equipment such as a forward looking sonar on a pan and tilt unit, or an underwater manipulator. e second one is a portable torpedo shaped AUV that can integrate classical perception payloads such as cameras, sidescan or multibeam sonars.
The open hardware and software architecture and the extended maneuvering capabilities have allowed successful inspection applications such as: pipe following by means of robot learning, chain detection and following with a forward looking sonar, online path planning for 3D seabed mapping, and path planning with kinematic constraints for seabed inspection; and also intervention applications such as: target localization and grasping, valve turning by means of learning by demonstration, and panel operation from a docking AUV. Details and results about these applications will be given, pointing out future capabilities of commercial AUVs in inspection and intervention applications. e talk will conclude with the presentation of the Sparus II AUV, which was recently developed and will be available for BTS attenders in a practical tutorial about mission definition and AUV operation.

Dr. Marc Carreras is Associate Professor in the Computer Engineering Department at the University of Girona (Spain), and member of the Underwater Robotics Research Centre (http://cirs.udg.edu) of the same university. He holds a B.Sc. degree in Industrial Engineering (1998) and PhD in Computer Engineering (2003). He is currently involved in several European projects (FP7 STREP “PANDORA”, FP7 IP “MORPH”) and National project (“TRITON”) about autonomous underwater robotics. He has collaborated recently with the euRathlon FP7 project developing 3 Sparus II AUVs to be loaned to teams participating at the underwater robotic competition that the project organizes. Since 1999, he has participated in 14 research projects (6 European and 8 National), he is author of more than 80 publications, and he has supervised 3 PhDs thesis (2 more under direction). His research activity is mainly focused on underwater robotics in research topics such as intelligent control architectures, robot learning, path planning and AUV design.

Tutorial 3: A Laser Tracker System for Fast and Precise Relative Localisation of Marine Robots, Thomas Glotzbach, Ilmenau Technical University (Germany)

In the tutorial we will provide an overview on a new designed laser tracker system which was especially designed for usage in marine robotics. e emphasis of the design was put on the ability to be used in an underwater housing for fast and precise relative localization of Autonomous Underwater Vehicles (AUVs). In the current research on marine robotics, there is an increasing in the importance of cooperative and coordinated behaviour between single autonomous vehicles that aim at challenging tasks beyond simple group behaviour. In the research project MORPH (FP7-ICT-288704), in which the work presented in this paper was performed, the goal is to develop a novel concept in which several spatially separated single autonomous robot-modules (nodes) are working in close vicinity to create a supra-vehicle with logical links between the single nodes. For those missions, a fast and very accurate relative localization between the vehicles is needed. Currently, acoustic localization systems like Long Baseline (LBL), Short Baseline (SBL), or Ultra-Short Baseline (USBL) are widely used. While these technologies are feasible in a lot of marine scenarios, the requirements of MORPH introduce some new challenges that might require a new approach. Acoustic based range measurements suffer from a relative high level of failure and a small frequency of availability (approx. 0.2 – 0.5 Hz). For vehicles operating in the vicinity of several meters with velocities of up to two meters/second, a system which guaranties a high level of precision at close vicinities at high frequencies is needed. We propose a new optical laser system to increase update speeds and measurement quality. In the tutorial we will present the tracker in a lab environment, with the laser beam running through a water bowl to prove the general eligibility for the aimed applications

Tutorial 4: Satellite remote sensing for seafloor mapping and water quality monitoring
Anders Knudby, Simon Fraiser University (Canada)

Traditional collection of information about the marine environment, whether the seafloor or the water itself, is limited to a series of point observations. Remote sensing, particularly using sensors mounted on satellites, enables repeat and spatially continuous data collection over very large areas. is tutorial will cover two areas of investigation for which satellite remote sensing is frequently used, 1) large-scale water quality monitoring and 2) shallow seafloor habitat mapping. We will use open source software (QGIS and R) and publicly available satellite data to investigate trends in Adriatic Sea water quality over the last decade, and we will develop a method to automatically delineate sand and seagrass in shallow areas surrounding Kornati National Park. Lastly we will review current and future remote sensing data sets with applications for the marine environment

Dr. Anders Knudby has studied satellite remote sensing throughout his B.Sc. and M.Sc (Geography, University of Copenhagen) and PhD degrees (Geography, University of Waterloo). After working on a coastal biodiversity conservation project in Eritrea, an interest in shallow water environments combined with his remote sensing background in PhD research to map coral reef habitats using high-resolution satellite imagery and use the habitat maps to infer reef fish biodiversity patterns. After a post-doc that focused on automated cloud detection at the Canada Center for Remote Sensing, his current research interests include medium-resolution mapping of tropical and temperate nearshore environments, radiative transfer modeling, and long-term change detection using publicly available satellite data archives.

Tutorial 5: Remote Presence: Long Endurance Robotic Systems for Routine Inspection of Offshore Subsea Oil & Gas Installations and Marine Renewable Energy (MRE) Devices,
Edin Omerdić, University of Limerick (Ireland)

The OceanRINGS is a suite of smart technologies for subsea operations developed over last ten years at Mobile & Marine Robotics Research Centre (MMRRC), University of Limerick, Ireland. Applied to mini ROVs, OceanRINGS technologies enable remote presence: long endurance robotic systems for routine inspection of offshore subsea oil & gas installations and marine renewable energy devices controlled from remote control centre (Virtual control Cabin) through Internet in real time. Remote presence with mini ROVs enable more regular (even continuous) inspections of subsea structures, including observatories, MRE devices and offshore oil & gas installations (wellheads, pipelines etc.) and detection of abnormalities and defects at early stages. e majority of the cost-savings for offshore oil & gas is the prevention of failure in one of the production arteries (downhole tubing, pipelines, production vessels). Money lost through lost production far outweighs expenses associated with maintenance. The OceanRINGS smart technologies could lead to significant savings in time, maintenance and operational costs (20% or more), if they become available for wide scale commercial and industrial use. MMRRC research team is developing next generation, low cost, Internet-enabled smart ROV. This paper will describe motivation, the main idea and concept, including live demostration (through Internet) of real-time remote control of UL-based mini ROVs, including commercial VideoRay Pro3 & Pro4 and hardware-in-the-loop simulator of new ROV. In addition, live demonstration will include application of novel input devices (microphone for voice commands and KINECT for gesture recognition).

Dr Edin Omerdic received the B.Sc. and M.Sc. degree in Electrical Engineering from the University of Zagreb, Croatia, in 1997 and 2001, respectively. He received his PhD in Electrical Engineering from the University of Wales in 2004. Since his arrival to Mobile & Marine Robotics Research Centre, University of Limerick, Ireland in 2003, he was engaged in numerous research projects in the area of submersible robotics. His research interests include modelling & simulation of dynamic systems (marine platforms, ocean dynamics & disturbances), renewable energy, real-time simulators, virtual reality, development and design of guidance, navigation and control system for marine vessels, nonlinear control systems, implementation of soft-computing techniques in intelligent systems, underwater robotics and fault-tolerant systems.