Exploring the Frontier of Cooperative Marine Robotics: Navigation and Control of Networked Autonomous Vehicles

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The last decade has witnessed tremendous progress in the development of marine technologies that are steadily affording scientists advanced equipment and methods for ocean exploration and exploitation. Recent advances in marine robotics, sensors, computers, communications, and information systems are being applied to the development of sophisticated technologies that will lead to safer, faster, and far more efficient ways of exploring the ocean frontier, especially in hazardous conditions. As part of this trend, there has been a surge of interest worldwide in the development of autonomous marine robots capable of roaming the oceans freely and collecting data at the surface of the ocean and underwater on an unprecedented scale. Representative examples are autonomous surface craft (ASC) and autonomous underwater vehicles (AUVs). The mission scenarios envisioned call for the control of single or multiple AUVs acting in cooperation to execute challenging tasks without close supervision of human operators.

This talk addresses the general topic of cooperative motion navigation and control of marine vehicles, both from a theoretical and a practical perspective. The presentation builds upon practical developments and experiments. Examples of scientific missions with ASCs and AUVs, acting alone or in cooperation, set the stage for the main contents of the presentation. Special emphasis is placed on the problem of operating groups of vehicles for scientific ocean studies, habitat mapping in complex 3D scenarios, geotechnical surveying, and sustained presence at sea in hazardous environments. From a theoretical standpoint, a number of challenging problems are addressed in the area of cooperative motion control and navigation of groups of autonomous vehicles. The connections with advanced methods for navigation, including geophysical-based navigation, are also discussed. The results obtained are illustrated with videos from actual field tests with multiple marine robots exchanging information over an acoustic network. The core material presented in the talk was obtained in the scope of the GREX (http://www.grex-project.eu), CO³AUVs (http://www.co3-auvs.org), MORPH (http://morph-project.eu/), and CADDY (http://www.caddy-fp7.eu/) projects of the EC.
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SHORT CV

PhD in Control Science from the University of Minnesota, Minneapolis, MN, USA. Professor of Control and Robotics at IST, University of Lisbon, Portugal. Member, Scientific Council of the Institute for Systems and Robotics, Lisbon. Adjunct Scientist, National Institute of Oceanography (NIO), Goa India. Expertise in Dynamical Systems Theory, Robotics, Navigation, Guidance, and Control of Autonomous Vehicles, and Networked Control and Estimation. Elected Chair, IFAC Technical Committee Marine Systems, 2008-2014. He was IST’s responsible scientist for eight EU funded collaborative research projects and several national research projects, all in the area of dynamical systems and ocean robotics. He has cooperated extensively with groups in Europe, US, and India on the development and testing of advanced robotic systems for ocean exploration. He is the author of more than 200 papers and communications on the subject, published in international journal and proceedings of conferences. His long-term goal is to contribute to the development of advanced robotic systems for ocean exploration and exploitation.

Webpages

Dynamical Systems and Ocean Robotics (DSOR) Group

DSOR Facebook page  https://www.facebook.com/dsor.lab.isr.ist
DSOR Lab Projects http://welcome.isr.ist.utl.pt/labs/dsor/project

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