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Guest editorial: special issue on long-term autonomy in marine robotics

Francesco Maurelli[1] · **Marc Carreras**[2] · **Kanna Rajan**[3] · **David Lane**[4]

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In recent years, persistent autonomous operations have become a key area of interest for marine robotics researchers. As hardware costs have plummeted, sensors measuring various oceanographic properties have proliferated and the use of robotic platforms within the ocean science community has emphasized the need for increased autonomy to perform tasks over large spatial and temporal durations. The challenge in doing so is particularly severe in the context of the marine environment, and especially for robotic assets to be observable and communicable over space and time. Over and beyond making time-series measurements marine robots have demonstrated their capability to respond to episodic events, perform targeted sample collection, track dynamic phenomenon in rough coastal environments and make quasi-synoptic observations in the meso-scale. However, there continue to be significant challenges to marine robotic operations. While commercial deep-water oilfield inspection with autonomous vehicles is now a commercial reality, fielded robots continue to rely heavily on accurate a priori models of the subsea assets and expose limited capabilities for autonomous decision making. Most autonomous vehicles in the marine environment are limited to preplanned missions, or to limited forms of autonomy involving script switching and re-parameterization in response to pre-programmed events. Realizing the persistent autonomy that users in the ocean increasingly demand is involving a greater capability in understanding sensed events to detect failure and error, and more capable task planning approaches that can adapt behavior and control in novel ways.

In this special issue the topic of long-term autonomy is addressed with contributions covering a wide range of topics, from planning to robust control, from reliable navigation to bio-inspired approaches. All scientific papers, selected through a rigorous peer-review process, show a clear link to long-term persistent autonomy and represent an important contribution not just towards scientific excellence, but also towards a world where autonomous intelligent marine systems will be key for economic development, environmental monitoring and safety.

Additionally, two invited papers from governmental and funding agencies show how the topic of long-term autonomy in the marine domain is key in autonomous systems research, what are the perspectives in the field, and the impact in the society. The Office for Naval Research (ONR) presents a view from the US, while the Unit Robotics and AI of the European Commission presents a view from the "Old Continent". Both papers represent an important view from governmental agencies regarding the importance of the topic, the current efforts into it and the future directions.

✉ Francesco Maurelli
f.maurelli@ieee.org

Marc Carreras
marc.carreras@udg.edu

Kanna Rajan
kannarajan.mbari@gmail.com

David Lane
d.m.lane@hw.ac.uk

[1] Chair of Robotics and Embedded Systems, Technische Universität München, Garching bei München, Germany

[2] Computer Vision and Robotics Institute, Universitat de Girona, Girona, Spain

[3] Underwater Systems Laboratory, University of Porto, Porto, Portugal

[4] Ocean Systems Laboratory, Heriot-Watt University, Edinburgh, Scotland, UK

- *Human-robot planning and learning for marine data collection*

Somers et al. present Bayesian learning techniques to combine waypoints provided by a human operator with historical data to improve the operation of autonomous vehicles in scientific monitoring scenarios.

- *Resolution-adaptive risk-aware trajectory planning for surface vehicles operating in congested civilian traffic*

Shah at al. propose a path planning strategy for autonomous Unmanned Surface Vehicles (USVs), which have to work for long periods of time and move next to civilian vessels. The method estimates the collision risk and generates trajectories for avoiding them.

- *Robust underwater obstacle detection and collision avoidance*

Ganesan et al. propose a probabilistic obstacle detection and avoidance system for AUVs which have to work in the long term, based on a local occupancy grid map.

- *Cooperative bathymetry-based localization using low-cost autonomous underwater vehicles*

Yew Teck et al. present a cooperative localization approach, with a team of low-cost AUVs, using the marginalized particle filtering technique in a distributed manner and extending the filter's measurement model to incorporate the information broadcast by other vehicles in the team.

- *Mid-water current aided localization for autonomous underwater vehicles*

Medagoda et al. present mid-water localization using ADCP as an alternative form of georeferencing for vertical dives during AUV missions.

- *Cooperative navigation of AUVs via acoustic communication networking. Field experience with the typhoon vehicles*

Allotta et al. present a low-cost and effective cooperative navigation scheme for several AUVs working together, based on acoustic communication networking.

- *Opportunistic sampling-based active visual SLAM for underwater inspection*

Chaves et al. present a comprehensive active SLAM framework for underwater visual inspections, which include a path planning algorithm integrated with SLAM, in order to balance the need for loop-closure and the need of exploration in an unknown environment.

- *Modeling curiosity in a mobile robot for long-term autonomous exploration and monitoring*

Girdhar et al. present an exploration technique that aims to learn an observation model of the world by finding paths with high information content.

- *Toward persistent autonomous intervention in a subsea panel*

Palomeras et al. present an integrated framework, involving mechatronics, localization, control, machine learning and planning techniques, in order to achieve robustness in autonomous interventions, coping with unexpected perturbances and failures.

- *Energy optimal depth control for long range underwater vehicles with applications to a hybrid underwater glider*

Claus et al. propose a depth controller design for AUVs, which has been optimized to reduce the energy consumption and improve the autonomy for long term deployments.

- *A multirobot platform based on autonomous surface and underwater vehicles with bio-inspired neurocontrollers for long-term oil spills monitoring*

Guerrero-González et al. present a monitoring system composed of an ASV with an associated AUV, designed for long-term missions of oil-spill monitoring, using a novel neurocontroller approach.

- *A distributed architecture for supervision of autonomous multirobot missions—application to air-sea scenarios*

Barbier et al. present a multi-layer deliberative architecture for managing mission execution for multi-robot systems.