



Editorial: Navigation and Perception for Autonomous Surface Vessels

Fausto Ferreira^{1*}, Alberto Quattrini Li² and Ørnulf J. Rødseth³

¹Faculty of Electrical Engineering and Computing, University of Zagreb, Zagreb, Croatia, ²Department of Computer Science, Dartmouth College, Hanover, NH, United States, ³SINTEF Ocean, Trondheim, Norway

Keywords: autonomous surface vehicle (ASV), autonomous ship, navigation and control, perception, reinforcement learning, machine learning, collision avoidance (CA)

Editorial on the Research Topic

Navigation and Perception for Autonomous Surface Vessels

While autonomous navigation for ground robots has been studied for a several decades, a large gap is still present for autonomous vehicles in the marine domain. Challenges include unpredictable dynamics, mostly unstructured environments, and comparatively high cost in terms of logistics and vehicles to conduct experiments. Solving such challenges require new methods that improve the navigation and perception abilities of autonomous surface vessels. Thus, this special research topic in the journal “Frontiers in Robotics and AI” aims at covering new advances around these issues. Four articles were selected for publication and the result is this edition of the journal. In the following we will give a brief overview of the four papers.

Deep Reinforcement Learning (RL) techniques have been thoroughly used in the field of Autonomous Surface Vessels both for perception and for navigation. However, many works propose a DRL technique and compare with a limited number of state-of-the-art methods. “Comparing deep reinforcement learning algorithms’ ability to safely navigate challenging waters” (Larsen et al.) addresses a so-much needed comparison of different techniques. Specifically, the authors tackle the trade-off between collision avoidance and path planning and analyse the behaviour impact in this trade-off depending on the choice of RL technique. The role of the reward function in this multi-objective optimization is discussed as well.

To generalize obstacle avoidance from ground mobile robots to marine vehicles and to bridge the gap between simulation and reality, “Robust ASV Navigation Through Ground to Water Cross-Domain Deep Reinforcement Learning” (Lambert et al.) proposes a navigation method based on a deep reinforcement learning framework for high-level control, integrated with low-level controllers specific to the vehicle. The paper demonstrates the cross-domain generalizability of the proposed method by training a Deep Q Network for a simulated Autonomous Ground Vehicle (AGV) with navigation tasks. It then successfully implements and tests the proposed DRL method on a real AGV as well as an Autonomous Surface Vehicle (ASV) in different scenarios without any re-training. While the paper can be expanded to handle more complex scenarios, e.g., with dynamic obstacles, the paper provides a good methodology for training reinforcement-learning based approaches in domains that are comparatively easier and lower cost for deployments compared to challenging target domains, as the marine one.

Deep RL are not the only techniques that can be used for autonomous navigation. The complexity of the issue requires a deep study of the field. Indeed, collision avoidance and safe navigation in environments where other crewed or uncrewed ships sail, are perhaps the biggest challenges for safe operation of autonomous surface vessels. In particular, the coexistence with other crewed ships require that autonomous vessels obey the rights of way for the sea, i.e. the international collision regulations or COLREG as they are called. “Autonomous Collision Avoidance at Sea: A Survey” (Burmeister and Constapel) gives a comprehensive overview of

OPEN ACCESS

Edited and reviewed by:

Kostas Alexis,
Norwegian University of Science and
Technology, Norway

*Correspondence:

Fausto Ferreira
Fausto.Ferreira@fer.hr

Specialty section:

This article was submitted to
Field Robotics,
a section of the journal
Frontiers in Robotics and AI

Received: 12 April 2022

Accepted: 02 May 2022

Published: 20 May 2022

Citation:

Ferreira F, Quattrini Li A and
Rødseth ØJ (2022) Editorial:
Navigation and Perception for
Autonomous Surface Vessels.
Front. Robot. AI 9:918464.
doi: 10.3389/frobt.2022.918464

relevant literature in this field and systemizes the approach taken by each reviewed paper in terms of what specific part of the problem they address, how they control the vessel, what sensors they use, and what algorithm or method they employ. This also includes a cross reference between the most relevant rules in COLREG and the papers that address them. In addition, the paper includes an analysis of how the performance of the different methods or algorithms have been validated. It is interesting to note that only around 10% of the 48 papers surveyed in detail refer to *in-situ* tests. The paper gives a very good overview of an important research area for autonomous surface vessels, but it also makes clear that much more research and validation are required.

Finally, good perception and navigation algorithms are sometimes not enough for guaranteeing a minimum performance of the situational awareness functionality. “Dynamic semantic world models and increased situational awareness for highly automated inland waterway transport” (Baelen et al.) addresses the need for good dynamic semantic world models for better situational awareness. Both internal and external world models are described. One important characteristic of this work is the ability to dynamically adapt to new situations and the simplicity of interpretation in those dynamic situations by all actors involved. The contribution to explainability and performance in dynamic environments is a significant step towards safer navigation.

The editors wish to thank all the authors, reviewers, and the whole editorial team for the hard work and perseverance in making this Research Topic come through.

AUTHOR CONTRIBUTIONS

All authors contribute to the introduction of the editorial. Each author contributed to the description of the papers for which they served as editors. FF coordinated the editorial writing.

Conflict of Interest: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher’s Note: All claims expressed in this article are solely those of the authors and do not necessarily represent those of their affiliated organizations, or those of the publisher, the editors and the reviewers. Any product that may be evaluated in this article, or claim that may be made by its manufacturer, is not guaranteed or endorsed by the publisher.

Copyright © 2022 Ferreira, Quattrini Li and Rødseth. This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY). The use, distribution or reproduction in other forums is permitted, provided the original author(s) and the copyright owner(s) are credited and that the original publication in this journal is cited, in accordance with accepted academic practice. No use, distribution or reproduction is permitted which does not comply with these terms.