A Generalized Reinforcement Learning Based Controller for Heading-keeping of Ships in Waves

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ABSTRACT

The industry standard for maritime motion control is to use traditional controllers such as PID (Fossen, 2021). However, recent works has shown that Reinforcement Learning (Sutton et al., 2018) methods can successfully be used in many decision-making problems. Considering the power of machine learning methods when dealing with highly non-linear problems, the feasibility of ship motion control using Reinforcement Learning has started to attract more attention in recent studies (Sutton et al., 2018; Woo et al., 2019; Meyer et al., 2020). As such, this study proposes a Reinforcement Learning based controller for heading-keeping of ships in waves. We train a single controller that can operate under a variety of sea conditions and investigate its performance in terms of yaw error and rudder usage. Instead of directly showing the final version of the controller, we present a weak controller as the starting point and improve it iteratively to tackle the weaknesses of the controller through reward shaping. An LQR controller is used as a baseline in performance assessment of the proposed controller and investigations have revealed that RL-based controller outperforms the LQR in every aspect. The paper is finalized by presenting the behavioral differences of the designed controller and the LQR. Our study shows the potential of Reinforcement Learning in ship motion control, which can learn powerful control policies through experience as opposed to handcrafted traditional methods.

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