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A reinforcement learning path planning approach for range-only underwater target localization with autonomous vehicles

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***Abstract*— Underwater target localization using range-only and single-beacon (ROSB) techniques with autonomous vehicles has been used recently to improve the limitations of more complex methods, such as long baseline and ultra-short baseline systems. Nonetheless, in ROSB target localization methods, the trajectory of the tracking vehicle near the localized target plays an important role in obtaining the best accuracy of the predicted target position. Here, we investigate a Reinforcement Learning (RL) approach to find the optimal path that an autonomous vehicle should follow in order to increase and optimize the overall accuracy of the predicted target localization, while reducing time and power consumption. To accomplish this objective, different experimental tests have been designed using state-of-the-art deep RL algorithms. Our study also compares the results obtained with the analytical Fisher information matrix approach used in previous studies. The results revealed that the policy learned by the RL agent outperforms trajectories based on these analytical solutions, e.g. the median predicted error at the beginning of the target's localisation is 17% less. These findings suggest that using deep RL for localizing acoustic targets could be successfully applied to in-water applications that include tracking of acoustically tagged marine animals by autonomous underwater vehicles. This is envisioned as a first necessary step to validate the use of RL to tackle such problems, which could be used later on in a more complex scenarios.**

[5]. To avoid these inherent issues, different strategies have been developed for tracking underwater targets, moving from the traditional, moored Long Baseline (LBL) systems [6], to GPS Intelligent Buoy (GIB) systems [7], or most recently range-only and single-beacon (ROSB) methods [8] where a single AUV surveys a marine area to estimate the position of an acoustically tagged target. Range-only methods have different advantages over angle-related localization methods (e.g., Ultra-Short Baseline (USBL) systems [9]) because it (i) reduces the power consumption and the number of required devices (e.g. an inertial measurement unit), and subsequently the cost and size of the overall system, and (ii) angle measurements are less robust in rough sea conditions compared to range measurements [10], especially if they are used in small platforms [11] such as an Autonomous Surface Vehicle (ASV) Wave Glider (Liquid Robotics, USA).

The main drawback in ROSB localization techniques is related to path optimization (i.e. what trajectory should follow the ASV to increase the accuracy of the predicted target position). The ultimate goal is to compute the optimal ASV trajectory that will yield the best possible accuracy of the