Energy Optimal Path Planning for Autonomous Underwater Vehicles

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Efficient path planning for Autonomous Underwater Vehicles (AUVs) is crucial for improving their operational efficiency in ocean exploration, ocean monitoring, and commercial activities. We present methodologies to optimize energy consumption and travel time for AUVs navigating dynamic ocean environments. We employ the level set method and Hamilton-Jacobi equation to model the evolving reachability front of AUVs, incorporating real-time ocean current data and solar radiation data. We conduct simulations across several scenarios, using idealized environments and real-world data, taking into consideration energy-rich zones where AUVs can harness solar energy. Our results show improved path optimization, with AUVs effectively navigating complex current patterns while minimizing energy consumption and travel time. The proposed methods are robust, and show the potential for adaptability, enhancing path-planning capabilities for AUVs. Our study demonstrates the effectiveness of combining advanced mathematical modeling with real-time environmental data to optimize AUV trajectories. We provide practical methods for developing efficient autonomous navigation systems, with potential applications extending beyond underwater vehicles to aerial and terrestrial robots, contributing to more sustainable and efficient operations in the broader field of autonomous vehicle research.

Awards Won: