

A MATLAB-Integrated Decision Support System for Autonomous ROV Navigation and Obstacle Avoidance

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Abstract

Autonomous operation of Remotely Operated Vehicles (ROVs) in unstructured subsea environments presents significant challenges due to limited visibility, complex hydrodynamic disturbances, and dynamic obstacles. This paper proposes a MATLAB-integrated Decision Support System (DSS) designed to enhance real-time autonomous navigation and obstacle avoidance for mapping ROVs. The proposed framework integrates a Deep Reinforcement Learning (DRL) algorithm for path planning with MATLAB's Navigation and Automated Driving Toolboxes to achieve adaptive decision-making under high-uncertainty conditions. Multi-sensor data, including forward-looking sonar and acoustic telemetry, are fused using MATLAB System Objects to generate a continuous 3D occupancy grid of the subsea environment. A hardware-in-the-loop (HIL) co-simulation environment was developed in MATLAB/Simulink to evaluate the vehicle's hydrodynamic control and response under varying thruster configurations. Experimental evaluation through simulated underwater mapping scenarios demonstrates that the proposed DSS reduces path deviation by 28.4% and successfully avoids dynamic obstacles with a response latency under 120 milliseconds. The integration of MATLAB drastically accelerates model deployment and provides robust real-time trajectory optimization, paving the way for safer, fully autonomous ROV-based subsea surveys and mapping missions.

Keywords

Remotely Operated Vehicle (ROV), Decision Support System (DSS), Autonomous Navigation, Obstacle Avoidance, MATLAB/Simulink, Deep Reinforcement Learning, Underwater Mapping.