Towards Design and Development of an Autonomous Marine Vehicle for Environmental Monitoring

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Abstract

In South Yorkshire, there are numerous shallow and fast-flowing aquatic environments that are inaccessible to humans and are impacted by industrial activities. This has created a pressing need to monitor water quality in the region. Consequently, there has been a development of tools and technologies aimed at facilitating continuous and widespread monitoring of aquatic environments, with a particular focus on local pollution monitoring. To address this need, this study explores the design and development of an autonomous marine vehicle to enhance the efficiency, accuracy, and coverage of environmental monitoring and data collection. By harnessing the autonomous capabilities of marine robots, this research aims to ensure a comprehensive understanding of dynamic conditions in South Yorkshire's aquatic environments.

The study presents the development and validation of a low-cost, agile Unmanned Surface Vehicle (USV) specifically designed for autonomous navigation in shallow waters. In shallow water environments, the primary challenge for USVs is maneuverability, highlighting the necessity for cost-effective platforms that can serve as efficient monitoring systems for various environments. The USV developed in this study is a 3D printed twin-hull catamaran-style platform equipped with an Inertial Measurement Unit (IMU), 3D LiDAR, and a Global Positioning System Real-Time Kinetics (GPS-RTK). It utilizes a Raspberry Pi 4 for high-level control and an Arduino MEGA for low-level control. The propulsion system is designed with a differential drive configuration powered by two DC motors. The design incorporates the Robot Operating System (ROS) for the development of the control framework and integrates Extended Kalman Filter (EKF)-based sensor fusion techniques. To evaluate the USV's autonomy, a series of maneuvering experiments were conducted using remote control methods to assess the vehicle’s maneuverability and overall performance characteristics in shallow water conditions.

Keywords: Unmanned Surface Vehicles, Autonomous Systems, Environmental Monitoring, ROS, Extended Kalman Filter