ABSTRACT

The use of Unmanned Surface Vehicles (USVs) is expanding rapidly across various sectors such as environmental monitoring, marine research, and maritime operations. One of the primary challenges in USV deployment is energy efficiency, especially for long-duration missions. This research aims to develop a motion control system for an autonomous boat that utilizes solar energy as its primary power source, thereby improving operational sustainability and reducing dependency on fossil fuels.

The method involves designing and implementing a system controlled by an ESP32 microcontroller to regulate two BLDC motors via Electronic Speed Controllers (ESCs) using a differential thrust approach. The system is also equipped with a 50W solar panel, solar charge controller, and a 12V 7Ah SLA battery as part of the power supply subsystem. Testing was conducted both manually using a Turnigy 9X remote control and automatically via programming, including square-pattern movement, GPS and compass-based navigation, and ultrasonic-based obstacle avoidance.

The results indicate that the boat operates stably, achieving an average speed of 0.83 m/s in manual mode and 0.56 m/s in autonomous mode. The system can function for 40–45 minutes on battery alone, extending up to 60 minutes with support from solar input. The system meets the design goals and demonstrates potential as a foundational prototype in the development of renewable energy-based Swarm USV technology.

Keywords: *USV, motion control, solar panel, SwarmUSV, BLDC, ESC*