

DEVELOPMENT OF AN AUTONOMOUS SURFACE VEHICLE FOR REAL-TIME AQUATIC ENVIRONMENT MONITORING AND DEPTH MAPPING

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Keywords:

Autonomous Surface Vehicle (ASV), Global Positioning System (GPS), Sonar-based Depth Mapping, water quality parameters, small-scale monitoring, aquatic environment monitoring.

Introduction:

This project focuses on developing an Autonomous Surface Vehicle (ASV) integrated with GPS for efficient depth mapping and water quality monitoring. Traditional methods are costly and labor-intensive, whereas the ASV autonomously navigates water bodies, collecting real-time data on depth, temperature, pH, turbidity, and contaminants. GPS ensures precise navigation, improving coverage and data accuracy. The collected data is processed onboard and transmitted for analysis, enabling continuous monitoring and early detection of environmental changes. This system enhances efficiency, reduces human intervention, and supports sustainable water management, scientific research, and environmental conservation, providing a cost-effective solution for aquatic survey applications.

Objectives:

- Design an autonomous navigation system for efficient water surveys with minimal human intervention.

- Develop accurate underwater bathymetry and 3D mapping to enhance environmental monitoring.
- Integrate advanced sensors for real-time water quality analysis and cloud-based data visualization using platforms like Blynk.

Methodology:

The Autonomous Surface Vehicle (ASV) is designed for stability and smooth navigation, featuring two cylindrical pontoons and dual propellers. A central compartment houses essential components, including a GPS module for precise waypoint navigation. Equipped with water quality sensors (pH, turbidity, EC, temperature), the ESP32 microcontroller transmits real-time data via the Blynk IoT platform. An ADS1115 ADC enhances sensor accuracy. Depth mapping is achieved using sonar sensors, with real-time data processed in MATLAB. The ASV operates in both autonomous and manual modes, with GPS waypoints guiding its movement. Mission Planner aids in navigation and telemetry, integrating with MATLAB for 3D depth visualization.

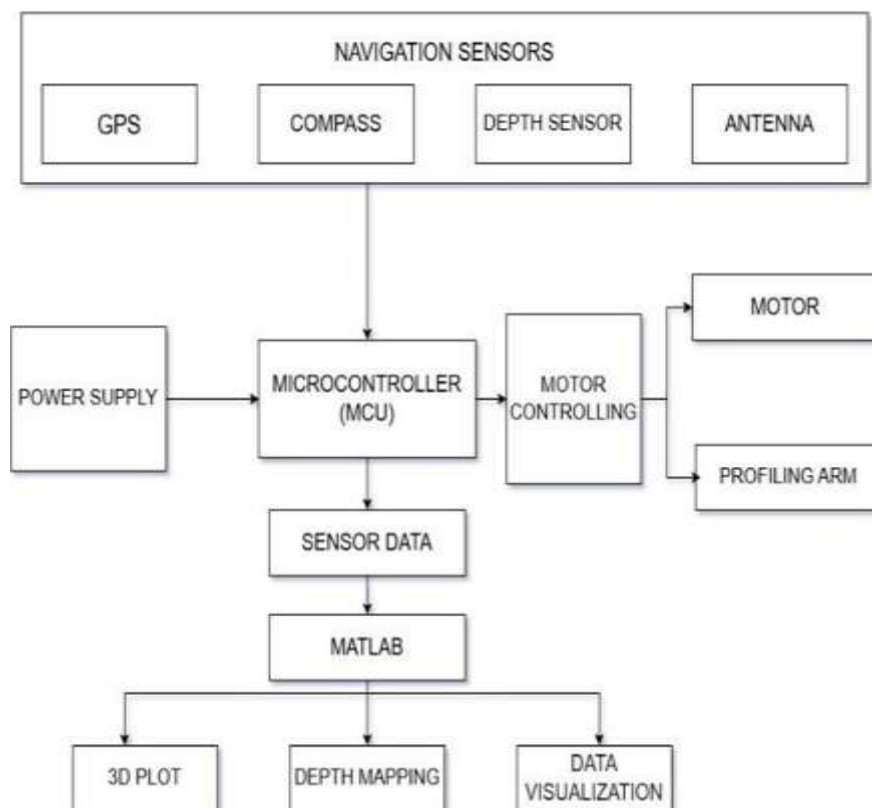


Figure 1: Block Diagram of ASV

The data collected by the ASV is sent to the cloud using the Blynk IoT platform, enabling remote monitoring in real time. This allows users to track water quality parameters and system status from any location. Additionally, 3D mapping is performed using MATLAB by processing sensor data, including latitude, longitude, and depth measurements. This integration provides a detailed visualization of underwater topography, aiding in environmental analysis, resource management, and research applications.

Result and Conclusion:

The Autonomous Surface Vehicle (ASV) is designed for water quality monitoring, depth surveying, and 3D underwater mapping. It autonomously navigates predefined waypoints using GPS, sonar, and water quality sensors, collecting real-time environmental data. The system measures pH, temperature, turbidity, and conductivity, transmitting data via Blynk for remote monitoring. For 3D mapping, the ASV integrates sonar depth readings with GPS coordinates to generate high-resolution bathymetric models. Data processing in MATLAB and Python visualizes underwater terrain, aiding in environmental analysis. Testing showed high accuracy in capturing water quality parameters, with minimal variation from manual sampling. The ASV's sonar provided precise depth profiles, ensuring reliable 3D mapping. Its differential thrust propulsion and obstacle detection enable smooth navigation in various water bodies. Solar power integration enhances autonomy, making it a sustainable and cost-effective tool for large-scale environmental monitoring and underwater mapping.



Figure 2: Autonomous Surface Vehicle Prototype

Future Scope:

- Sensors and remote sensing technologies enable continuous monitoring of river water quality, protecting aquatic ecosystems.
- Sonar technology provides detailed 3D mapping of riverbeds, offering insights into depth variations and underwater structures for habitat mapping and safe navigation.
- Future advancements in AI-driven navigation and real-time data telemetry will enhance river exploration, allowing autonomous vehicles to navigate complex environments and respond quickly to environmental changes.