

Development of Unmanned Surface Vehicle Platform for Lake Monitoring and In-Situ Water Sampling: An Initiative for lake health monitoring in and around GHMC

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1. Introduction

Urban lakes are vital ecological assets that provide water for domestic and industrial use, regulate microclimates, and offer recreational value. However, many such lakes are increasingly under threat due to untreated sewage, industrial effluents, and unregulated dumping. Traditional monitoring methods—manual water sampling and periodic laboratory testing—are labour-intensive, limited in spatial coverage, and often lag in detecting pollution trends. To address this challenge, IIT Hyderabad is developing a modular Unmanned Surface Vehicle (USV) platform based on the Blue Robotics Blue Boat, equipped with a comprehensive navigation and environmental sensing suite. The system aims to autonomously monitor, map, and sample urban lakes, generating high-resolution spatio-temporal datasets to support lake health monitoring and enable informed decision-making for sustainable water resource management.

2. System Architecture and Capabilities

The IITH-USV platform shown in Figure-1 is a compact, modular robotic system tailored for real-time monitoring, autonomous navigation, and adaptive sampling. Key hardware and software features include:

2.1. Navigation and Control

- GPS-aided INS for navigation and control
- Autopilot controller with real-time mission execution
- Path planning and obstacle avoidance algorithms
- Vision camera for obstacle detection and situational awareness

2.2. Environmental Monitoring

- Real-time water quality sensing suite: pH, Oxygen Reduction Potential (ORP), Dissolved Oxygen (DO), and Electric Conductivity (EC) sensors
- Echosounder and Side Scan sonar for bathymetry and sludge profiling
- GIS-based tools for geospatial visualization of water parameters profiles

2.3. Modular Sampling Mechanism

- Custom-built carousel water sampler capable of collecting discrete samples from targeted coordinates,
- Samples collected will be sent for extended lab analysis to sample for water parameters including nutrients, heavy metals, microbial content etc.

This integrated robotic system is designed not only to conduct autonomous surveys and lake health monitoring but also to adapt payloads depending on specific use cases. Figure 2 shows the USV platform being tested in the in-house pool at IITH. Figures 3a and 3b illustrate the waypoint navigation and survey missions conducted in the same pool

Objectives and Novelty

This project's vision extends beyond routine data logging. It aims to build a scalable, autonomous lake monitoring solution with the following key goals:

1. **Design a Modular USV:** Develop a robust platform with modular architecture, supporting future sensor and payload upgrades.
2. **Sensor Fusion for Navigation Safety:** Integrate data from GPS, radar, sonar, and vision to enable real-time collision avoidance and optimised routing.
3. **Comprehensive Water Monitoring:** Acquire high-resolution spatio-temporal data on water quality parameters, visualized through GIS mapping.
4. **Sludge Profiling and Bed Mapping:** Leverage sonar data for anomaly detection models and bathymetry
5. **Data Dissemination and Public Engagement:** Build a database for sharing water health dashboards with urban bodies, pollution control boards, and the public.

With its real-time data streaming and sample-collection abilities, the platform acts as both an automated scout and a mobile lab assistant, providing a rapid lake monitoring system. This initiative marks a significant step toward human-centric and environmentally responsible robotics.

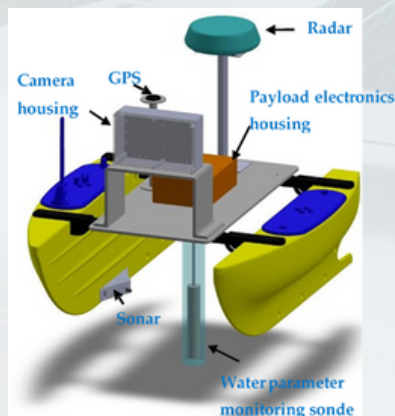


Figure 1. Configuration of the USV-IITH

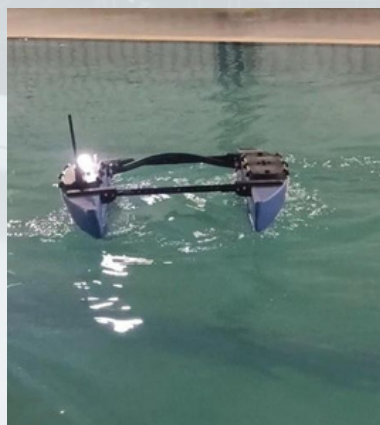


Figure 2. Trails of the platform – inhouse pool - IITH



Figure 3a. Survey mission



Figure 3b. Waypoint mission

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