

# Automatic Unmanned Surface Vehicle-Based Water Quality Monitoring System

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Water is an extremely important natural resource. However, our water supply is at risk. Droughts and contaminants threaten our water supply. With less water available we must do all we can to protect what water we have. In an interview with the Water Agency Coordinator & Lead Chemist at Sonoma Water, Sonoma, California, the coordinator stated that most water testing is currently done with either stationary sensors at water intakes or manually through water samples. This limits the area that is tested and can make it difficult to have continuous testing over a wide area. This in turn can allow potential water contamination to go undetected.

We propose an Automatic Unmanned Surface Vehicle-Based (USV) Water Quality Monitoring System (WQMS) to tackle this problem. The USV will be able to support a payload of electronics such as sensors, a microprocessor, an autopilot controller, and a global positioning system (GPS) module. The payload of these components will be water protected with a rating of IPX4 [1], and the USV will be stable and resistant to capsizing. The USV's dimensions are designed with portability in mind, it will be able to fit inside the back of a standard midsize SUV. A 12V battery will be used to power the electronic components, and an electronic speed controller (ESC) will regulate the speed of the thrusters that will be mounted on the USV. The Automatic USV WQMS moves along a predefined path through bodies of water taking sensor readings at specified locations. These waypoints are user-defined by path planning software. The USV will have a minimum forward speed of 3 kph with a minimum operational time of 1 hour.

1. Keystone Compliance, LLC. *IPX3 & IPX4 Spraying/Splashing Water*. Keystone Compliance. [Online]. Available: <https://keystonecompliance.com/ipx3-ipx4-spraying-splashing-water/> [Accessed: 2019, November 5].
2. G. D. Cooke and R. E. Carlson, "Water quality management in a drinking water reservoir," *Lake and Reservoir Management*, vol. 2, no. 1, pp. 363–371, 1986.
3. "Water Quality Standards Regulations: California," *EPA*, 23-Sep-2021. [Online]. Available: <https://www.epa.gov/wqs-tech/water-quality-standards-regulations-california#sect1>. [Accessed: 20-Nov-2021].

With these considerations in mind, our USV can travel a predefined path of 3 km round trip. There will be a safety function implemented into our design to instruct the USV to return to its defined home waypoint if its battery is less than or equal to 50%. An on-board GPS module that is connected to the flight controller will stay in constant communication with the path planning software to track the movement of the USV. With this autonomy, this design feature will allow the USV to operate unmanned, so less manpower is required to perform testing. It will be able to cover a larger area more consistently and constantly than a manned boat trolling a body of water. While this WQMS will allow for continuous monitoring of a body of water it will not completely replace lab testing. The sensors installed on the USV will only cover four of the most basic water quality testing points Ph, dissolved oxygen, temperature, and turbidity [2]. The data from these sensors will be stored on the onboard microprocessor where it can be transferred via LoRa to the local gateway. From this gateway, the data would be transferred to cloud storage. Due to the remote testing locations, the LoRa gateway would rely on cellular service to transfer data. That data then could be accessed through a website that interprets the data into an easily readable format for the user.

The result is a USV that can be deployed on a body of water, and automatically obtain water quality data which will be sent to a website where it will all be visualized. This will solve the problems of manpower, area coverage, and continuous water quality monitoring that testers face today. With these problems solved, water quality testing will be less of a cumbersome process, and our environment and ecosystem will be safer for it. We hope to build a device that can meet the state of California's water quality standards [3] and be implemented by local water agencies to perform these vital tests.

1. Keystone Compliance, LLC. *IPX3 & IPX4 Spraying/Splashing Water*. Keystone Compliance. [Online]. Available: <https://keystonecompliance.com/ipx3-ipx4-spraying-splashing-water/> [Accessed: 2019, November 5].
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