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Autonomous Unmanned Surface Vehicle System for Bathymetric Measurements and Environmental Monitoring

The Russian River is an essential resource in the Pacific Northwest that provides a habitable home for aquatic organisms. During hot summers in California, the river experiences tidal actions, creating large sandbars at the mouth of the Russian River [1]. Many salmonids utilize estuaries to adapt to conditions before entering the Pacific Ocean, and reciprocally adapt to freshwater before flowing upstream. The lack of resources to efficiently monitor freshwater topography can interfere with the sustainability of the fish and wildlife environment [2]. Our goal is to develop an autonomous Unmanned Surface Vehicle (USV) to achieve a more economic and sustainable approach to collecting bathymetric and environmental measurements in the Russian River. In doing this, we will be able to observe the dynamic changes in the environment and be witness to any drastic impacts in the estuary ecosystems. This allows for individuals and Russian River experts to make informed predictions on future habitat conditions and water quality of the Russian River based on the data gathered. This USV thus aids aquatic conservationists in their research to sustain a healthy freshwater ecosystem.

The central core of our USV is its onboard control system. The control system employs a compact single beam echo sounder (SONAR) to collect the depth and map the topographic features of the Russian River bed floor. It also employs an autonomous path planning algorithm for large-coverage, and two analog environmental sensors; temperature and salinity. The sensors work to ensure that the USV accurately analyzes the underwater conditions for future research efforts. It uses the microcontroller for communicating with the flight controller through UART via MAVlink protocol- a reliable and standardized communication link. The flight controller ensures stability and control of the system, with its built-in peripherals that are essential for autonomous navigation. The microcontroller is responsible for recording this data and storing it in an SD card. The SD module and the microcontroller are our central hub for data collection, storage and management. We also have a telemetry module, which helps us in communicating with the control station and overviews the parameters of the boat whilst it is deployed. In developing our USV with a safe navigation system and advanced sensors, we utilize it to efficiently gather bathymetric surveys at sensitive locations whilst monitoring essential tributary parameters.

By using this cost-effective USV that houses all the essential environmental sensors for the measurement within the estuaries, we provide a way to collect this critical data for the benefit of Russian River specialists. Once deployed, the sensors will continually gather this data. Additionally, our USV produces minimal environmental disturbance, minimizing their impact on aquatic ecosystems during data acquisition—a key consideration for sustainable marine research and conservation efforts. Overall, our USV represents a technologically advanced and environmentally responsible approach to bathymetric measurement, revolutionizing the field of underwater topography mapping. Our design will be open-source, allowing the design process and implementation of it to potentially aid other research team's prototype development in the prospect of helping the conservation and sustainability of river ecosystems.

References

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