

Knight Foundation School of Computing and Information Sciences

Fall 2024 Senior Design Project

Water Sampling with Applied Microcontrollers

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INTRODUCTION

Biscayne Bay is increasingly threatened by pollution, rising water temperatures, and human activities, which negatively impact water quality and marine ecosystems. Traditional approaches, such as manual sampling, are labor-intensive, costly, and limited in coverage, while fixed monitoring stations only provide localized data, failing to capture broader, dynamic changes across the bay.

This highlights the urgent need for a scalable, efficient, and autonomous system capable of delivering continuous, high-resolution water quality data. The autonomous surface vehicle (ASV) system meets this need by integrating autonomous functionality, a modular design, and real-time data transmission, revolutionizing water quality monitoring in a more comprehensive and effective manner.

RESEARCH

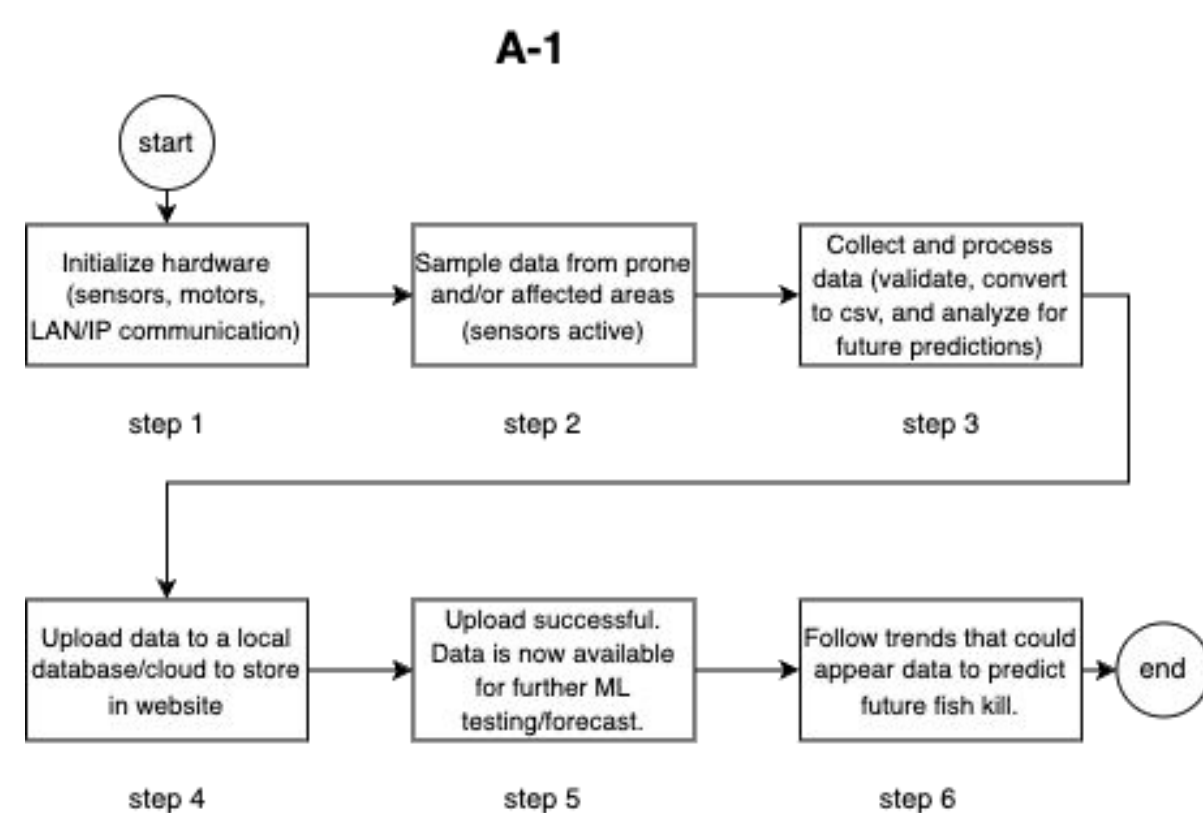
The integration of microcontroller technology and database management, offers a valuable educational model for students in engineering, computer science, and environmental science. Studies on pollution, rising temperatures, and human activities emphasize the need for continuous, high-resolution data to combat the degradation of aquatic ecosystems like Biscayne Bay.

Future developments could include remote access capabilities, mobile applications, and cloud-based storage solutions, enabling broader access and remote monitoring. These enhancements make the system viable for large-scale deployment across industries like agriculture, environmental management and readiness.

REQUIREMENTS

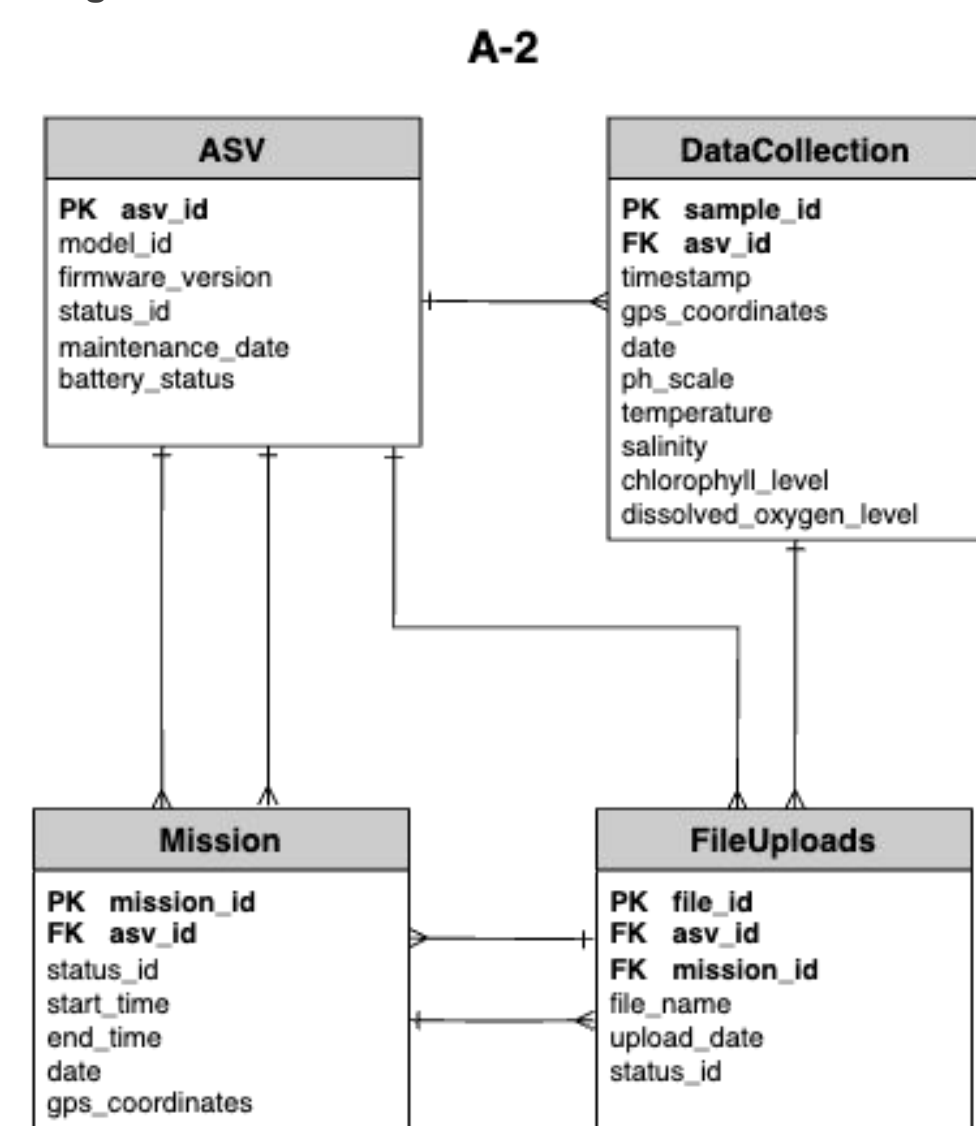
1. Establish a functional connection between the EXO2 Sonde and the Raspberry Pi to facilitate data collection from the water quality sensors.
2. Ensure the raw data collected from EXO2 is processed and converted into CSV files for further analysis.
3. Upload the CSV files to the cloud and then integrate them into a local website, managed by your mentor, for easy accessibility and data sharing.
4. Build a website to:
 - Display the collected water quality data.
 - Use machine learning algorithms to generate predictions and conduct an analysis of water quality trends between March 2024 and October 2024.

DIAGRAMS



A-1. State Diagram

This diagram illustrates the necessary steps for the Autonomous Surface Vehicle to inquire before deployment, which provides a clear view of the system's workflow and operational logic.



A-2. Database Schema

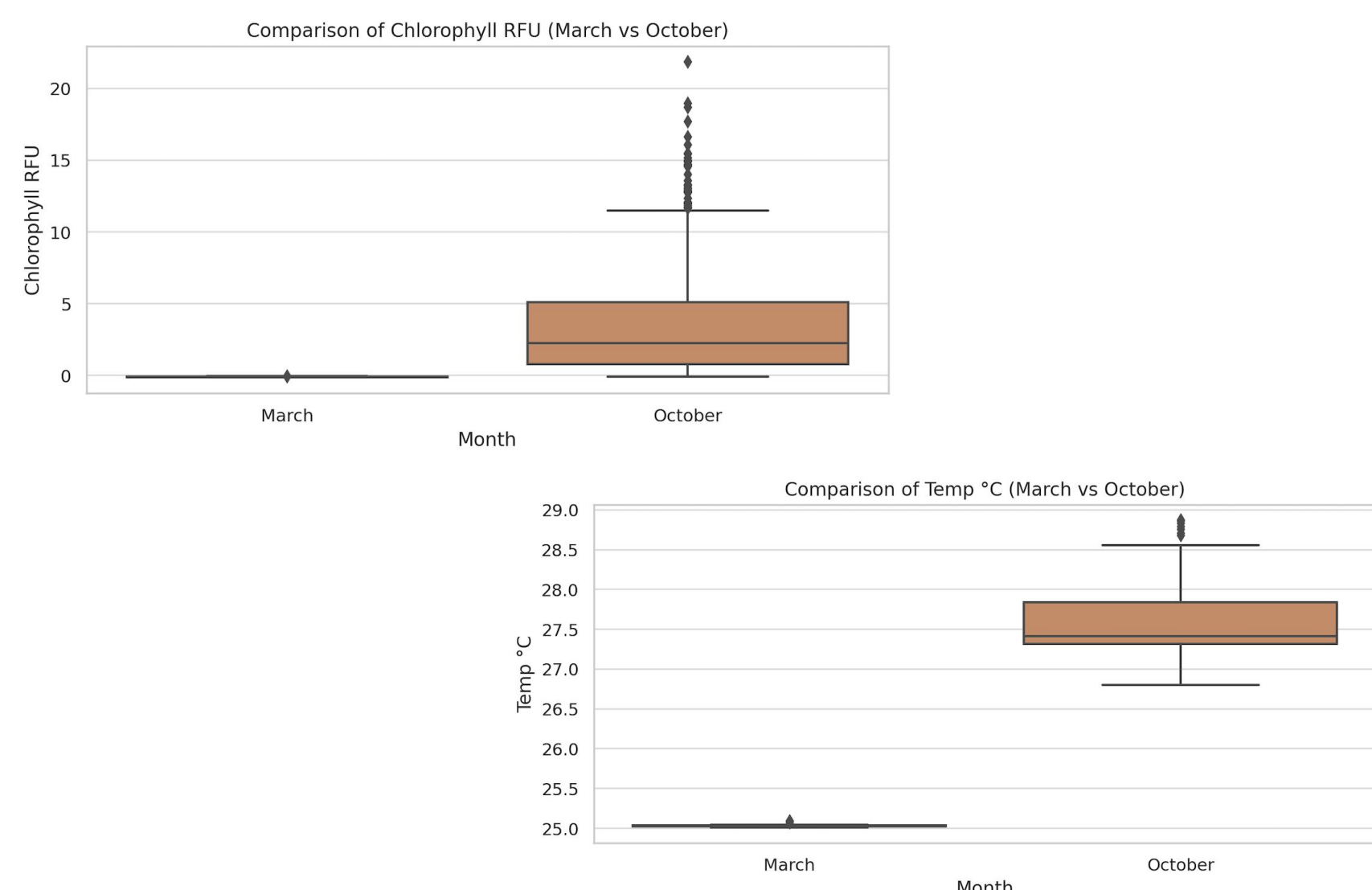
This schema organizes data related to sensor readings, sampling locations, timestamps, and environmental parameters to ensure efficient storage, retrieval, and analysis.

LANGUAGES & FRAMEWORKS



FIELD TESTING ANALYSIS

From March to October 2024, water quality in Biscayne Bay exhibited notable seasonal and spatial variations. October recorded higher water temperatures (27.58°C vs. 25.03°C in March), increased dissolved oxygen variability (113.27% with SD: 19.93%), and elevated turbidity (mean 147.07 FNU), likely influenced by runoff and human activities. Chlorophyll levels also spiked in October, indicating heightened algal activity. In contrast, March showed more stable conditions with lower turbidity and consistent dissolved oxygen levels. These findings highlight the dynamic environmental changes in the bay and underscore the importance of continuous, high-resolution monitoring for effective management and conservation.



CONCLUSION

The findings reveal that Biscayne Bay experiences significant seasonal shifts in water quality, with October showing increased biological activity, turbidity, and temperature compared to the more stable conditions in March. These changes are likely driven by warmer temperatures, runoff, and human activities during the summer and early fall, contributing to nutrient influx and sediment disturbance. The rise in chlorophyll levels in October indicates heightened algal growth, which could lead to eutrophication if left unchecked. The variability in dissolved oxygen further suggests dynamic ecosystem responses to environmental pressures. These patterns highlight the bay's vulnerability to climatic and anthropogenic influences, emphasizing the critical need for scalable, real-time monitoring solutions like autonomous surface vehicles to enable proactive water management and mitigate long-term ecological impacts.

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