Underwater Robotic Unit with Smart Sensing Technology for Water Quality Testing

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Project Objectives

The current methods for water quality testing either use a single sensor to get a random sample for testing each water quality parameter separately, or data buoys that are able to obtain readings from multiple sensors at a stationary location.

This project presents:

- A single unit comprised of **multiple sensors** that are able to collect data simultaneously for water quality testing.
- This multi-sensor unit attachable to the **underwater robot** to collect data at various depths of the water column for an extended period of time.
- **Data collection** and **data analysis** software to manage the data and assess certain trends in the water quality over time.

Algal Blooms

Lake Erie algal blooms are an annual threat to the health of **more than 11 million people**. Toxins produced by harmful algal blooms deeply affected the economy of the coastal towns and the health of the environment and the public.

Figure: Great Lakes: Oct. 2011

System Design

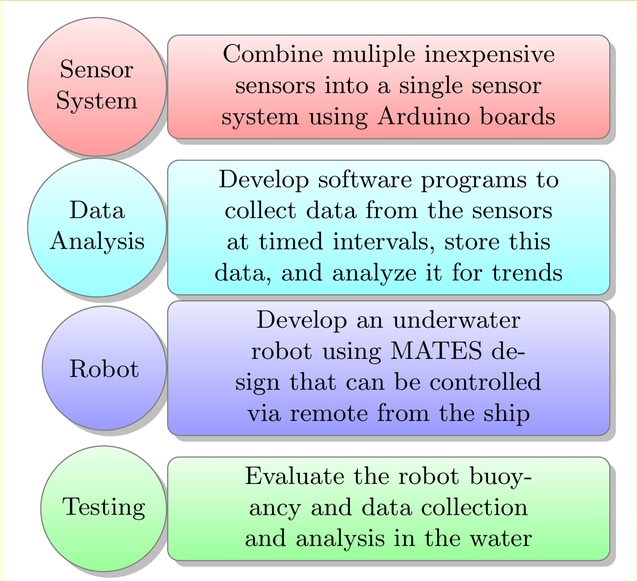


Figure: Different portions comprising the system

Robotic and Sensor System

Our system includes a robotic unit, a collection of sensors, Arduino boards, and programs.

- A **waterproofed case** was designed to house sensors and boards on the robot.
- A remotely operated **robotic unit** was constructed with PVC pipe, mesh, propellers, solder, and other materials, and is easily deconstructable.

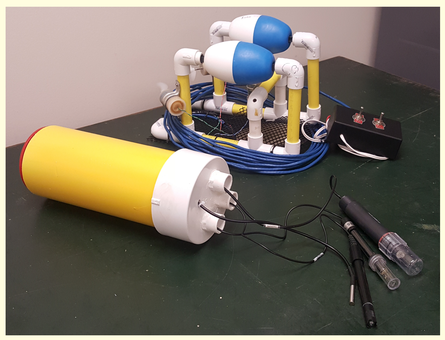


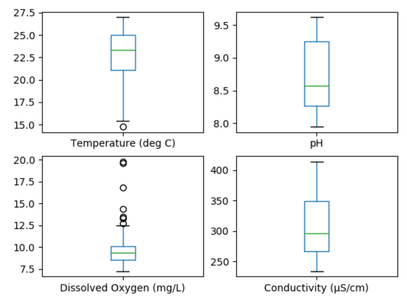
Figure: Detached system Drilling holes for sensors

Testing

The robotic system was initially tested in the pool for buoyancy and general operation validation.

Sensors	Testing Values
Temperature	40F - 70F
pH	Standard Buffer Solutions 4.0 and 7.0
Dissolved Oxygen	0.5 mol/L NaOH Solution
Conductivity	Buffer Solutions 1413us/cm and 12.88ms/cm

Data Analysis



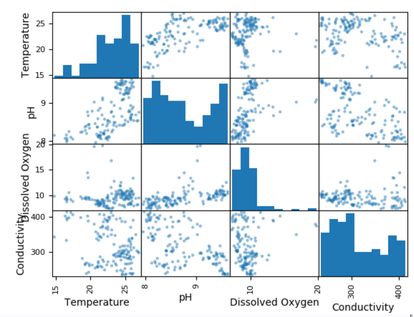


Figure: Distribution Relationship of the sensor data collected in Lake Erie

- Statistical analysis of the collected data is first performed.
- Time series **forecasting** is used to predict future trends in the water quality.
- K-means **Clustering** is applied to learn relationships between water quality sensor measurements.

Future Work

1. Over a period of this summer, measurements from Lake Erie will be taken at different levels of the water column.
2. The results of this work, including collected data and its analysis will be shared with other researchers.
3. Data analysis algorithms will be enhanced and automated with the data collection workflow.
4. Autonomous robotic unit will be designed.