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Toward Crowd-Sourced Solutions for Global Citizen-Science Water Analysis

Hippocamp Learning Group

Mathew Schwartzman, Constantine Christelis, William Dziuban, Esther Ling, Alex Markoski

Outline

- Introduction
- Citizen Science as a resource
- Feasibility Study
- Technology Overview
- Our CTD design
- Long-term Goals
- Conclusion

Introduction

- Seatime and research vessel operation is expensive
  - Typical research vessel: 12k for daily operating costs
  - Larger research vessel: 40k for daily operating costs
- Ocean Sensing technologies are expensive
  - 5k + for the average CTD
  - ~6k for the cheapest mapping sonars
- Hobbyist Oceanography/Marine Robotics is impractical
  - Consumer ROVs are still relatively new, often for particular use-cases
  - Still ~7k for practical models, 10k for additional sensing

Citizen Science

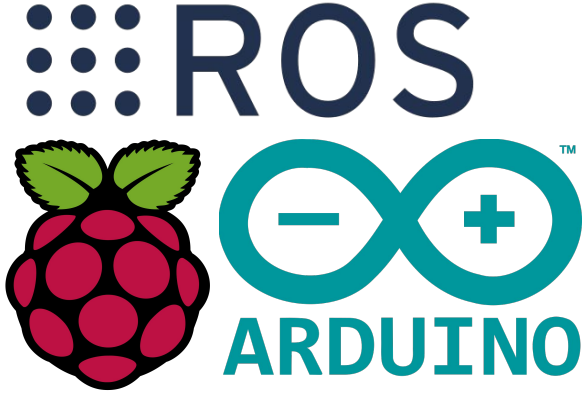
- An underutilized resource
- Oceanographic Institutions are typically geographically restricted
- Funding has been cut in the US
- Citizen Engineering
- Leveraging students, hobbyists, and freelancers
- Initiative Principles
  - Low-cost
  - Modular
  - Remotely Operated
  - Globally Available
  - Open Source
  - Learning-Focused

A feasibility study

- Mechanical Documentation
  - CAD Drawings/Schematics
  - Bill of Materials
  - Assembly instructions
- Software Repositories
  - Git repos
  - Dockerhub images
- Web Application
  - Crowdsourced data
  - Available for review

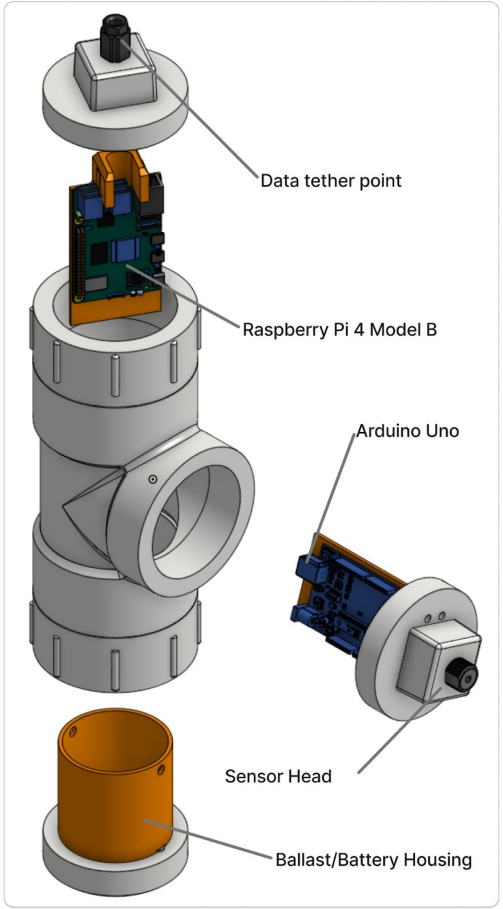
Technology Overview

- ROS and Robotics Middleware
  - Massive community support
  - Existing driver software
- Raspberry PIs and single-board-computers
  - Common linux computing
  - Direct GPIO and modularity
- Arduino and embedded systems
  - Cheap hardware solution for small projects like custom drones
  - And actively used in large projects like the 3D-AT



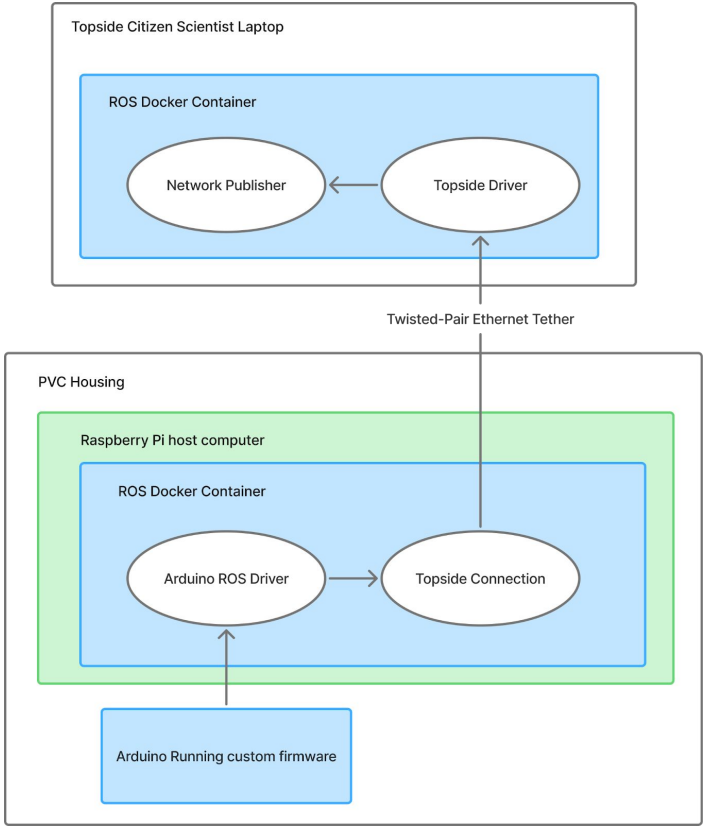
Our CTD Design

- Aimed at classrooms and hobby roboticists
- BlueRobotics Fathom Tether
- BlueRobotics Bar30 Pressure/Depth sensor
- Standard DS18B20 1-wire backup temp probe
- Low-cost copper-electrode conductivity circuit
- Raspberry PI 4 Model B, 8GB ram
- Arduino Uno Rev3
- 10000 mAh Battery Pack
- < $300 USD



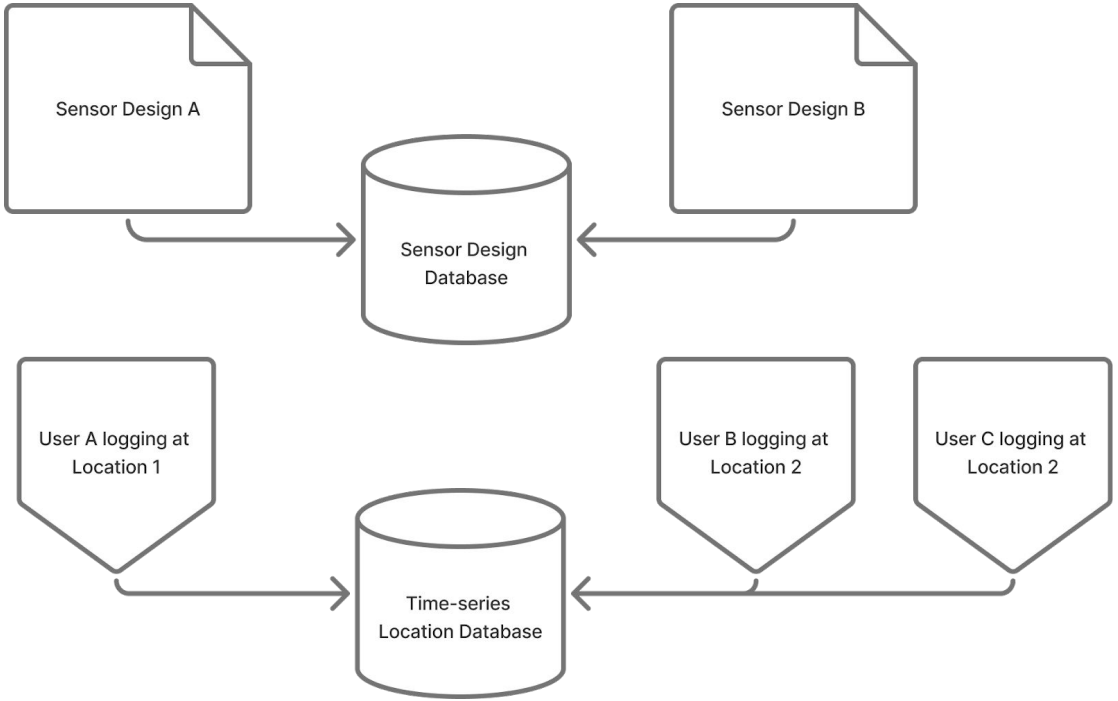
Sensor Software Architecture

- Easily networked into ROS robotics
- Containerized with Docker
- Swappable single-board-computer
- Data can be routed directly to a laptop via serial
- Blends oceanographic standards with modern software best practices
- ARM64 + x86 Arch support



Web platform and database

- Time-series GIS database allows citizen scientists to contribute samples
- Design database and forum allows citizen engineers to contribute and share additional sensors



Conclusion and future work

- Continuous improvement to sensor designs and databases
- Evaluation of web platform and CTD at upcoming NEREID Hackathon (Fall 2025)
- Partnership with local education organizations and schools
- Long-term Goals
  - Empower citizen scientists to:
    - Immediately participate in environmental revolution
    - Take measurements across the world to bolster global repositories
    - Connect with other scientists and engineers
  - Expand to support additional custom/traditional sensors
  - Make marine research and engineering more accessible

Thank you!

Questions?