

Ocean drones mesh network

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Figure 1: S1 Sailboat dragging electronic box, G1 motorboat test platform, G2 motorboat test platform (left to right)

Problem

Realtime maritime data is valuable for ship route planning and weather prediction, yet we have no way to collect real-time (update frequency < 20 min) maritime data in a large scope due to the limitation of power efficiency and satellite communication.

Proposed solution

In order to tackle the problem above, we proposed to design an USV unit that has the functions below:

1. Real-time collection of sensor data, such as position coordinates, air temperature, seawater temperature, inertial measurement, etc.
2. Form a mesh network with other USVs, which can send, receive and forward data with other nodes in a certain range via radio antenna.
3. After receiving the command, it can automatically cruise to the specified coordinates and maintain the position within a certain radius.
4. Energy self-sufficient, charging through solar panels and hydro generators

Working Scheme

The project is still on-going, we worked on 2 processes in parallel, and they will be integrated into one design in the future.

1. Motorboats are for testing the robustness and stability of our data collection and transmission:
G1: two working boats in the lab, still need some stability tests on the mesh network
G2: a swarm of motorboats (more than 10) with our own control system, and optimized hull design.

2. Sailboat is designed as the prototype of the final product, it should be self-sufficient and have enough space for mounting all the electronics from G2 in the future:

S1: based on an off-the-shelf RC sailboat, S1 is for testing the autonomous control system

S2: customized design aiming for our ultimate purpose

Technical Details



Figure 2: The controller and other electronics such as wind vane are mounted in a tote dragged by the sailboat because of space limitation. The specially designed connection mechanism between the tote and the sailboat allows the tote to maintain horizontal regardless of the gesture of the sailboat.

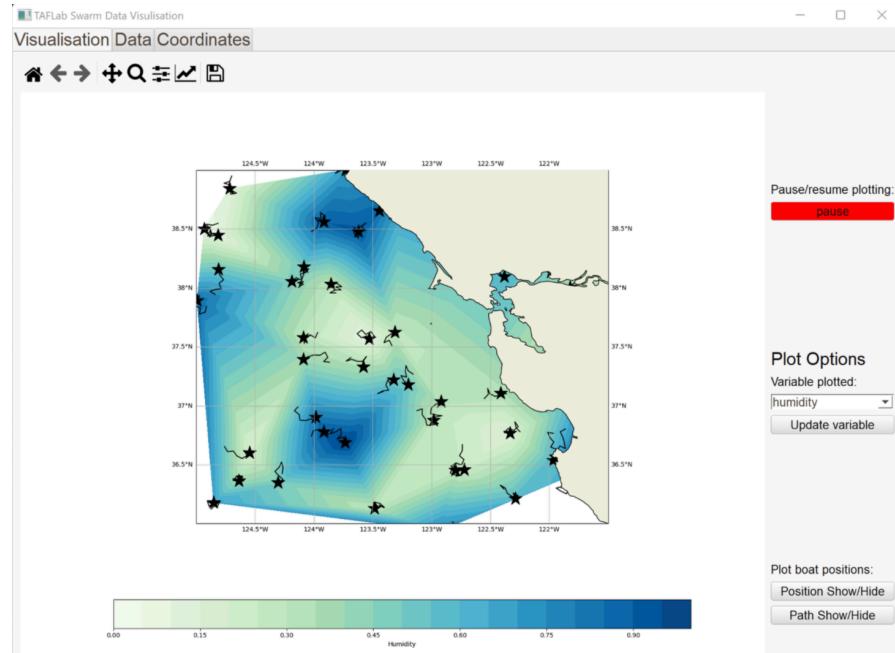


Figure 3: GUI design for control multiple boats simultaneously and plotting the heat map from real-time data collected.



Figure 4: CAD Mockup of S2 sailboat Design, will be manufactured in the future and equipped with electronics that was already tested in S1 and G2.

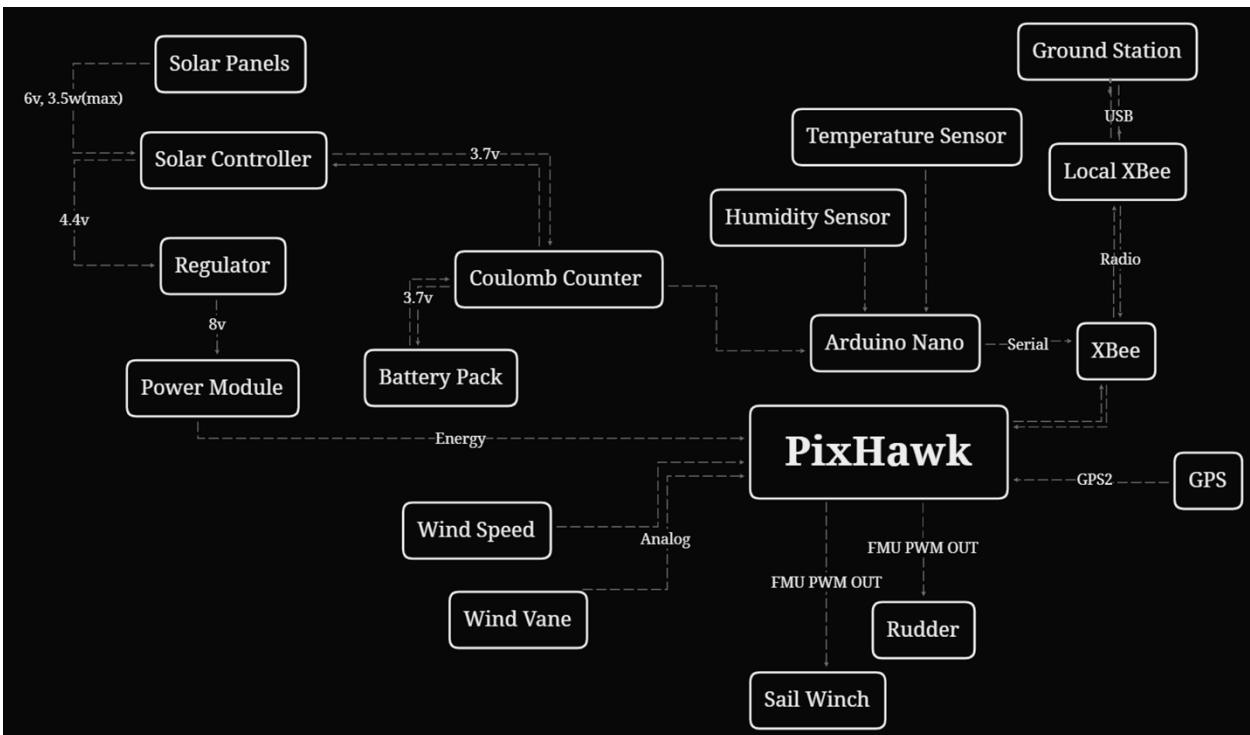


Figure 5: G1 Hardware Block Diagram, pixhawk and Arduino are replaced by beagle bone blue controller in the newest G2 boat

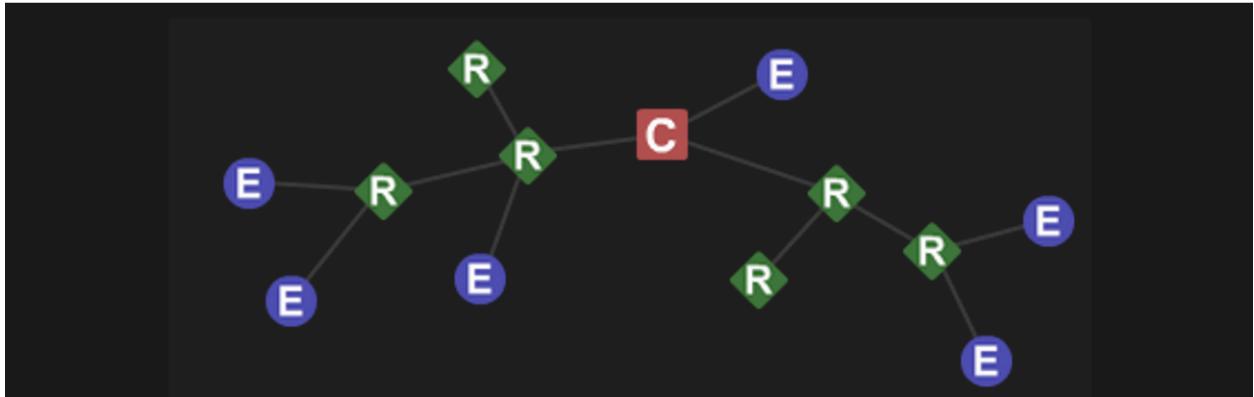
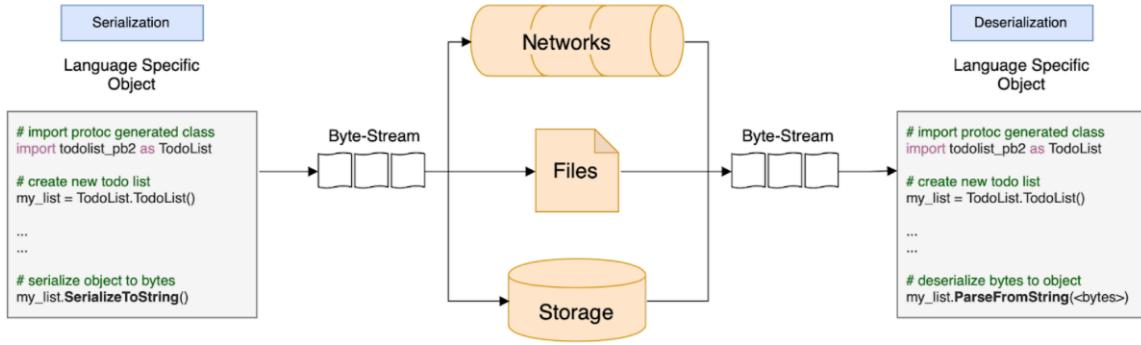


Figure 6: Google Protobuf working scheme and XBee mesh network demo. We used XBee 3 module to create a mesh network among all the boats for real-time communication, protobuf message is utilized to shrink the size of each message.

My Contribution

1. I built the first generation of electrical systems, including autopilot based on ArduRover firmware, ocean environment sensors using Arduino, and mesh network communications based on DigiMesh protocol.
2. I also designed G2, the second generation of twin-hull motorboat testing platforms using pink insulation foam, which was 60% lighter, 200% faster and 50% cheaper compared to what was previously being used.
3. As a part of my thesis, I worked with another undergrad to integrate all the controls into BeagleBoard.
4. Reduced packet size by 75% using google protobuf.

Leadership

On behalf of Prof. Alam, I took charge of the new undergraduate apprentices' selection of 2022 fall semester. As the project manager of five undergraduates and five graduates, I planned a general work scheme, divided the work with everyone's strengths in mind, organized weekly meetings and water tests, and managed group documentation on Notion.