

Water Sampling with Applied Microcontrollers

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PROBLEM

- Biscayne Bay faces many issues including pollution, increased temperatures, and other chemical imbalances which can cause fish kills.

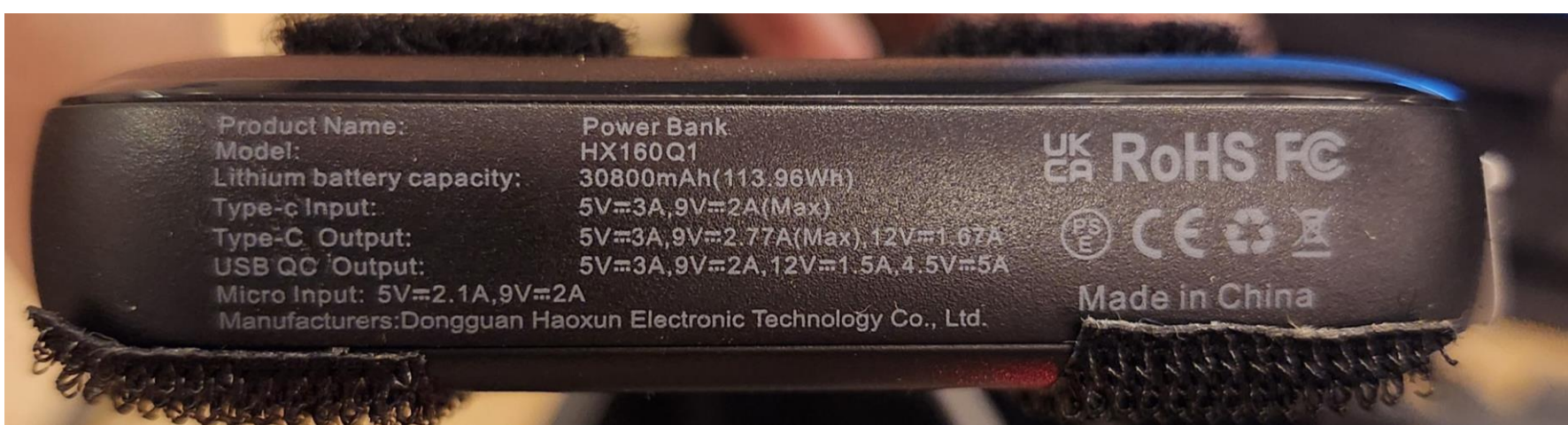


Kathryn Mikesell

- Manual water sampling has been used to monitor the health of Biscayne Bay but is not efficient.
- Autonomous Surface Vehicles (ASVs) can automate the water sampling process.

POWER DRAW TESTING

- With the chosen battery pack, the Raspberry Pi 5 can only provide 600mA to all peripherals.
- Testing showed that even with all peripherals connected, this limit will not be reached unless the integrated display is powered by the Pi.
- Calculations showed the Raspberry Pi 5 would have a battery life of 18.2 hours at idle and 8.4 hours under heavy load.

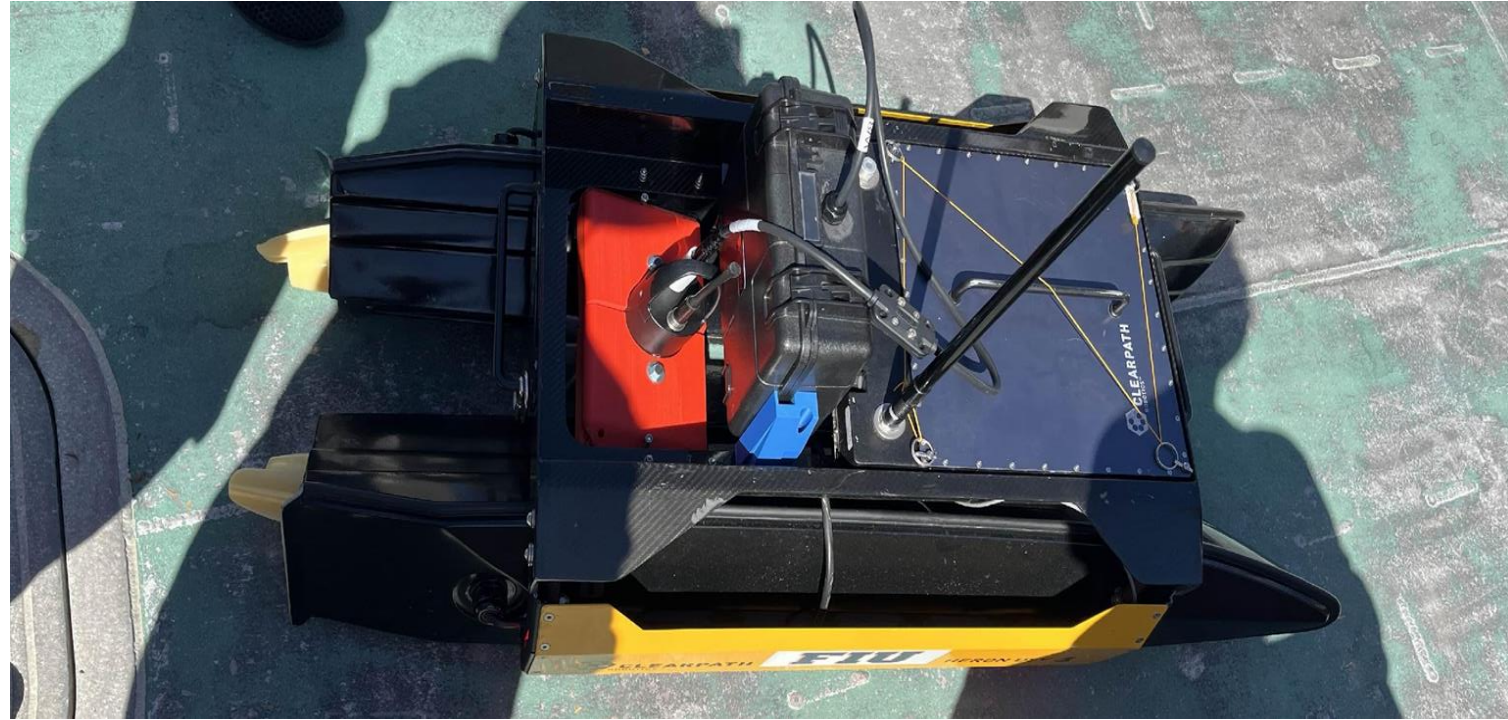


FUTURE CONSIDERATIONS

- In case the testing proved excessive temperatures would be encountered, a bracket for a vent in the case was designed in OnShape to hold waterproof mesh and mount a 40mm case fan.
- Additionally, a suitable conformal coating was found for protecting the electronics from the salt air should a case vent be necessary.
- If excessive temperatures are encountered during the summer, the bracket can be printed and modified if necessary and the aforementioned conformal coating can be purchased.

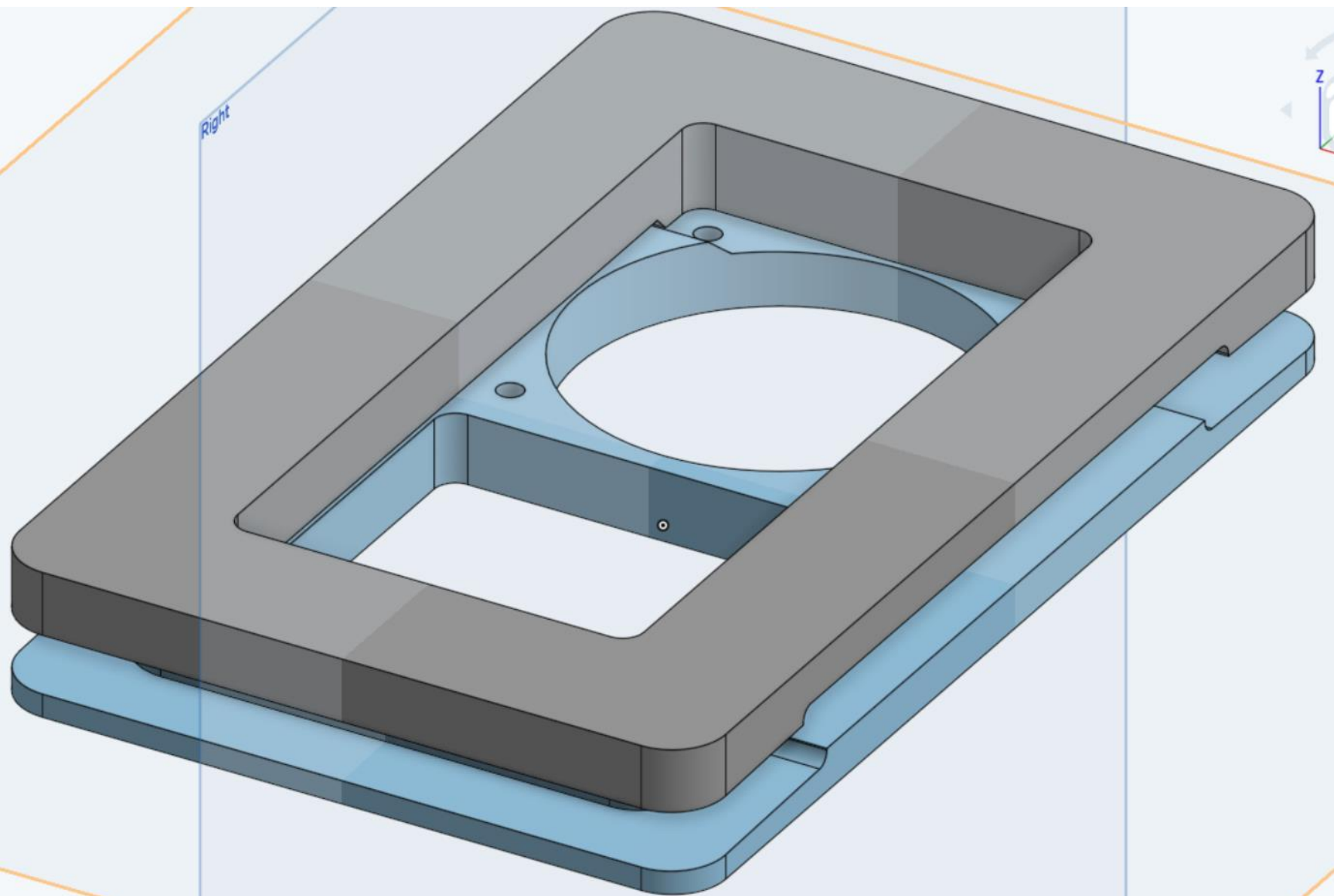
SYSTEM DESIGN

- A Raspberry Pi 5 was housed within a waterproof case and mounted it to a Clearpath Robotics Heron USV.
- The Raspberry Pi 5 was used to read and transmit water parameters read by an YSI EXO2 Multiparameter Water Quality Sonde.



TERMAL LIMIT CALCULATION

- The Raspberry Pi 5 thermal throttles at 176°F (80°C).
- At idle, the Raspberry Pi 5's internal CPU temperature is approximately 79°F (26°C) above ambient temperature.
- This means the Pi will thermal throttle at idle when the ambient air is 130°F (54°C).
- Temperatures inside a parked car on a 95°F (35°C) summer day can reach 133°F (56°C) in just 40 minutes (NBC 6 South Florida).



REQUIREMENTS

- All batteries powering the water data collection system must last for at least 2 hours, the battery life of the Heron USV itself.
- The Raspberry Pi 5 and the batteries within the waterproof case must not be damaged due to extreme heat.
- The Raspberry Pi 5 must not thermal throttle excessively and jeopardize the data collection.
- If contact with the salt air is expected, the electronics must not corrode.

THERMAL LIMIT TESTING

- A temperature monitoring Python script was created to determine if the Raspberry Pi 5 had exceeded acceptable temperatures.
- The inside of the waterproof case was brought to 130°F and placed in the sun to see if the internal case temperature would increase, decrease, or stabilize.
- Temperatures slowly decreased; however, testing was performed in the afternoon on a relatively cool fall day and thus testing remained inconclusive.
- Considering the inherent dangers of opening a vent in the case, it was decided to not cut a vent until testing can be performed in the summer.

CONCLUSION

- There is minimal threat to exceeding the Raspberry Pi 5's peripheral current draw limit.
- The batteries currently in use are sufficient for the water data collection system.
- The Pi may or may not thermal throttle during the summer.
- Should the Pi thermal throttle, preparations have been made to ease the creation of the necessary case vent and prevent any issues such as corrosion due to contact with the salt air.

ACKNOWLEDGEMENT

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