MEMORANDUM

To: Alena Chercover
CC: Mel Dundas
From: Sebastien Robitaille, Braden Trig, Eric Samer, Kayleb Stetsko
Date: October 25th, 2024
Subject: Project FishWorks Progress Report

SUMMARY

Alena, Project FishWorks has worked diligently and has been able to make significant progress on our capstone project, putting us well ahead of schedule. With initial testing on custom hardware, Fish Sense, our monitoring and control system for aquariums has progressed healthily. We have achieved communication between our nodes and base stations, and we have multiple devices completed or in progress, with only a single outlier unable to be started due to delayed components. With our finances on track, and a solid view forward grounded by what we know we can do, we are confident that we will have our hardware and software finalized for late November. This will give us additional time for us to fully focus on our capstone presentation and symposium in December as well as our final documentation and reports. We are excited to be able to show everyone what we have been working on.

THE STORY

Kayleb Stetsko started to draw up designs for an aquarium control system decades ago when he first started keeping coral and larger aquariums. Using his passion for fish, experience managing aquariums, and his and his colleague's knowledge gained through their time Camosun College, he and Project FishWorks are designing a solution

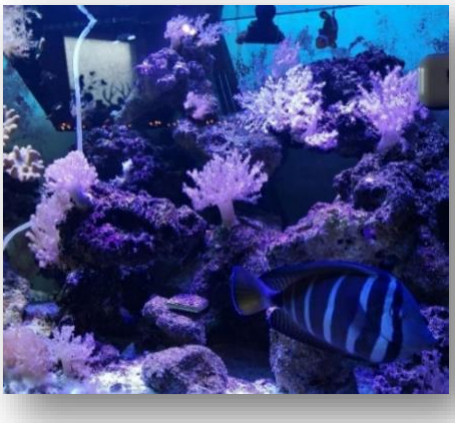

Figure 1 - Kayleb's Tank

for monitoring and controlling various aspects of fish tanks. We are calling this solution Fish Sense.

Though some consumer systems exist in the aquarium monitoring space, they are expensive and often inflexible. They are either overly complex or not expandable enough to meet many user needs. By focusing on modularity and expandability with Fish Sense, we will give the user a choice in both the size and complexity of their system. This will allow us to bring down the initial set up price of Fish Sense and 'plug and play' concept will lower the barrier of entry, allowing more people to get into the pursuit of fishkeeping. Having a reliable control system tailored to their needs will give them peace of mind when it comes to their aquarium, leaving more time for other importing things in their life.

As of this progress report, I am happy to say that we are on track to meet our goal of having a fully functioning prototype of our aquarium monitoring and control system with several devices. We believe that this setup will showcase the core functionality and modularity of Fish Sense while managing the project's scope. This setup will demonstrate our core communications, basic fail-safes and alerts, and system control and monitoring using our web app.

PROGRESS

Our focus before the start of the capstone was on proving the underlying technology that allows for communication between devices and the base station and between the base station and the web app. We were successful in proving this technology by the start of the capstone semester, giving us confidence to continue with this project. Our progress from the start of the semester until now has been focused on getting this core communication technology, both hardware and software, fully working. This included creating bespoke PCBs for both the node controller and the base station, working on the firmware for both boards, and continuing work on the web app. In addition to this

core technology, we have started or completed prototypes for several of our devices and completed two of them.

Base Station and Node Controller

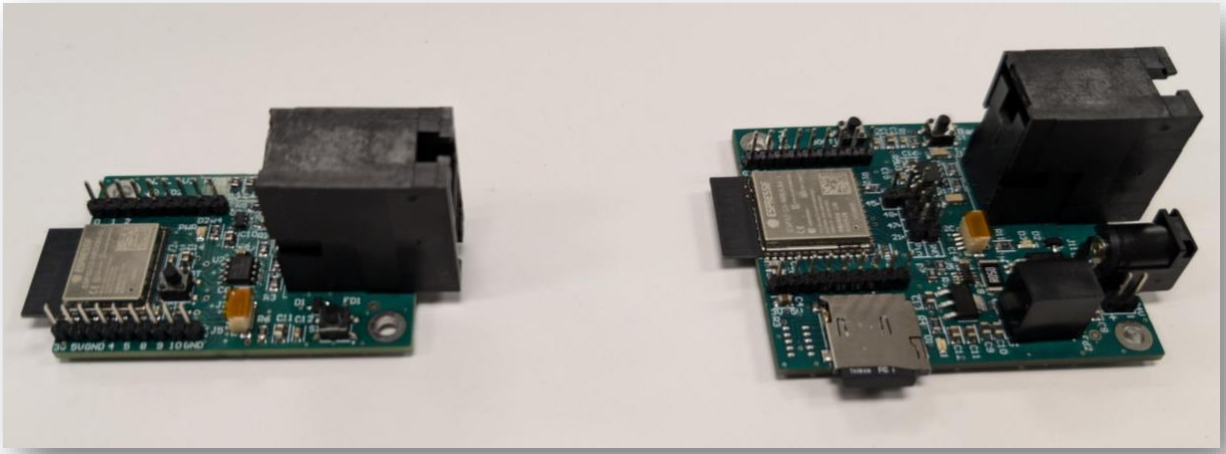

Figure 2 - Node and Base Station Controllers

Finishing our two custom circuit boards was the most crucial progress we have made on Fish Sense so far. These two boards serve two important purposes. The node controller acts as the controller for each device. It connects with the device specific peripherals (sensors, relays, etc.) and allows them to be interfaced with the CAN Bus network to send/receive information from the base station. The base station acts as the controller for the whole system. It's connected to the node controllers over CAN Bus and to the Web app using MQTT, a widely used protocol that connects internet of things (IoT) devices to the internet. These connections allow the user to monitor and control the devices from the web app. As well it logs data from the devices, alerts users via light, sound, and email when there is an issue with the system. The base station also provides the node controllers with power.

As of October 18th, we have designed, fabricated and assembled nine node controllers and five base stations. This will be enough to complete our demonstration setup with extras in case of hardware

failures. We have completed testing of all major features of these boards and are confident that they don't need any hardware revisions. We have also implemented most of the major firmware features required for communication between the nodes and the base station and between the base station and the web app.

Web App

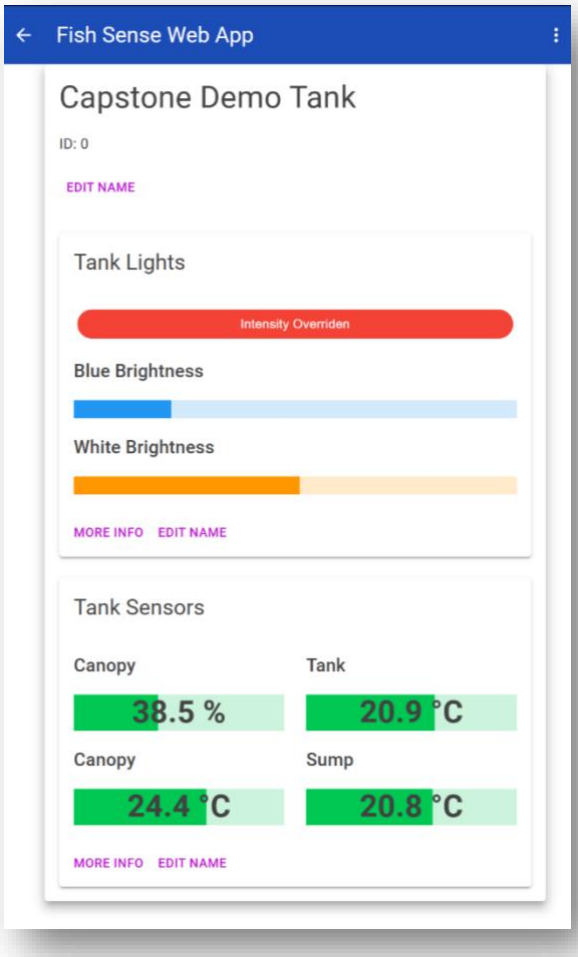

Figure 3 – Fish Sense Web App

Our web app allows the user to monitor and control their aquariums from any browser. Most of the main features of the web app have been implemented with only minor changes and bug fixes required going forwards. Connection to the MQTT broker, with a login page, has been implemented along with the backend code required to display widgets for all connected devices on the dashboard page (Fig 3). Device specific user interface functionality has been implemented for our two completed devices and the interfaces for the remaining devices will be implemented as each device is completed. . The MQTT broker facilitates the transfer of data between the base station and the web app. We are currently using a free private broker from HiveMq.com. While this broker has some limitations that would make it unsuitable for use in a finished product, we feel that this is a reasonable tradeoff as setting up a custom broker would add a significant amount of complexity to the project.

Lighting Control

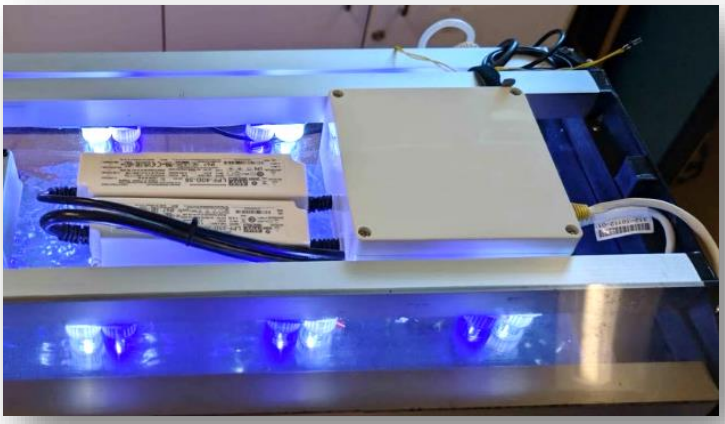

Figure 4 - Lighting Control Module

The first device that we completed was an LED lighting controller for our demonstration tank. This will allow the user to adjust the intensity of the LEDs and program simulated day night cycle using the web app. We currently have a functioning control circuit soldered onto a protoboard connected to a node controller in a final enclosure on the top of the tank. All hardware, software, and web app user interface are implemented for this device and should only require minor tweaks going forward.

Temperature and Humidity Monitoring

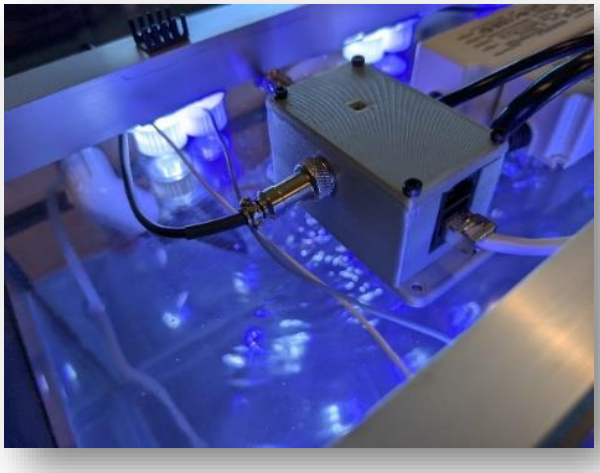

Figure 5 - Temperature and Humidity Monitoring Node

We have completed our device that monitors canopy temperature and humidity, along with tank and sump water temperatures (figure 5). This will allow users to monitor their tank for issues related to temperature. Users will be able set high and low alarm setpoints so that they can be alerted when a temperature or humidity is out of range. The code for sending email alarms and temperature/humidity data is implemented and functioning and the hardware assembled and

installed on the tank (Fig 5). The web app user interface for this device has been completed (figure 3) including historical graphs for all measured parameters (figure 6)

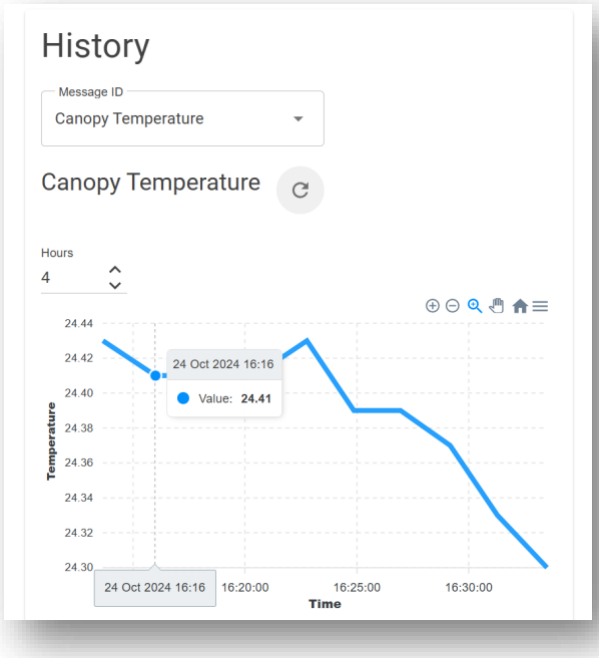

Figure 6 – History graph of canopy temperature.

AC Outlet Control

Our AC outlet control device will allow users to control standard AC outlets using the web app. They will also be able monitor the power used by devices plugged into these outlets. We have a basic prototype (figure 7) of current monitoring and ac outlet control hardware completed and are waiting for additional hardware. As well Eric has started the design of various 3D printed enclosures for the device. Basic test software for the hardware is in

Figure 7 - AC Outlet Node in Development

progress, but final integration with the node controller hardware and web app will be completed in the coming weeks.

PH Sensor

We are still awaiting delivery of the Atlas Scientific PH sensor to start work on our tank PH monitoring device. While the order for this sensor was placed in the third week of the semester, it was backordered and has still not shipped from the supplier as of October 18th. If we do not receive it by the start of week 10, we will pivot to implementing a total dissolved solids sensor as a replacement.

Water Overflow and Leak Sensor

Initial hardware prototyping for a basic leak and tank overflow monitoring control device is well underway, but not yet in use. This device will alert the user and turn off the tank's pump if the tank level is too high or if a leak has been detected. Test code has been written and device testing has been started. A basic widget and Ui are displayed in the web-app but will be expanded on. In addition, plumbing of flow sensors for the pump output as well as the drain on the display tank have been installed. This would allow us to add more precise pump control based on the output of these flow sensors. This would be an expansion of scope, so we will not start further implementation of these sensors until all other devices have been complete and an engineering change order is approved by Camosun faculty.

Demonstration Tank Setup

We are using a two-tank system for our demonstration setup (figure 8), one tank on the top shelf acting as the display tank, and a sump tank, used for filtration and additional sensors, on the lower shelf. Our setup uses a DC pump to move water from the sump tank to the upper display tank. The display tank then returns water to the sump tank using a hang-on syphon design (figure 9). This syphon design is used when drilling a hole in the tank is undesirable. There is an inherent danger of overflowing with this design and it has proven to be quite delicate to balance and has required manual monitoring and control during the testing of our system. Once the tank overflow sensor is implemented it will turn off the pump before the tank can overflow, mitigating the danger of this type of system. We chose this design to demonstrate that with proper control this system can be used safely.

Figure 8 - Demonstration Tank

Figure 9 - Hang-on Syphon

TIMELINE

As seen in our Gantt chart, (figure 10) our initial timeline has us finishing up work on the Node Controller and Base Station hardware by October 19th. We have met this milestone and in addition we made significant progress into the device and web app user interface development, finishing our first two devices. This puts us ahead of our initial schedule by about two weeks. With both our Base Station and Node Controller PCBs built, tested and now well into UI and device development, we are confident that with continued smart planning and time use, we will be well within our estimated

schedule for completion.

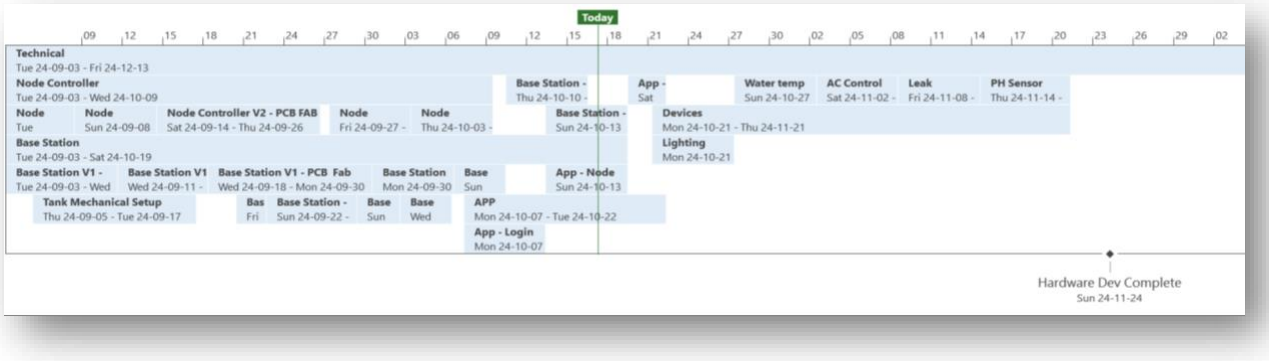

Figure 10 - Gantt Chart showing our initial estimated timeline

FINANCIALS

As we are ahead of schedule, we have spent more than expected at this point in the project. But overall, we are on target to meet our spending goals. Our most impactful issues have come from ordering and shipping, with our PH sensor still on order after almost an entire month. Additionally, a lack of organization during ordering has caused a few redundant parts on orders. We also have had the extra expense of hiring an external excel contractor, but the expense has already proven worthwhile academically and for our financial organization. Regardless of these issues we have been able to stay within our expected maximum cost of $2,000.00 with most of our materials purchased.

OUR PATH FORWARD

We plan on having all hardware and software finalized no later than November 24th. This gives us a two-week buffer before the final presentation in case any unforeseen issues arise and to allow for time to finish the final documentation and presentations.

Our largest task going forwards will be finishing hardware and software for our remaining devices. In addition, while most of the major functions of the core communications infrastructure have been

implemented, there is still performance optimizations and bug fixing to complete. As we get into the later part of the semester, once our hardware and software has been completed, we will start preparing our symposium demonstration setup. This includes setting the final tank setup, designing posters and other graphical elements and technology to showcase Fish Sense. As well, more of our time going forwards will be dedicated to final documentation work including our Circuit Celler article, project website, and user manual.

CONCLUSION

Building off Kayleb's and the rest of the team's passion, we were able to hit the ground running well before the start of the semester allowing us to set ourselves up for success. We have been able to fully migrate our aquarium control system to our new hardware, with several devices in a finalized state. Although we have encountered some issues in ordering and aquarium keeping, we have been able to maintain our planned timelines and finances at this midpoint in the project.

Our web app has progressed steadily. We have most of the core technology implemented and working and user interfaces added for our completed devices. Our presentation tank is also nearing completion, with the lighting module fully finished and functional, the temperature and humidity monitoring device installed, and the pump and plumbing components working.

With the past eight weeks of effort now behind us, and seven weeks left to go, we are confident that we will have the hardware and software elements of the project finished by November 24th, which will allow us to then fully focus on the final presentation and symposium aspects of the Capstone semester. We thank you for your continued support in our endeavor and are excited to move into the final stretch of realizing our product.