

Portfolio - Evan Li

For a summary of the most important projects/experiences listed here, please refer to my resume. In this portfolio I go into a bit more depth for each item and include some older experiences in case they're relevant.

6DoF Robotic Arm — Nov 2024

This was a generic and open-ended project meant for me to learn more about robotics. I designed, manufactured, and programmed a small robotic arm with 7 servos (6 joints and a claw), along with a PCB which distributes power to the servos.

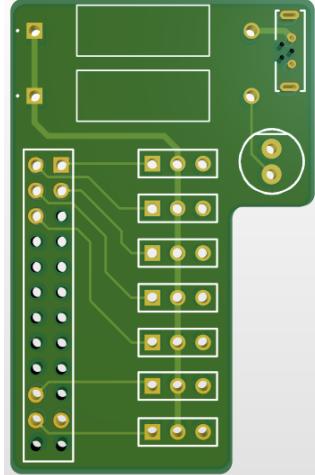
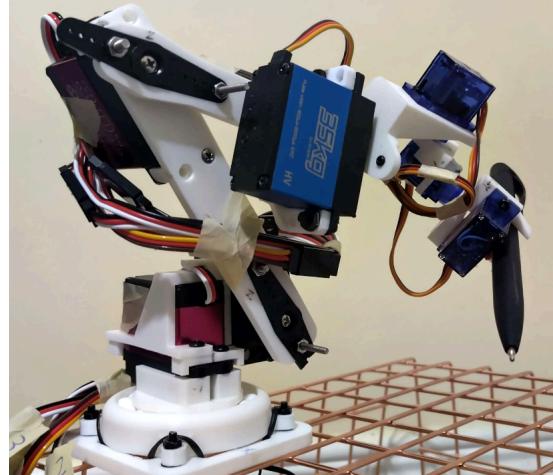
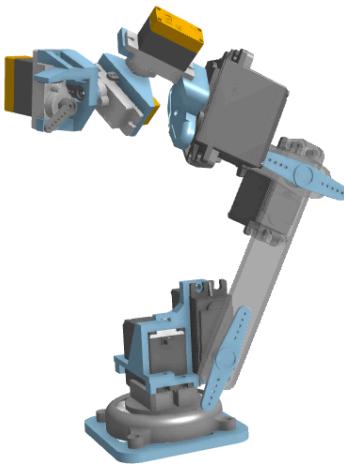
The machine is controlled by my trusty STM32 microcontroller which runs FreeRTOS and processes servo angle requests from my laptop through a COM port. It also sends data from an IMU to my laptop, which I used as a controller and combined with my keyboard in a few ways to control the desired pose of the claw (e.g. the IMU controls claw direction and keypresses move in claw-relative x, y, and z directions).

The biggest challenge was calculating the desired servo angles from the desired pose, and I spent weeks poring over robotics textbooks and my clipboard trying to figure out. Another challenge was calculating the IMU's heading from raw angular velocity data — a mixture of math and I²C sensor reading optimization. I used ROS2 and RViz to help out with the IMU debugging and other parts of my "laptop code".

Next Steps

I am currently working on a chopstick robot to help me learn about control systems; it will hopefully be able to pick up soft objects like tofu without breaking them by using feedback from a pressure sensor. I plan on adding this to the end of my robotic arm too.

Left: CAD model of the arm. Centre: the arm holding a pen. Right: The relatively simple servo power PCB



Links

https://github.com/HappyRedMapleLeaf/arm_controller
https://github.com/HappyRedMapleLeaf/arm_host

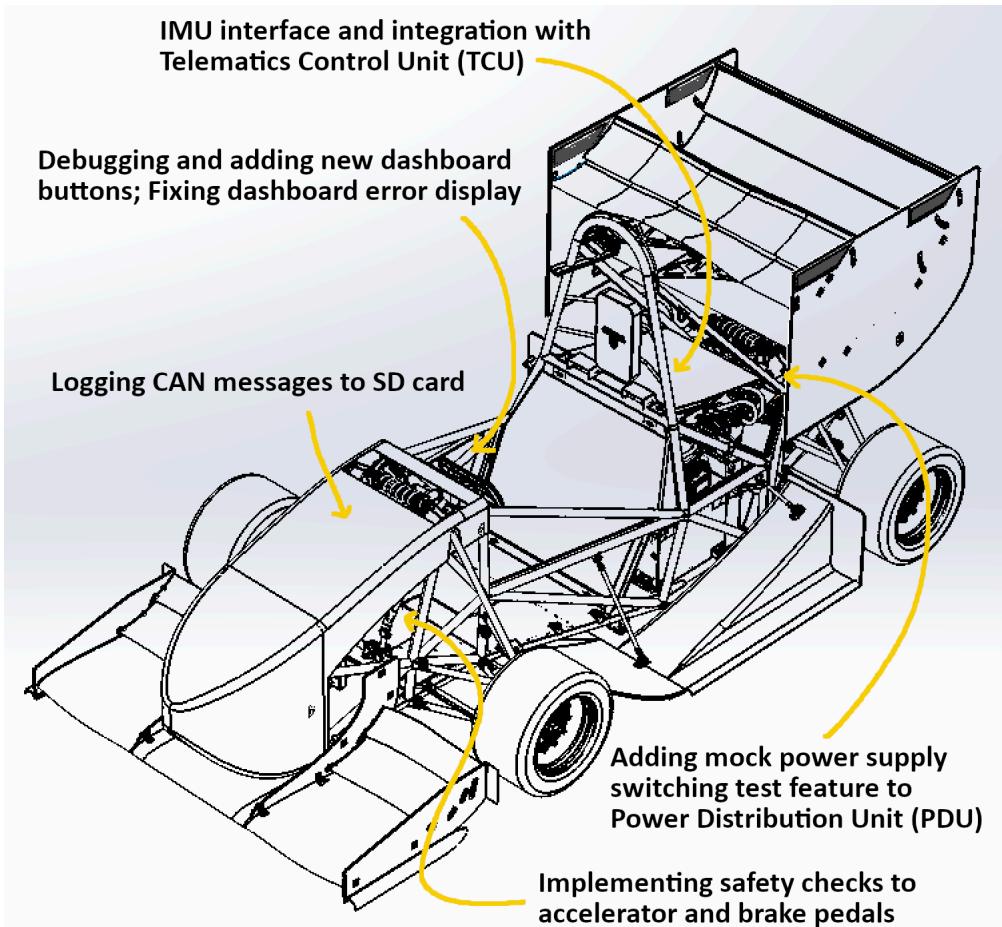
UWaterloo Formula Electric — Sept 2023 - Now

I am on the firmware team of our university's Formula team where we participate in the Formula SAE competition. So far, my most notable work has been in 5 areas:

- Wrote C firmware for I2C communication between BMI088 IMU and telematics control unit (TCU)
 - The data then had to be integrated with the TCU code for it to be logged properly
 - I actually reused this code for the arm project above!
- Prototyped CAN message logging through SDIO to a microSD card
 - A brief but interesting project I worked on with the firmware lead that taught me about CAN and SD
- Added circuitry and firmware to power distribution unit's HIL testing board to imitate power supply toggling
- Fixed dashboard button detection and double-click issues in dashboard firmware and embedded UI scripts
 - I fixed a bunch of dashboard issues, from button debounce bugs to the screen not turning on at all
- Implemented APPS/brake pedal plausibility check ensure safety in case of accelerator pedal failure
 - Although it was a simple task, it was safety critical and taught me how to be thorough with my work

Next Steps

In the coming months, I hope to dabble in our car's vehicle dynamics algorithms (e.g. traction control), and I hope to participate in the bring-up of some new boards.

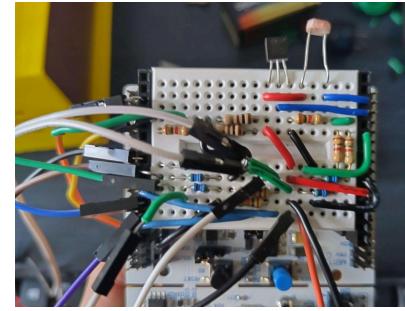
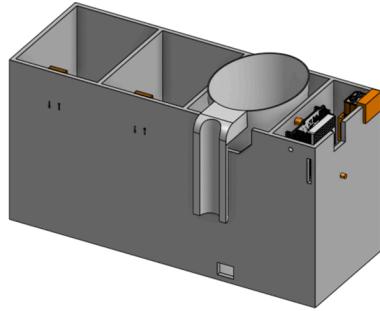


Freshguard — Dec 2023

This project started as an in-class project, but my friend and I decided to continue working on it just for the fun of it. We made a device that would warn users of spoiled milk, motivated by a few... "bad milk experiences" I had.

The device was again controlled with an STM32 MCU, and used 6 inputs (3 buttons, a force-sensing resistor, a temperature sensor, and an ambient light sensor) along with a timer to roughly determine when one of the bags has spoiled, and would alert the user with LEDs and a buzzer. All of the circuits were snugly fit onto a small breadboard.

Left: The device. Centre: A CAD model. Right: The jam-packed breadboard

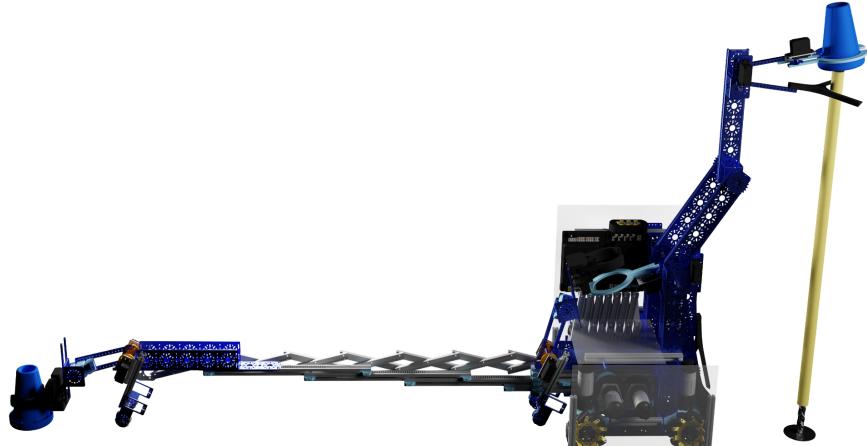


"HAZARD 2.0" Competitive Robot & Robotics Mentorship — Oct 2021 - Now

I founded and was the lead programmer and builder for my high school FIRST Tech Challenge team — and today, I am still heavily involved in the team as a mentor, giving feedback, sharing my experience, and motivating the team to stay as one of the best in Ontario.

We build a robot each year to perform a set of tasks that score points. The building process involves many iterations of design, manufacturing and testing, and the code involves PID control, computer vision, motion planning, localization, and more — our 2022-2023 season robot, nicknamed "HAZARD 2.0", had 7 sensors, 15 motors, and a camera. We are also expected to document their engineering work and present it to judges.

Left: the 2022-2023 robot in its initial configuration. Right: A 3D render demonstrating its full range of motion



Links

- <https://github.com/HappyRedMapleLeaf/Devolotics-2023>
- <https://devolotics.github.io/>

Honourable Mention: Game Development — 2018 - 2023

My interest in programming started in middle school through game development. This is where I developed my problem-solving skills, spending hours thinking through collision detection algorithms, physics simulations, edge case handling, tricky game mechanic implementations, and code optimization.

Although some of the skills I learned here are not exactly transferable to other kinds of programming, such as music composition, graphic design, and game balancing, I still use most of what I've learned today: how to devise algorithms to solve a problem, how to consider the needs of users, how to track down bugs, and how to stay passionate about projects and have fun.

Screenshots of some of the games I created: "Accept", "BluSquare", "Bounce Back", and "BadKid"

