FLYDER BOT

the propeller powered robot that wall climbs

by Jacob Kuczynski, Henry Nguyen, and Izabel Wu

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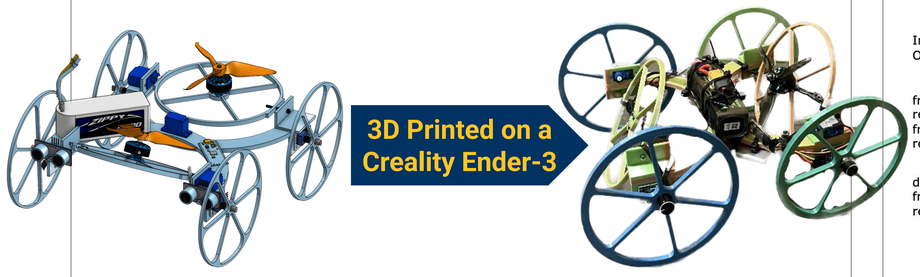
— Motivation / Goals / Intro/ Overview —

Our goal was to build a robot that would detect the presence of a wall, transition onto it, and then climb the wall.

We were inspired by similar robots that could wall climb, or propeller powered cars–but all that lacked the ability to transition from the floor to the wall autonomously.

— Design Process —

We designed the robot in OnShape.



The front and rear frame each have a servo fastened to the end that pivots the propellers. The wheels are attached to encoders on the frame.

— Sensors & Calibration —

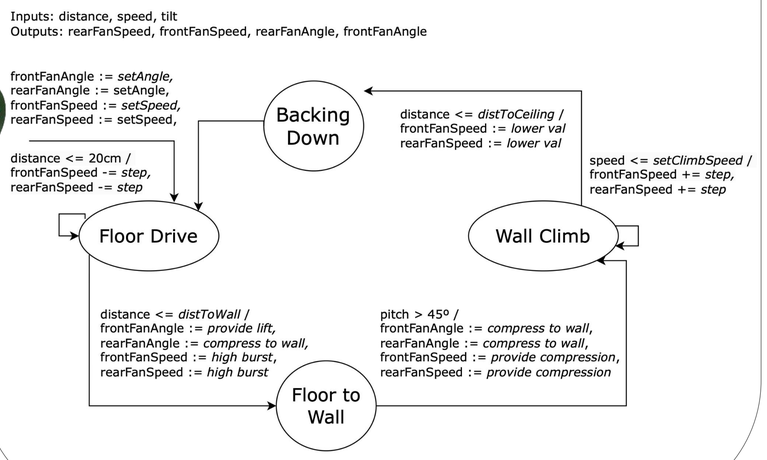
Our robot consists of two motors, two servos, and three sensors for maintaining stability.

Sensor:	Detects:
Ultrasonic	Distance
IMU	3-D Rotation
Encoders	Speed

— Implementation —

We incorporated two feedback systems using Lingua Franca's modal system:

1) Sensing tilt via the MPU, and adjusting the set angle of the servos to adjust the propeller direction. This was because as we transition from the floor to wall, the ability to set a single absolute angle of the fan relative to the ground simplified our code immensely.
2) Sensing speed via the encoders, and adjusting the fan power was useful for preventing the robot from dangerously over-accelerating



— Challenges —

In mechanical & design included:

- Maintaining breadboard connections was difficult due to servo movements and fan vibrations.
- Securely supporting the weight of all components on the servo hinge.
- Wiring sensors in the limited space, preventing stray wires near the propeller.

In software development included:

- Lacking built-in libraries for sensors, requiring manual configuration, unlike platforms like Arduino.

In physics and feedback included:

- Controlling speed of robot through momentum buildup.

— Future Improvements —

Incorporating more states like ceiling navigation or wall to roof transitions, steering capabilities, and better speed control.

Addressing jittering in servos.

— Current Status / Results —

Due to difficulties in our hinge design, our robot is unable to turn.

We focused on a single transition because of timing constraints due to multiple rebuilds from robot falls and flips requiring robot rebuilds and new parts ordered.

— References —

Liang P, Gao X, Zhang Q, Gao R, Li M, Xu Y, Zhu W. Design and Stability Analysis of a Wall-Climbing Robot Using Propulsive Force of Propeller. Symmetry. 2021; 13(1):37. https://doi.org/10.3390/sym13010037

The Fedmog Challenge. (2023). It is blue, it is fast, it is Sonic. [Video]. YouTube. https://www.youtube.com/watch?v=97oa9ppZ5uI&t=144s

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VIDEO DEMOS

Floor to Wall and back

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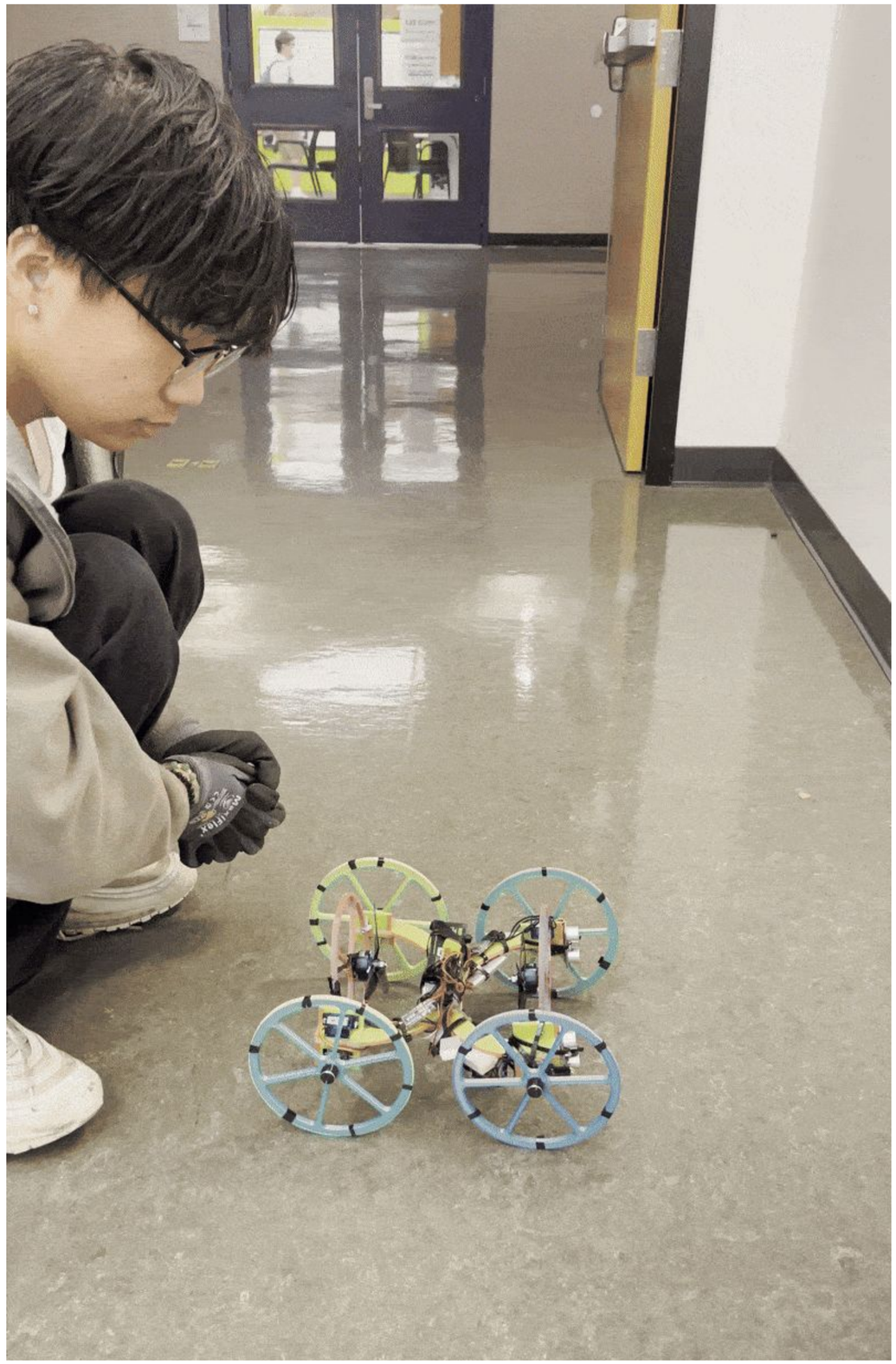

Floor Drive Demo

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Floor to Wall Demo

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Wall Climb Demo

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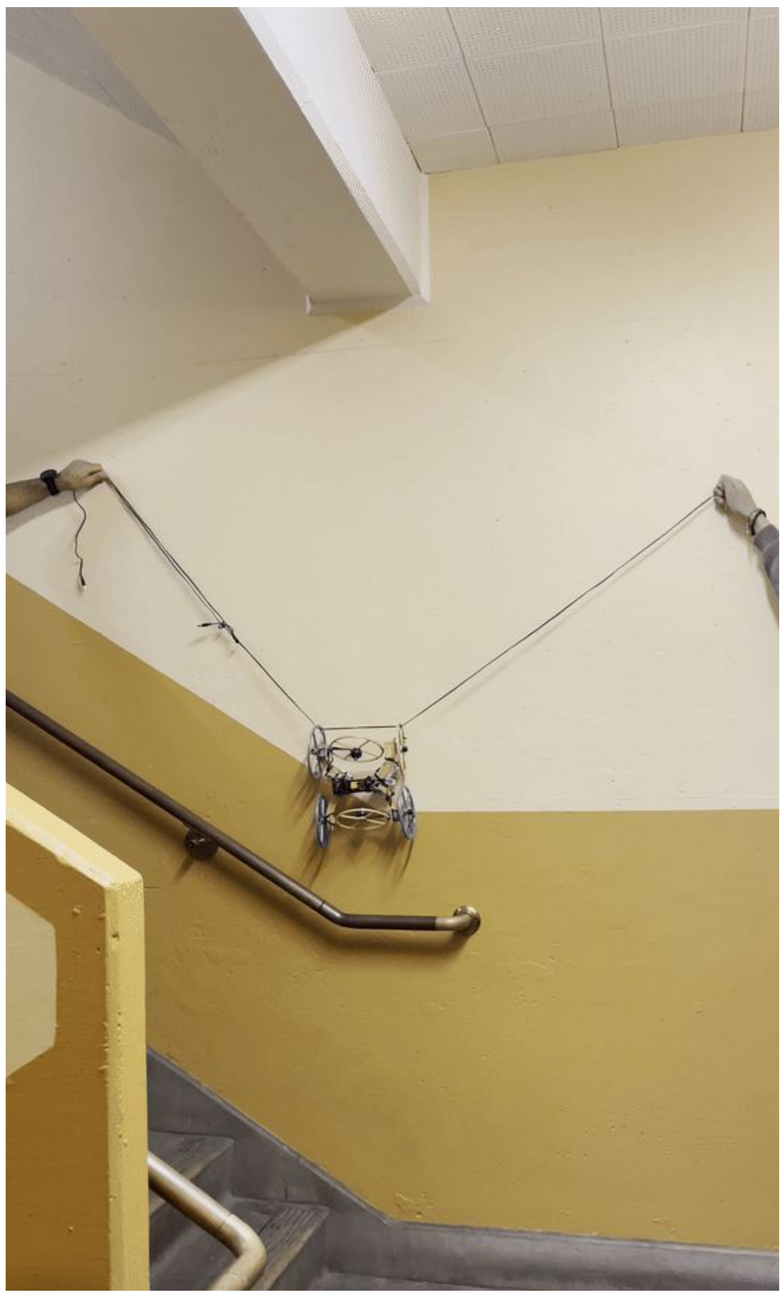
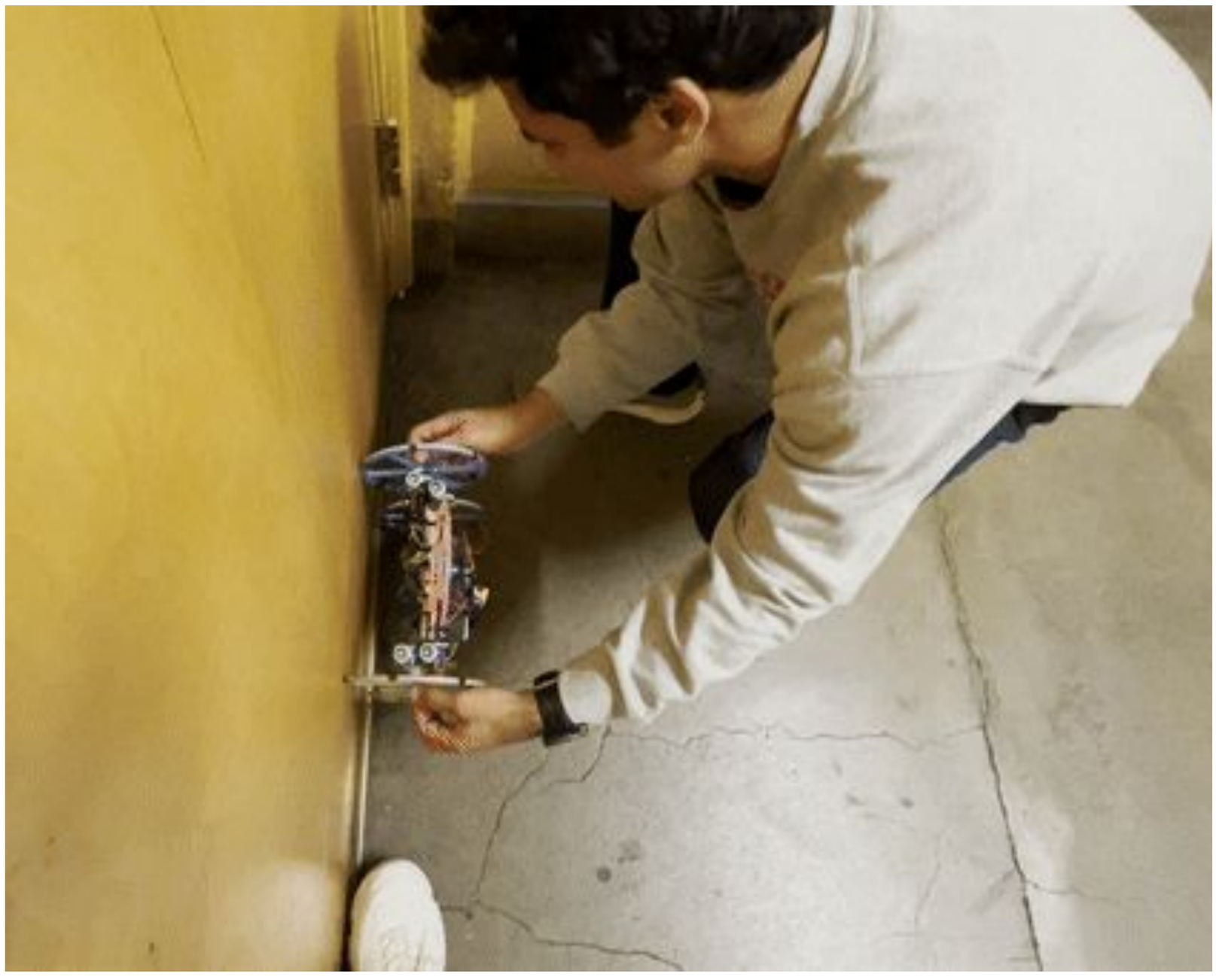
On a leash



With distance sensor stop at the “ceiling” + backing down



Backing Down → Wall to Floor

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CHALLENGES

Challenges: Encoders

Weak hardware

- Broke during first crash when propeller went haywire. (Probably due to bad connection)
- Broke multiple times during floor to wall testing
- Ordered 5, and then another 5. Snapped a total of 5.

Not very sturdy.

Jostling breaks wheel off bot

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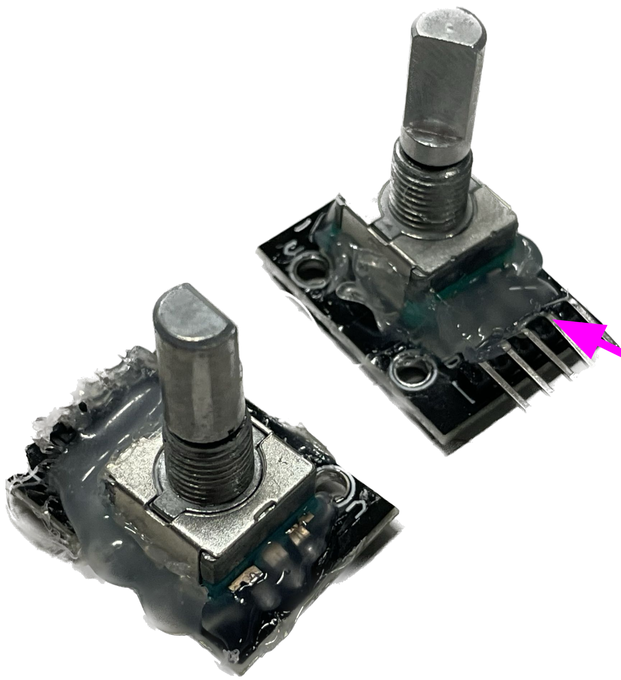


Glued encoders back together

Not very sturdy.

Jostling breaks wheel off bot

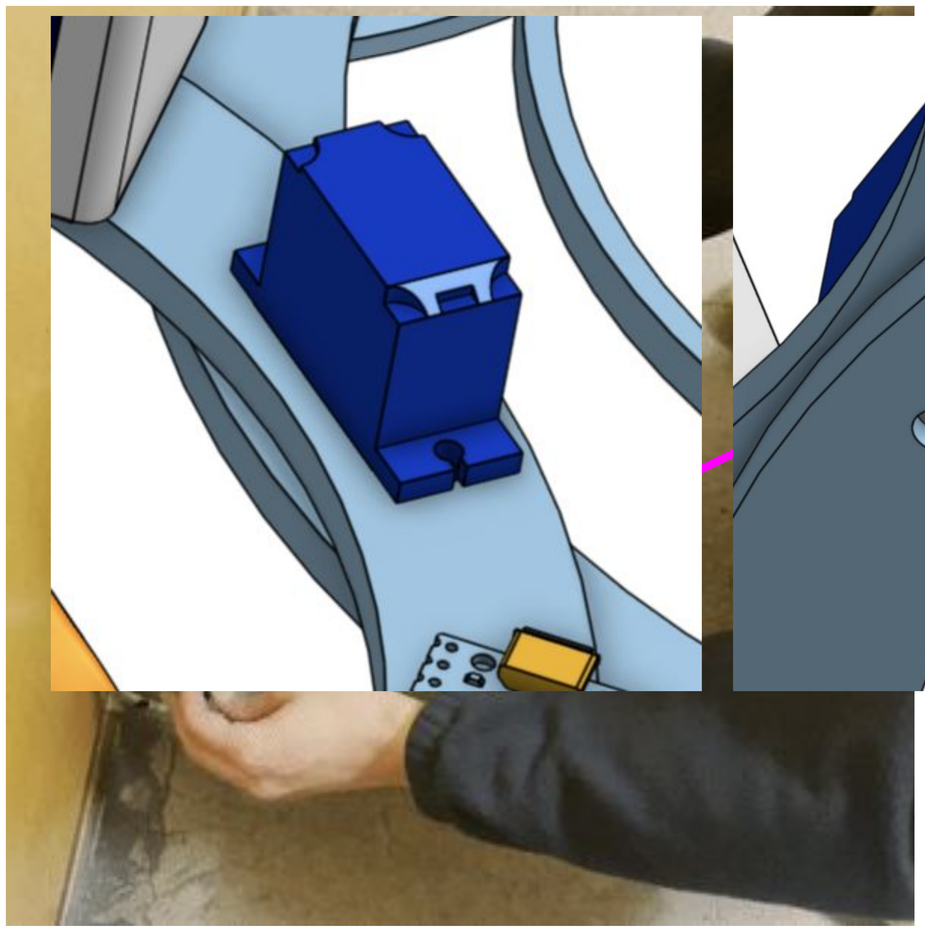
Challenges: Propellers

Bounces a lot:

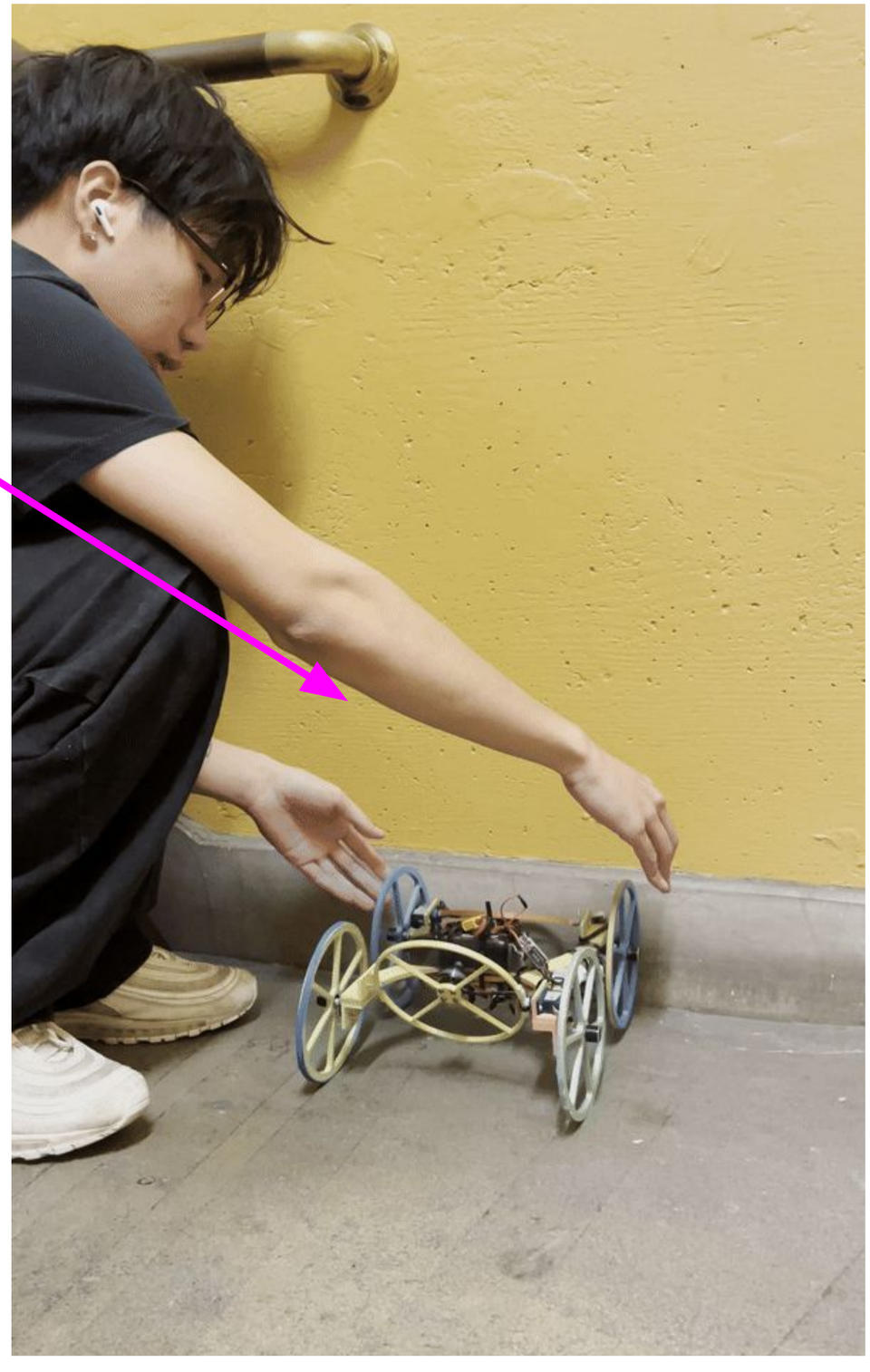
- Servo hinges not very secure. Bounce off and flap.

Top

Bottom



Robot flipping and propeller frame coming off servo



Challenges: Propellers

Bounces a lot:

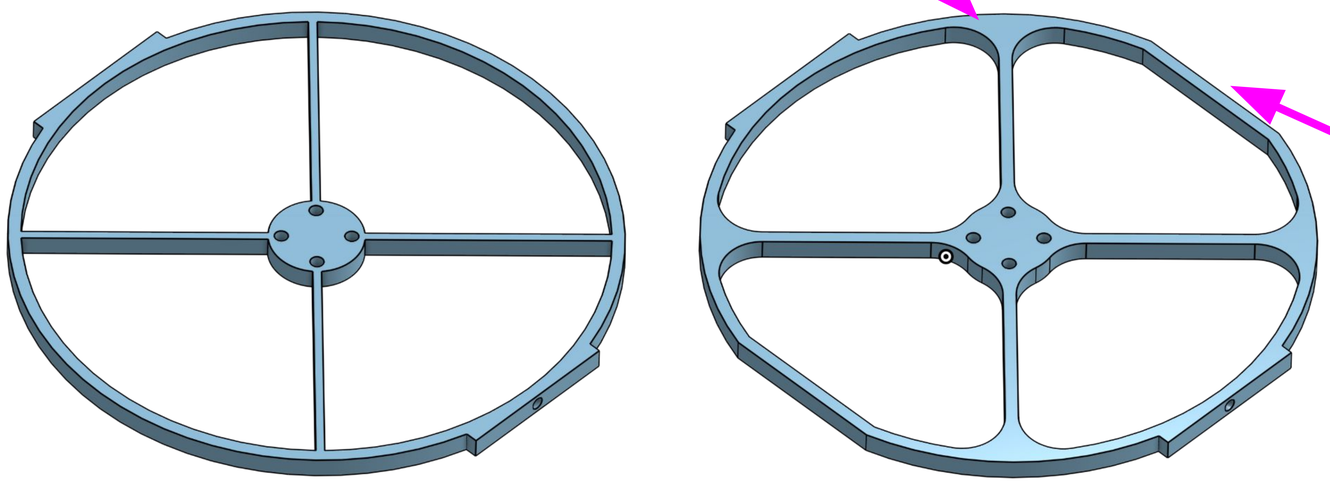
- Servo hinges not very secure. Bounce off and flap.

Propeller Frame weak:

- Added fillets

Broken frame

Added fillets



Cropped because wheels were too small and frame would hit the door/walls.

Challenges: Propellers

Bounces a lot:

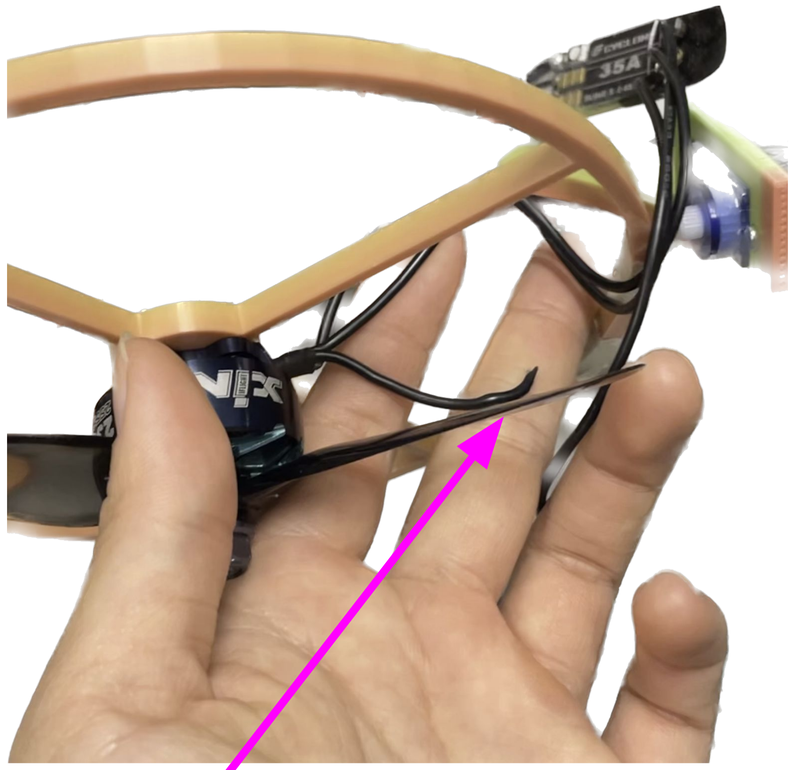
- Servo hinges not very secure. Bounce off and flap.

Propeller Frame weak:

- Added fillets

Cut things:

- Cut into ESC wire, burned out a whole row of GPIO pins.
- Cut into the battery pack and chipped.



Blades cut through things. ESC wire cleanly cut through. (also Jacob's finger)

Challenges: Mechanical Design

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No Functioning Turning Mechanism:

- We ziptied the battery to the hinge of the rear and front frame. The servo axis was already very short, so with the sagging, it would just pop right out.
- A fully autonomously transition was risky, especially with the chance that hitting the ceiling could cause a turn of the robot that steers it straight into the ground.
- Wheels were too big to turn easily, but making them smaller would let the propeller hit the wall even more.

Prints Too Flexible:

- Didn’t snap as frequently as the laser cut wheels but components that weren’t fully fastened like the propeller frame onto the servo were at risk.

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TAKEAWAYS

Takeaways

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Structural Integrity ←→ Safety
- Mechanical design had flaws.
- Fastening servos securely would have saved us a lot of time.
- Propellers should have safety frame so the blades can't cut people or wires.

Quality Sensors
- Stronger servo, encoders that wouldn't constantly break, etc.
- Servos that can react faster.

Planning for Space
- The weight, positioning, wiring of the sensors was bulky. Caused bouncing on the flexible frames.

Interrupts
- Numerous sensors on Rasberry Pi need an Interrupt Service Routine.

Systematic Testing
- Calibration and recalibration every time we had to do a rebuild was super important, and pretty time consuming.

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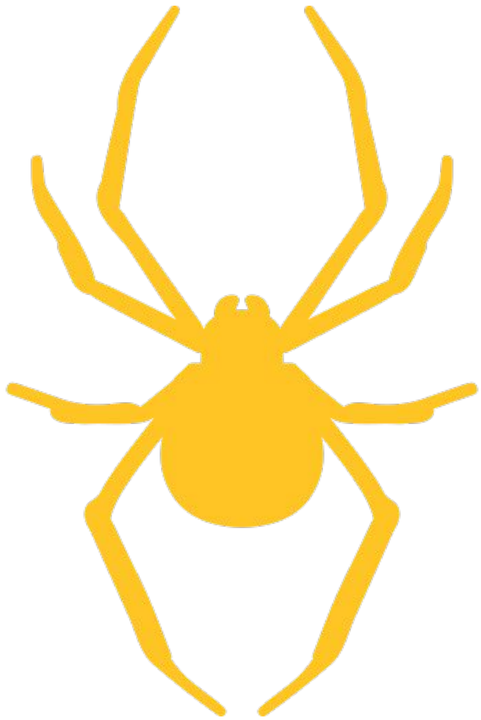
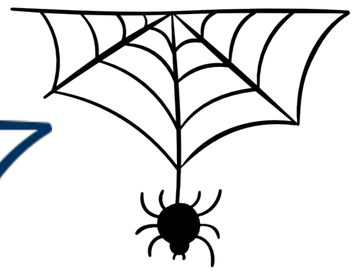
THANK YOU

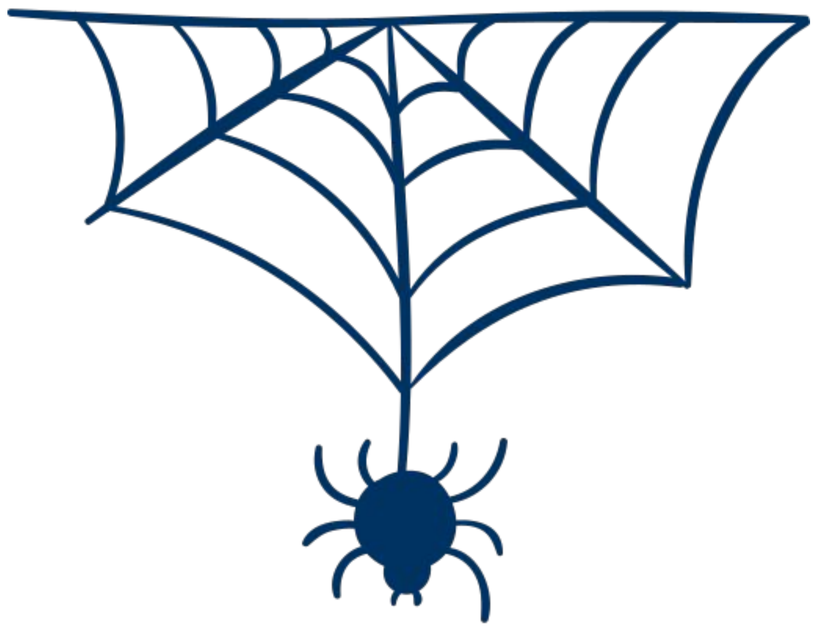
Other images we might want

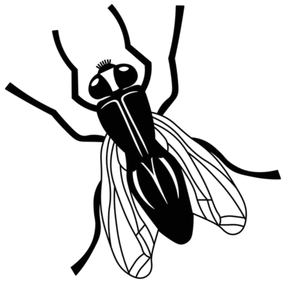
TODO:

- Needs more images
-







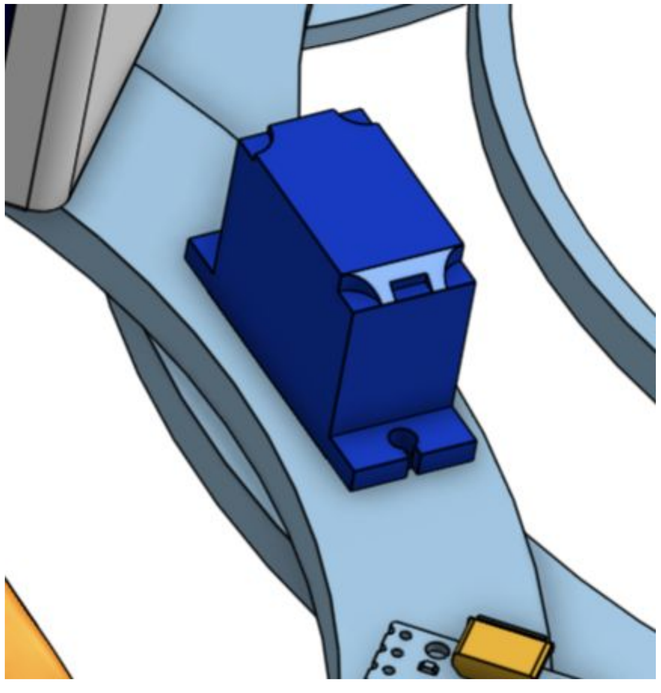


Challenges: Mechanical Design

Future Design:

- Servo!! Hinge for turning would add **hugely** to the stability of the robots functionality

Top



Bottom