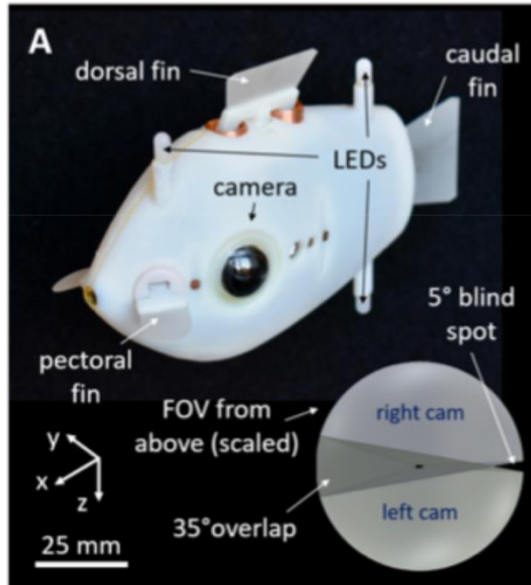


Flow Sensing Robot Fish Summer Findings

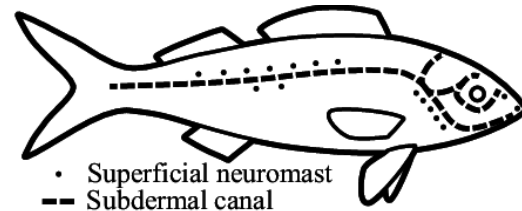
Adriana Holtzman

Project Goal: Build fish-like robots that use flow sensors to navigate without centralized control

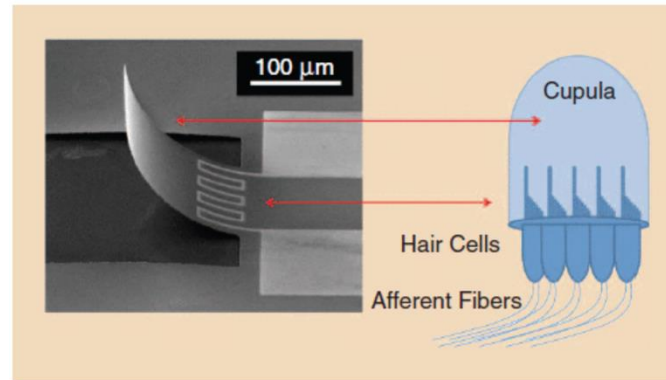


Nagpal Lab:
coordinated fish-like
robots using vision

Berlinger, Florian, et al. "Fish-like three-dimensional swimming with an autonomous, multi-fin, and biomimetic robot." (2021)



(a) Typical layout of the lateral line in a fish



Svenning: flow sensors to mimic
lateral line system in fish

M. Kruusmaa et al., "FILOSE for Svenning: A Flow Sensing Bioinspired Robot," (2014)

Although many fish-like robots exist, they generally use vision to achieve coordinated behaviors.

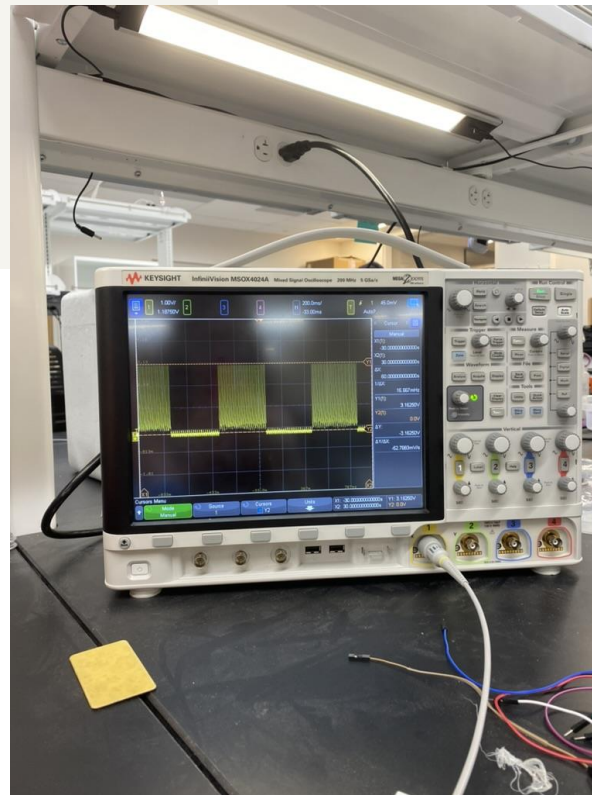
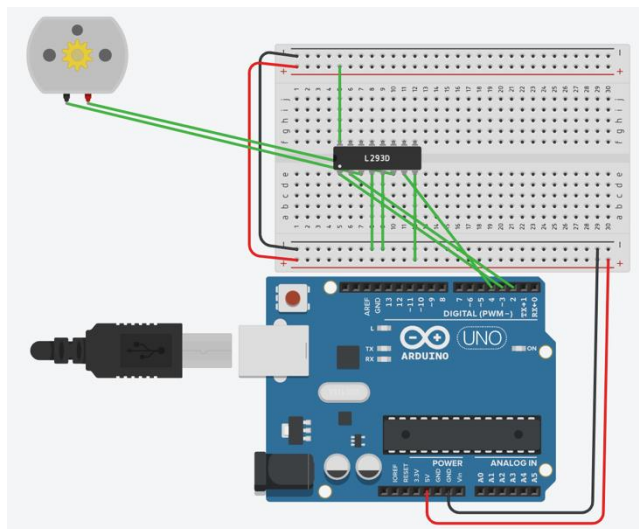
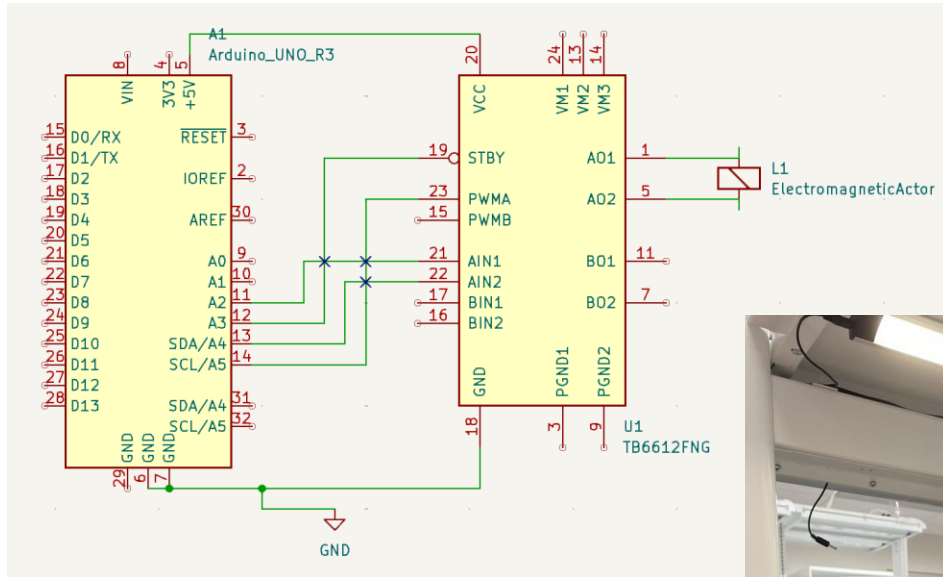
Using whisker-like flow sensing, fish-like robots should be able to achieve coordinated behaviors like **rheotaxis** (following a current) and **milling** (swimming among other fish in a circular pattern).

So far, I have made an actuator with adjustable speed and momentum-based turning

Process:

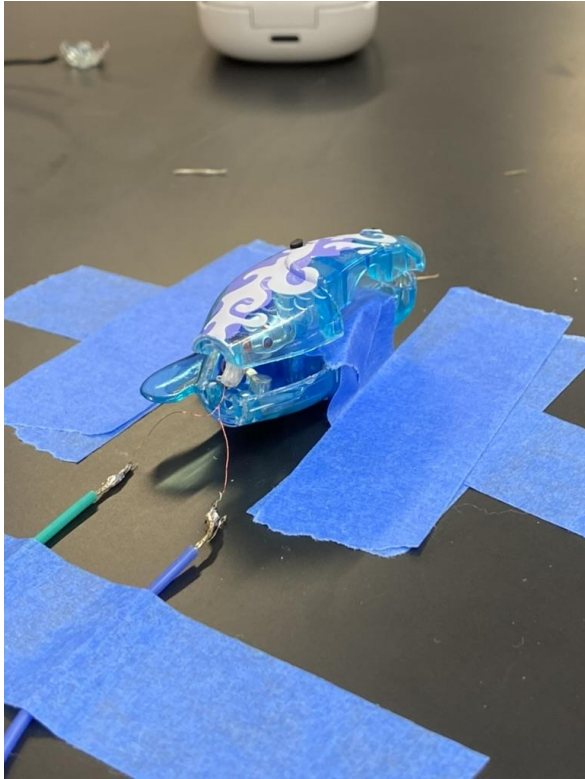
1. Circuit + signals + code
2. Prototyping test setup
3. Actuator quantification in water

Circuits, Signals, and Code

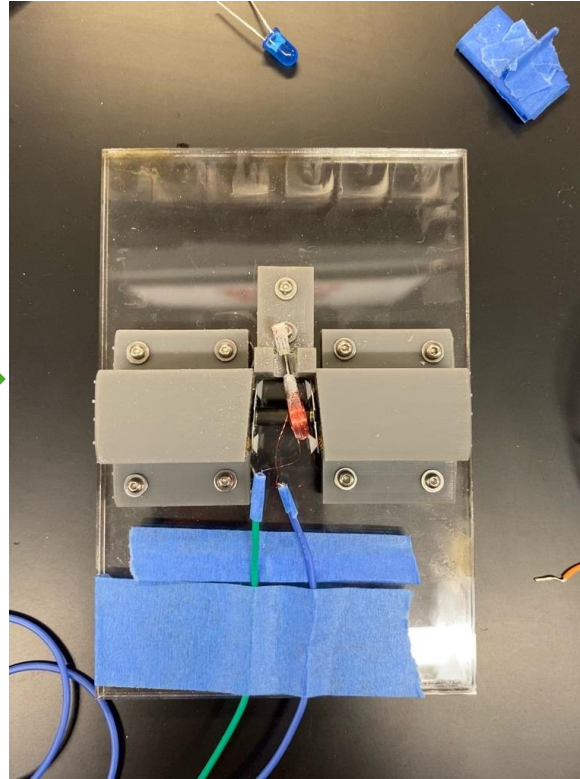


- Deconstructed toy robofish and built small electromagnetic actuator into circuit
- Kicad schematic to visualize circuit and be able to PCB design / miniaturize in the future
- Tinkercad proof of concept when wires broken
- I can control actuation speed reliably by changing the signal input to the PWM pin on the h-bridge
- Code to control speed of caudal fin actuator in each direction for momentum-based turning capability

Test Setup Iterations



- Worked
- Hard to see differences between signals because gravity

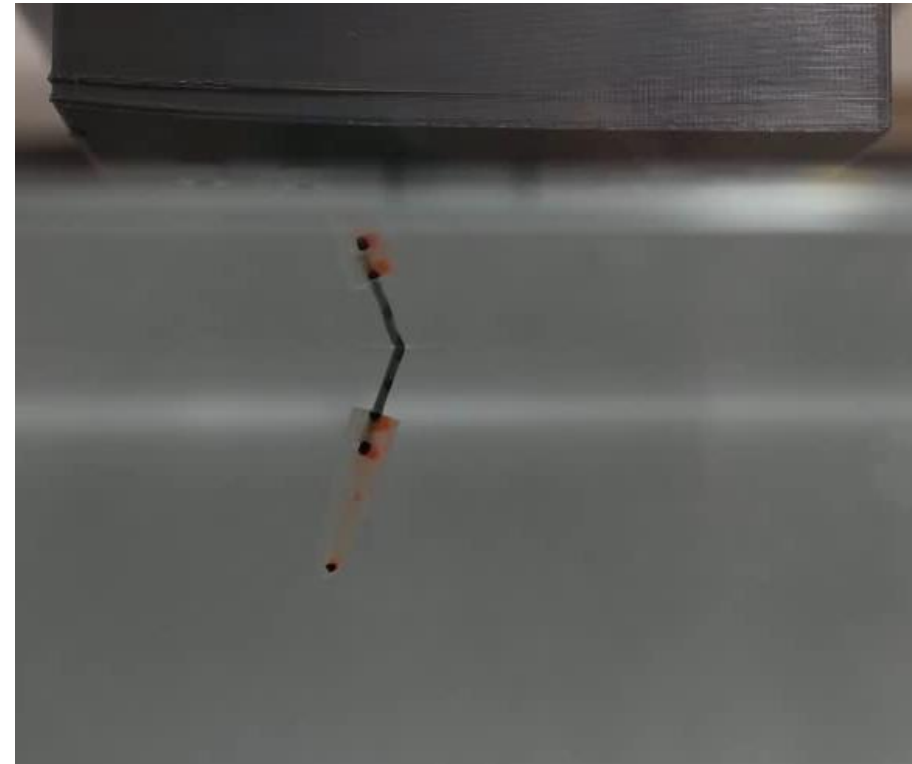
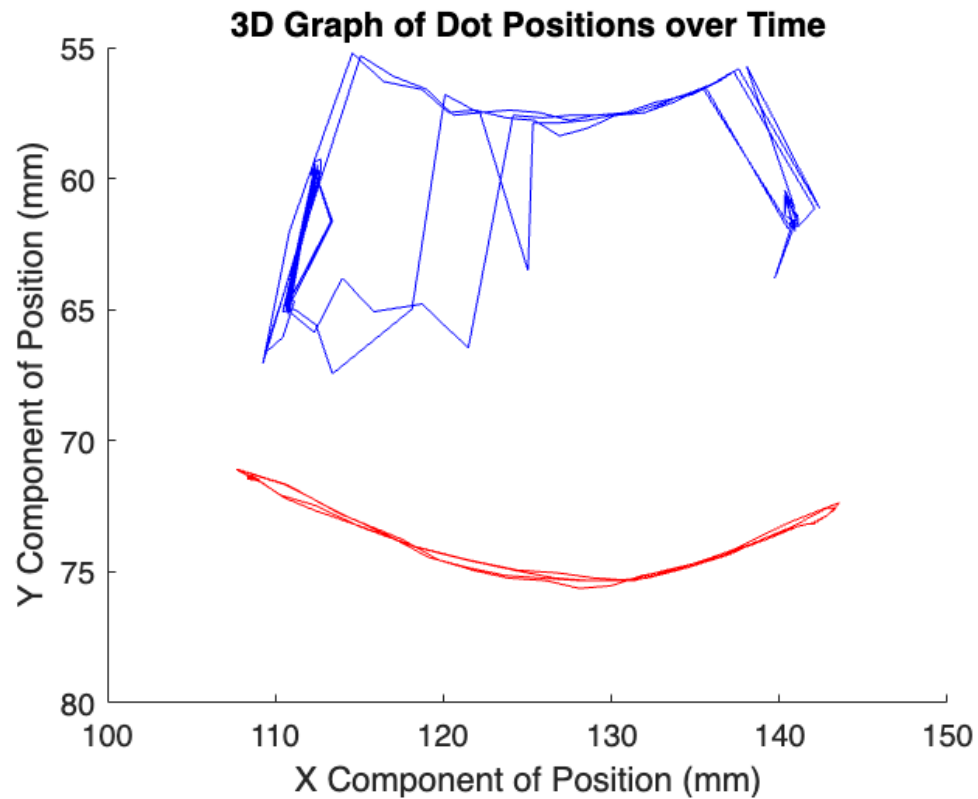


- Visually see speed differences
- Small and good for testing code changes
- Wires don't break

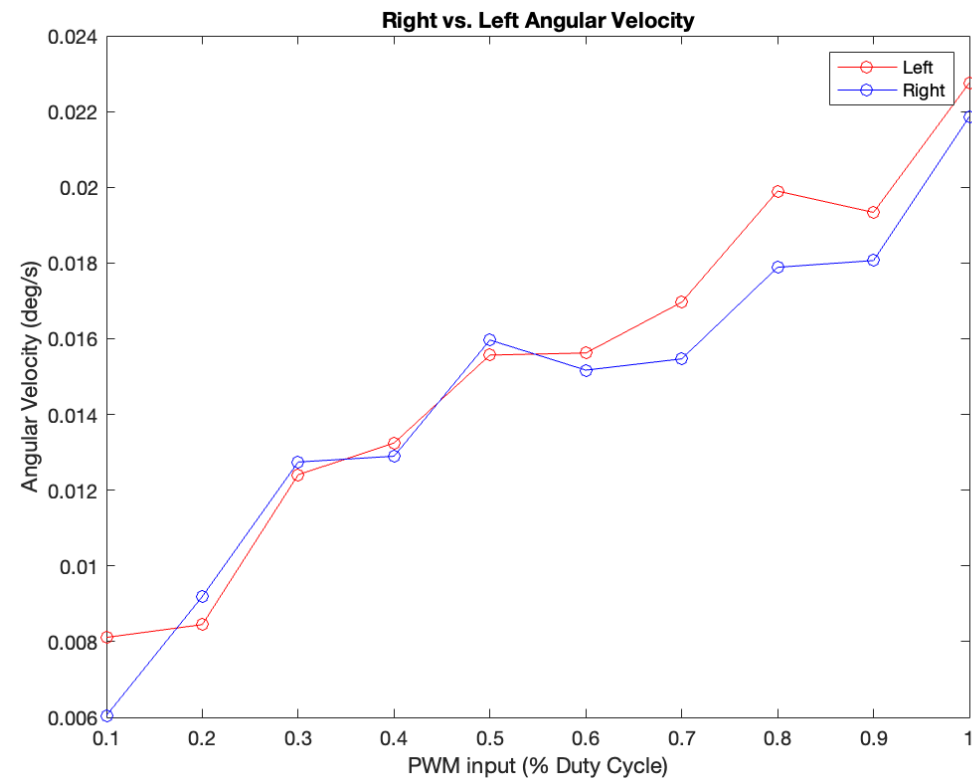
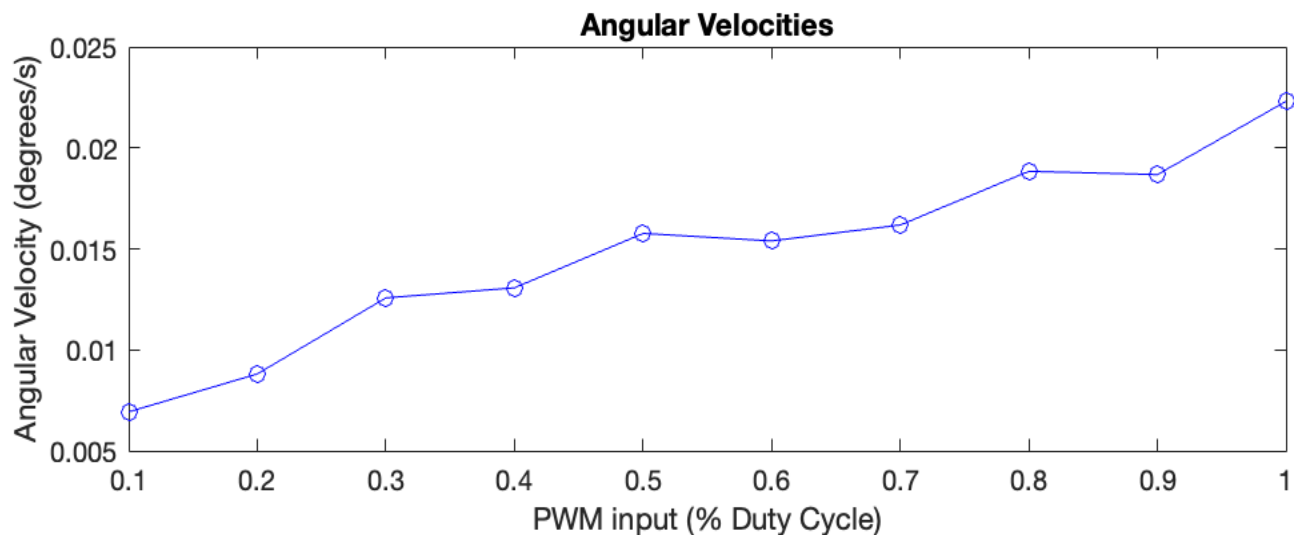
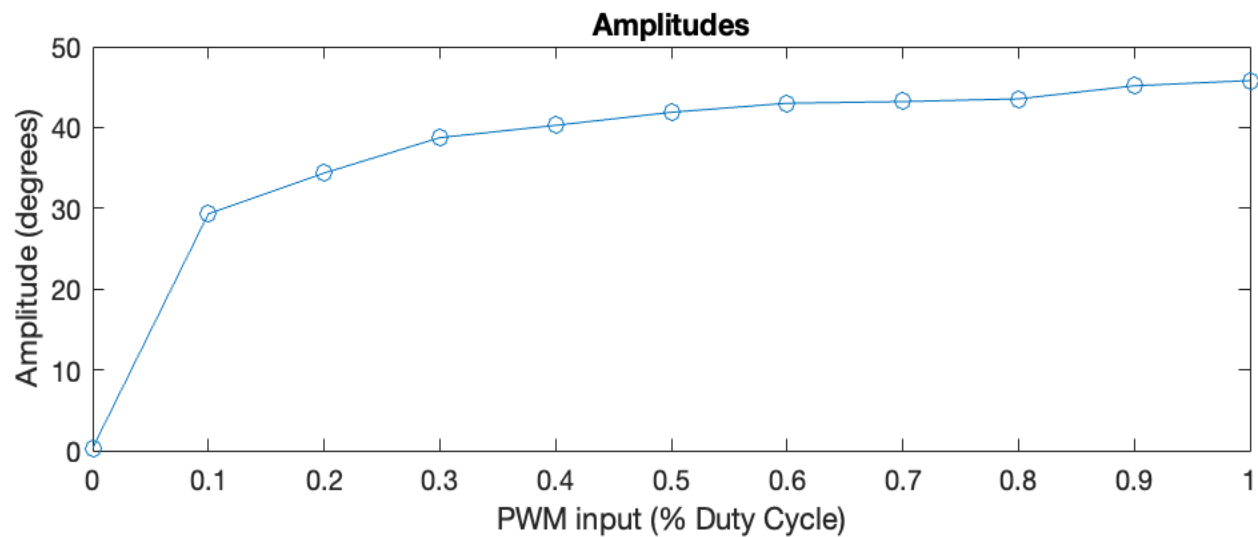


- Waterproof for tank
- Flexibly constrained axis of rotation
- Less reliant on tape :)
- Printed / rebuilt actual fin

Quantification: Segmentation Tracker Outputs



These are from the same trial '0.6-wet-t2'. The Segmentation Tracker outputs positional data over time (plotted on the left) and movement data over video inputs (right).



Conclusions: PWM input is linearly related to the actuator's angular velocity.

Questions: Why isn't the angular velocity graph more linear? Are differences between left and right statistically significant? These questions will be answered by processing more of the data.

Thanks for a fun summer of robots!