Improved Silicone Fish Tail Actuator With Variable Stiffness

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Motivation

In continuation of research presented at The University of Maryland Undergraduate Research Day, this work focuses on improvements regarding a fish-inspired robot actuator capable of variable stiffening.

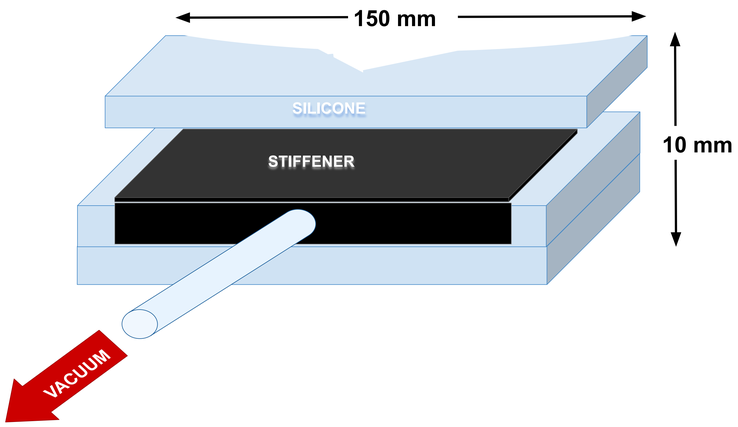
In the effort to improve the efficiency and performance of robots in water, several fish such as tuna naturally adjust their swimming behaviors through tunable musculature. Prior research has observed muscle stiffness to impact swimming efficiency [1].

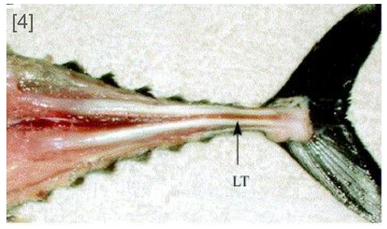
Background

- Bio-inspired robotics is an interdisciplinary field offering advantages that diversify robot designs and improve functionality. Incorporating soft robotics techniques into bio-inspired designs expands the potential of new robots.
- A fish's naturally flexible body and reaction to the hydrodynamics of its environment provide useful inspiration for robots of similar design.

Design

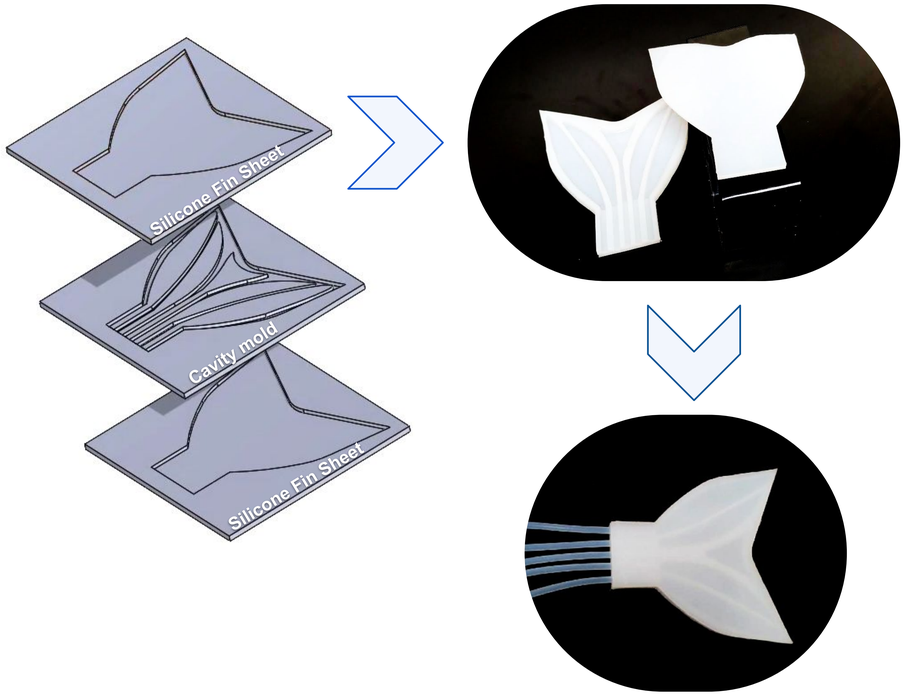
- Waterproof fish fin 10mm thick and 150mm at the widest point.
- Negative pressure and material friction to induce stiffening.
- Sectioned internal cavities to vary pressure across fin area.





Previous Work

- Thick 20mm prototype fin was developed using 0A hardness silicon rubber.
- Challenges included:
  - Stiffener fabrication.
  - Placing internal components and tubing.
  - Waterproof sealing.
  - Weight.



Refining the Process

- Higher quality 20A silicone rubber Dragon Skin™ 20.
- Vacuum degassing to remove air bubbles - improves sealing.
- Layered molds.
- High pressure and humid environment to quicken curing process.

Results

- The new mold designs are easily adjustable and capable of fitting more complex geometries.
- Improved assembly and overall fin aesthetic.
- Simple to separate, adjust and rebond layers together with silicone.

Next steps

Observe the impact of variable stiffness on flow dynamics.

- Adjust base of tail to fit body being worked on by colleague.
- Perform testing in a small water tank to measure thrust.
- Create beams of the same composition to measure weight vs. deflection.

Body work of Isha Hemant Serjuse

References

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