BIOINSPIRED DESIGN AND SHARED AUTONOMY FOR UNDERWATER ROBOTS WITH SOFT LIMBS

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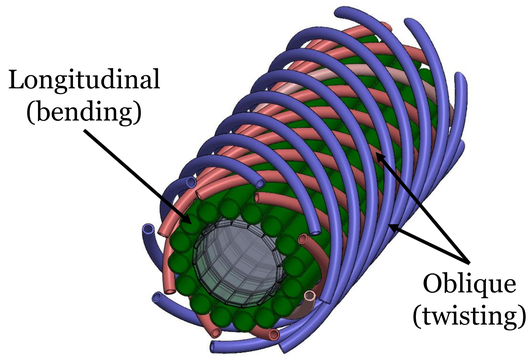
Project Goal: Establish a framework for underwater soft manipulation by studying the structure, control and planning of cephalopod-inspired robot arms.

PROJECT OVERVIEW

Soft robotic actuator systems have yet to achieve the range of motion possible in aquatic biological systems. We are exploring:

1) new morphologies and fabrication techniques;
2) the inclusion of integrated liquid metal sensors;
3) shared autonomous control.

BIOINSPIRED MORPHOLOGY

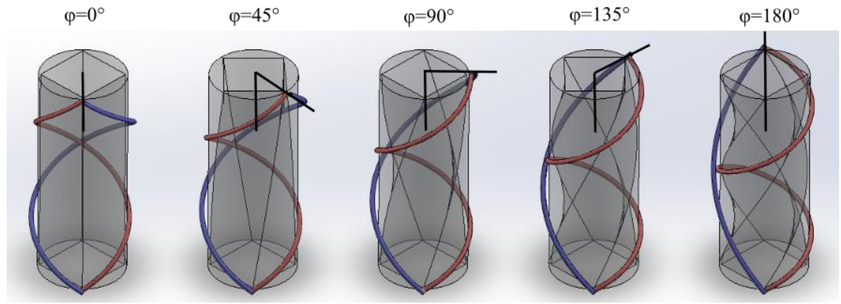


Biological organisms like the octopus rely on complex systems built out of relatively simple – and similar – components. We can mimic this with McKibben actuators.

McKibben actuator, contracting

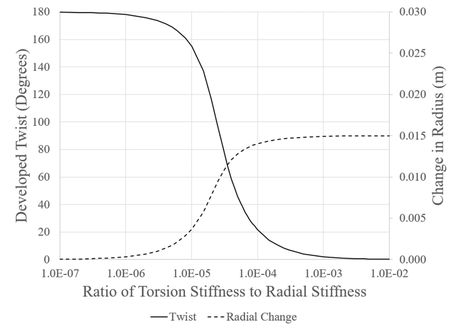
TORSION CONTROL VIA HELICAL ACTUATORS

We began with torsion control via two sets of helically wrapped actuators.



Twist in the structure is developed as length contracts. The amount of contraction, though, is determined by the properties of the internal structure.

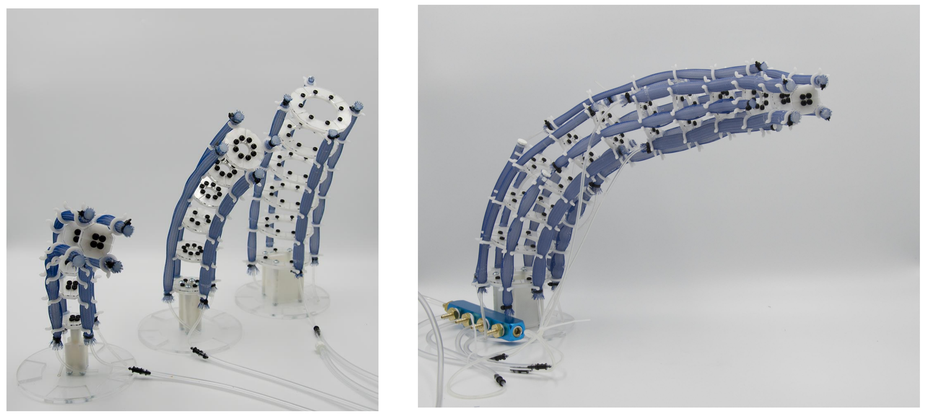
MODELED TWIST TRADE-OFF



Our energy model predicts the developed twist will decrease as torsional stiffness increases or as radial stiffness decreases.

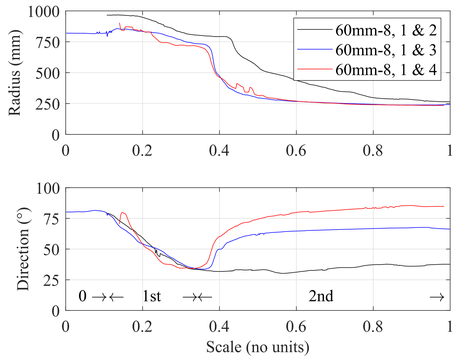
BENDING IN MANY-ACTUATOR ARMS

The arm is bent by contracting only the actuators on the underside, while the internal discs provide a radial and rotation constraint.



Decreasing the arm diameter and number of actuators decreases the minimum bend radius and the arm stiffness, as the actuators are also the arm structure.

BEND RADIUS AND DIRECTION



Our tests show that bend radius and direction change together. Increasing the number of actuators improves control during dual activation by mapping the same pressure space to a smaller actuation space.

FUTURE DIRECTIONS

- Mechanical modeling of bending with longitudinal actuators.
- Integration of pressure and strain sensing for closed loop position and force control, informed by mechanical models.
- Development of path planning and shared autonomy for intuitive control.

REFERENCES & ACKNOWLEDGEMENTS

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