Gecko Adhesion Based Sea Star Crawler Robot

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Motivation

Sea Star locomotion is provided by a combination of limb motion and the coordinated movement of thousands of adhesive microstructures called tube feet. To date, sea star inspired robots have relied on limb motion for their **displacement but that does not accurately mimic the actual movement of the sea stars due to the lack of foot adhesion.**

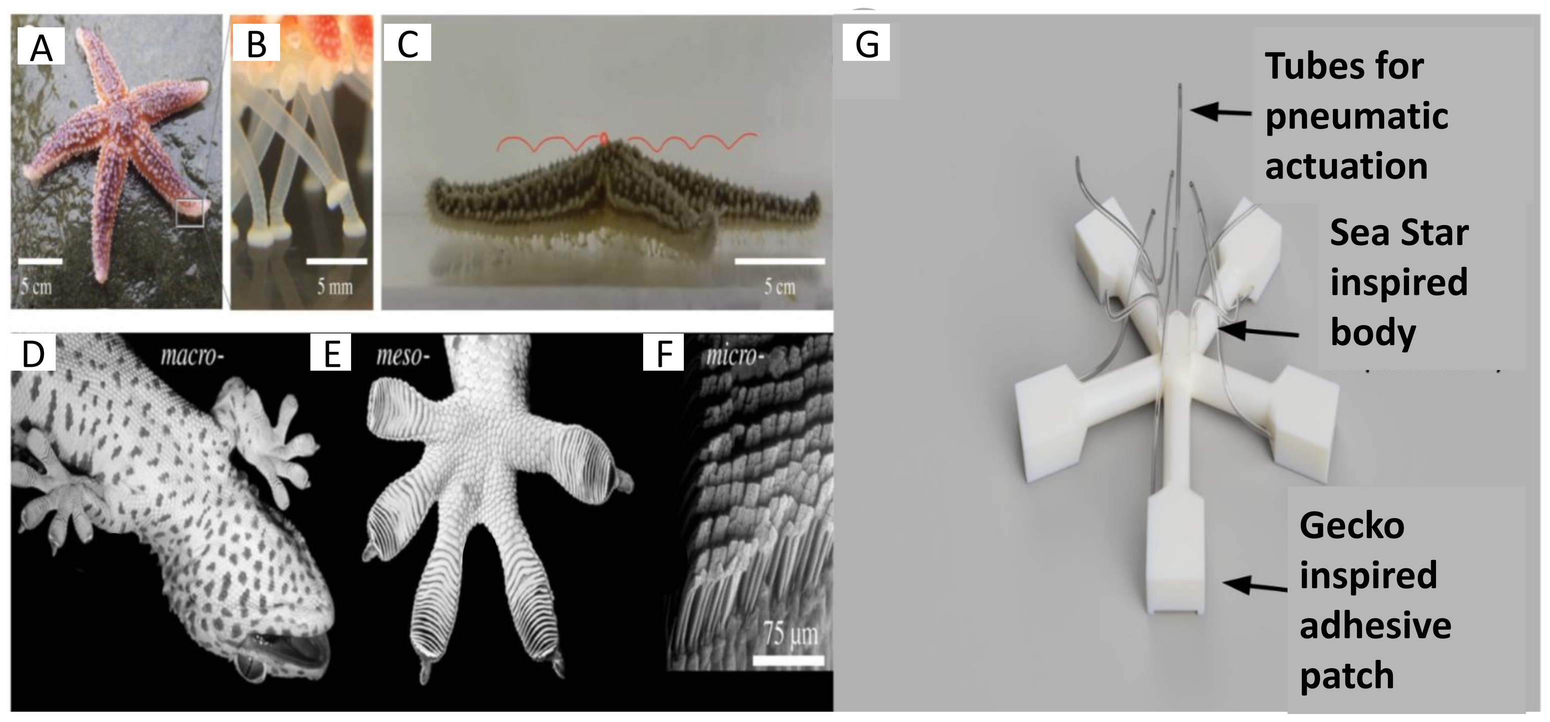

Fig. 1 Bio-inspiration adapted from [1,2] (A-F). Gecko adhesion based sea star crawler (GASS) robot (G)

We hypothesized that a sea star inspired robot with a gecko inspired adhesive foot surfaces will improve locomotion on wet and slippery surfaces.

Methods

Gecko Adhesive Fabrication

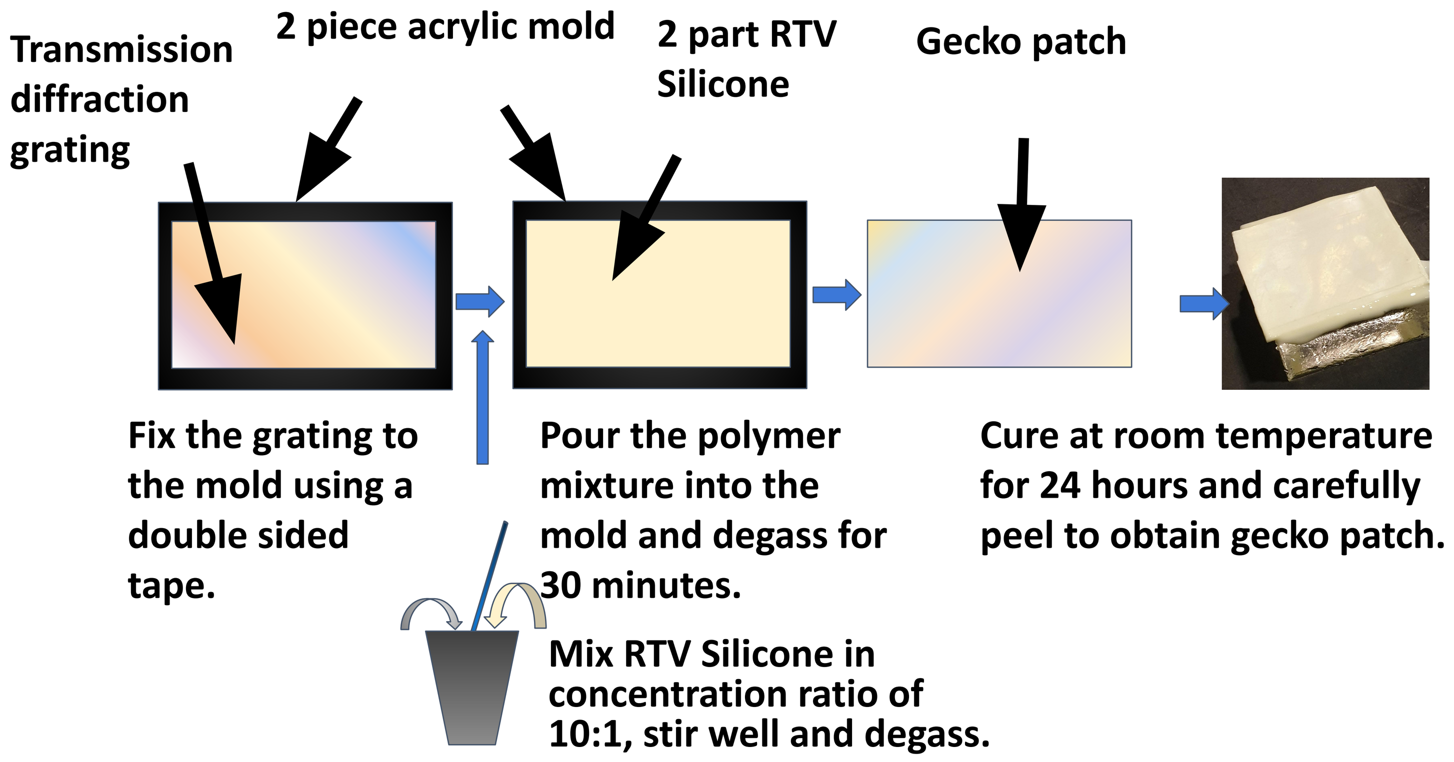

Fig. 2 Fabrication process of the gecko patch using diffraction grating.

Gecko Chamber Fabrication

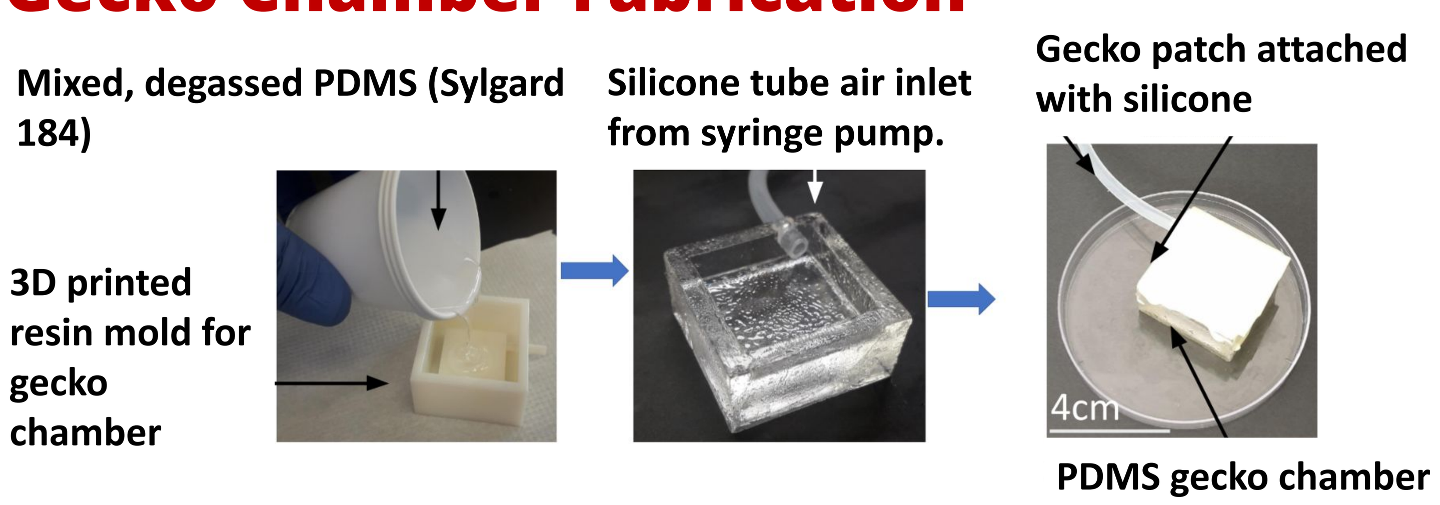

Fig. 3 Fabrication process of the gecko chamber using a 3D printed resin mold and PDMS.

Methods

Robot Limb Fabrication

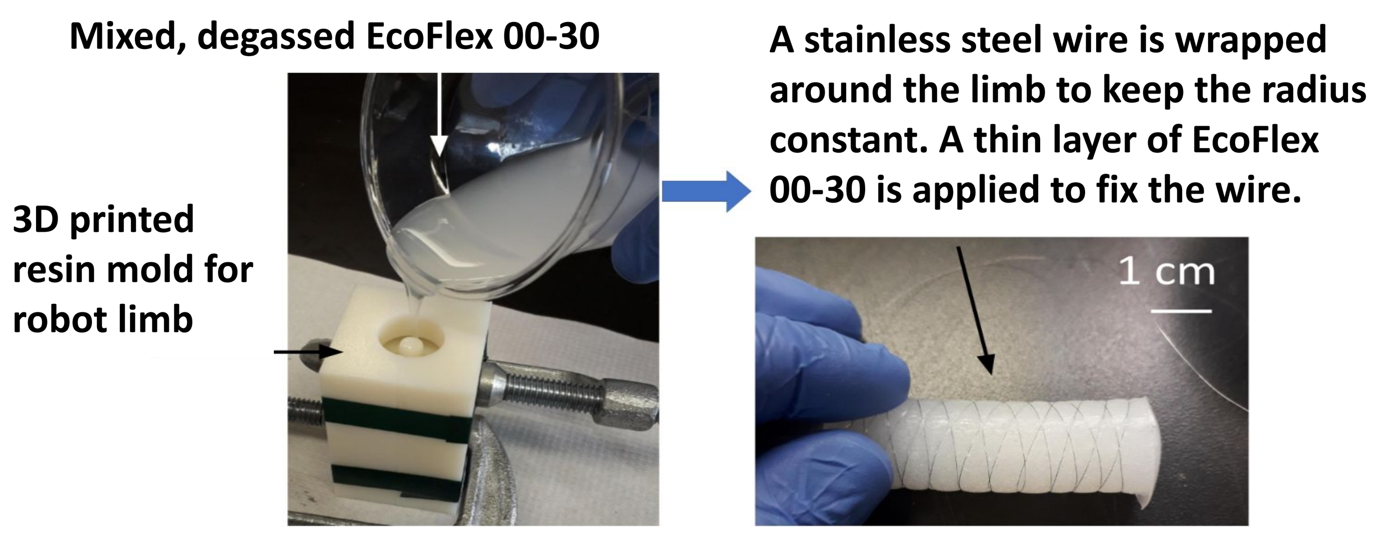

Fig. 4 Fabrication process of the robot limb actuator using 3D printed resin mold and EcoFlex 00-30.

Robot Assembly

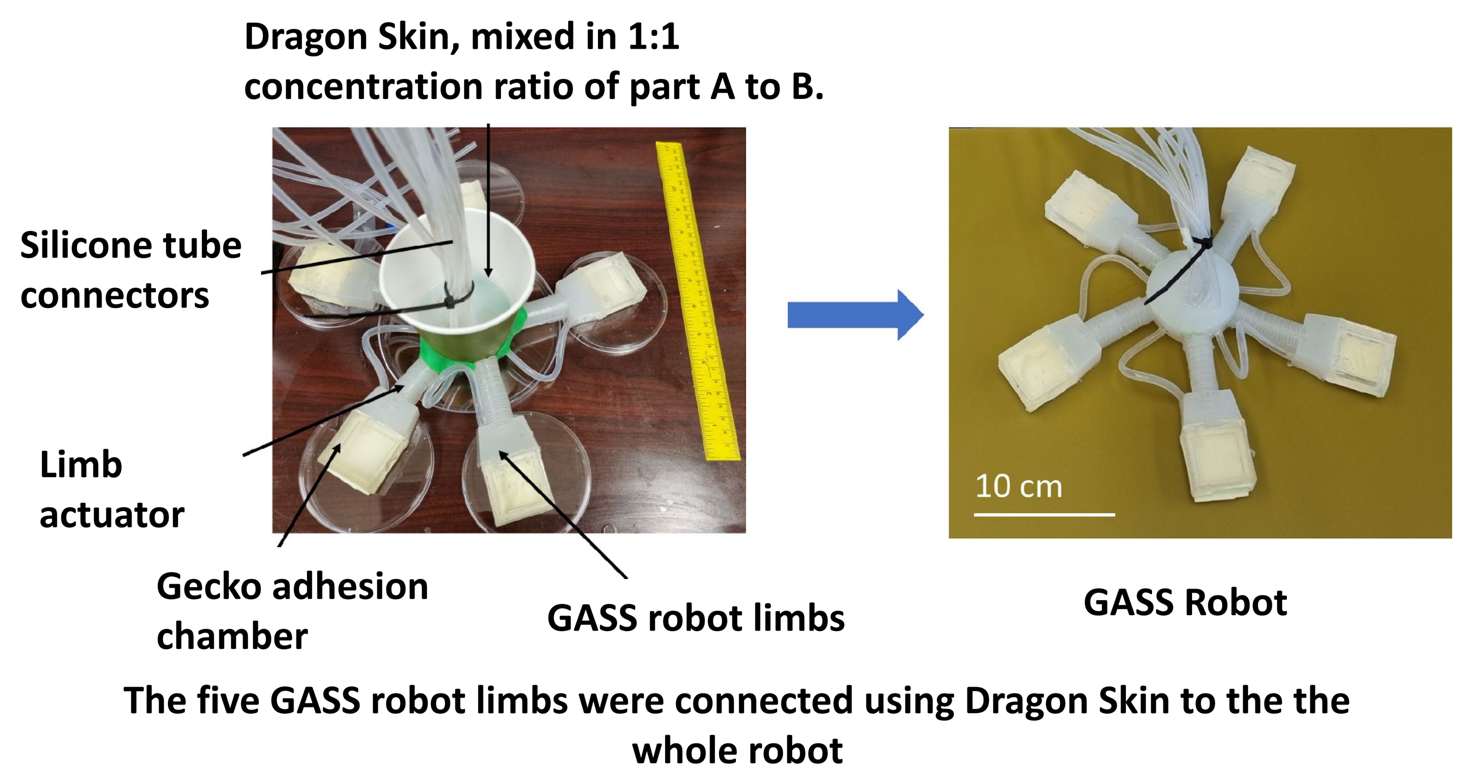

Fig. 5 Fabrication process of the final robot.

Actuation, Sensing, and Control Strategy

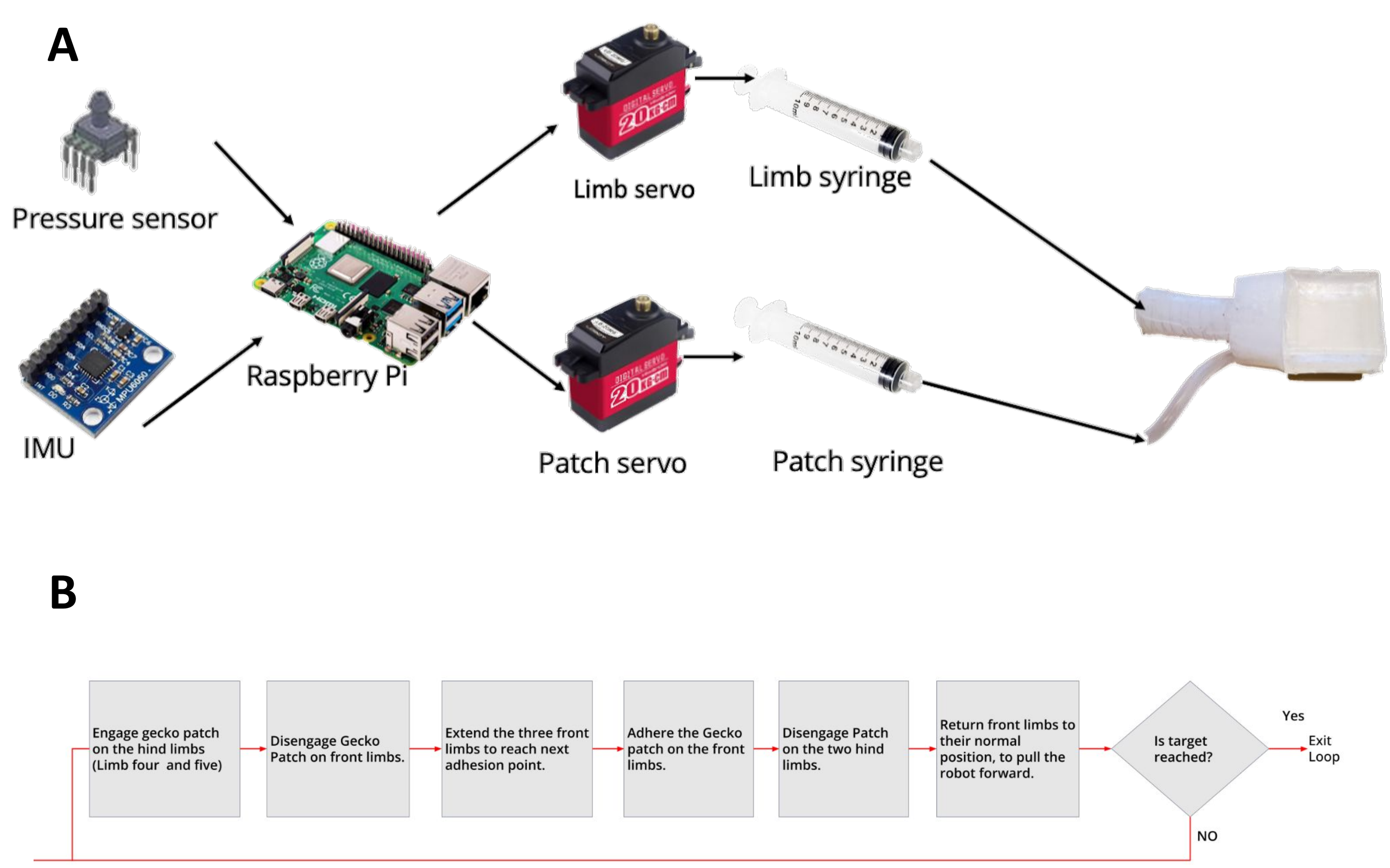

Fig. 6 Representation of the hardware of the overall control mechanism (A). The overall actuation strategy (B).

Results

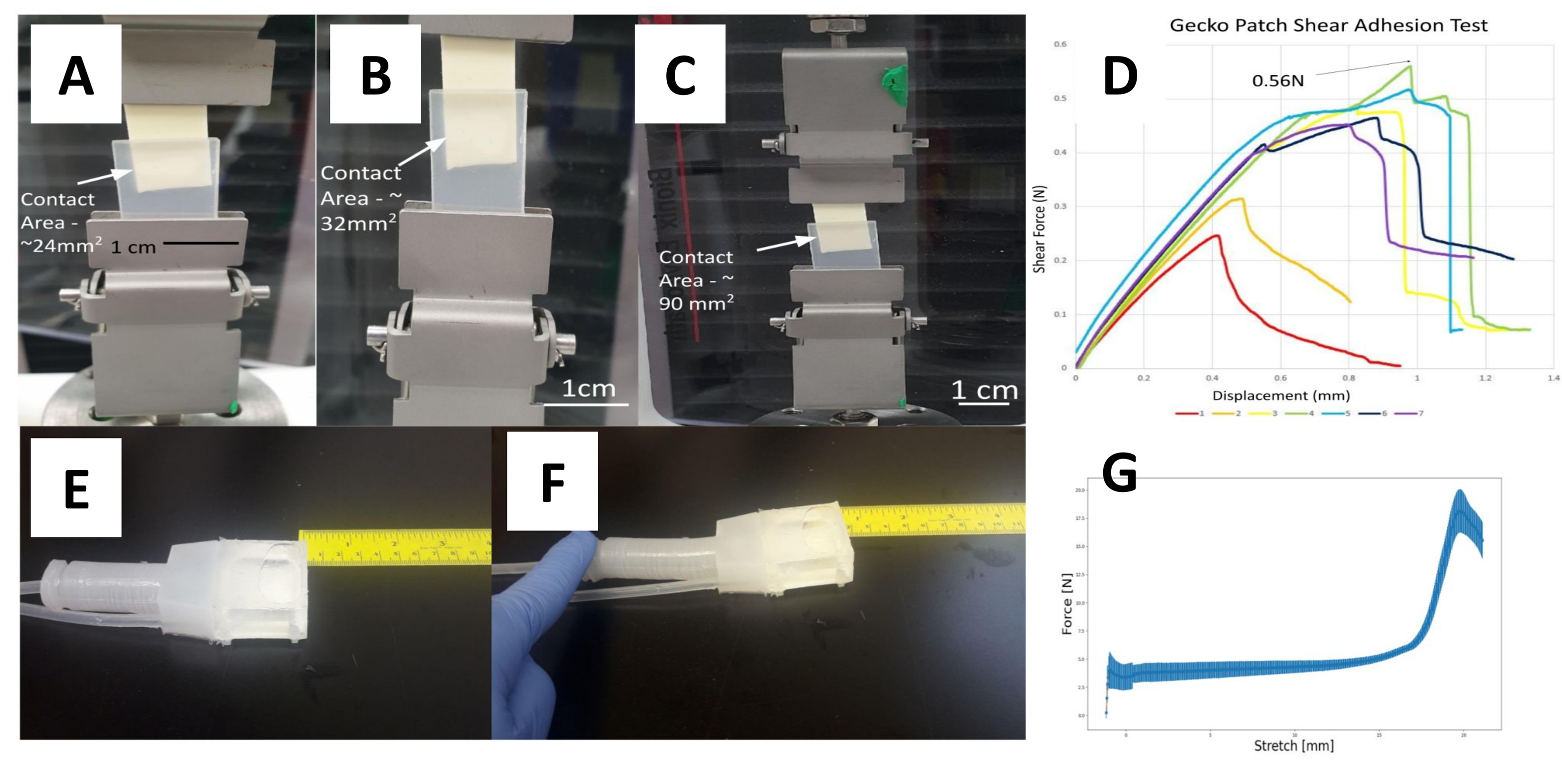

Fig. 7 Shear test was performed on the gecko patch to get the average shear force needed to detach the patch completely (A-C). The average value is 0.5N for a contact area of 90mm^2 (D). Limb extension test was performed to measure force required for total limb extension (E, F) reaching average force of 17.5N for 20mm extension.

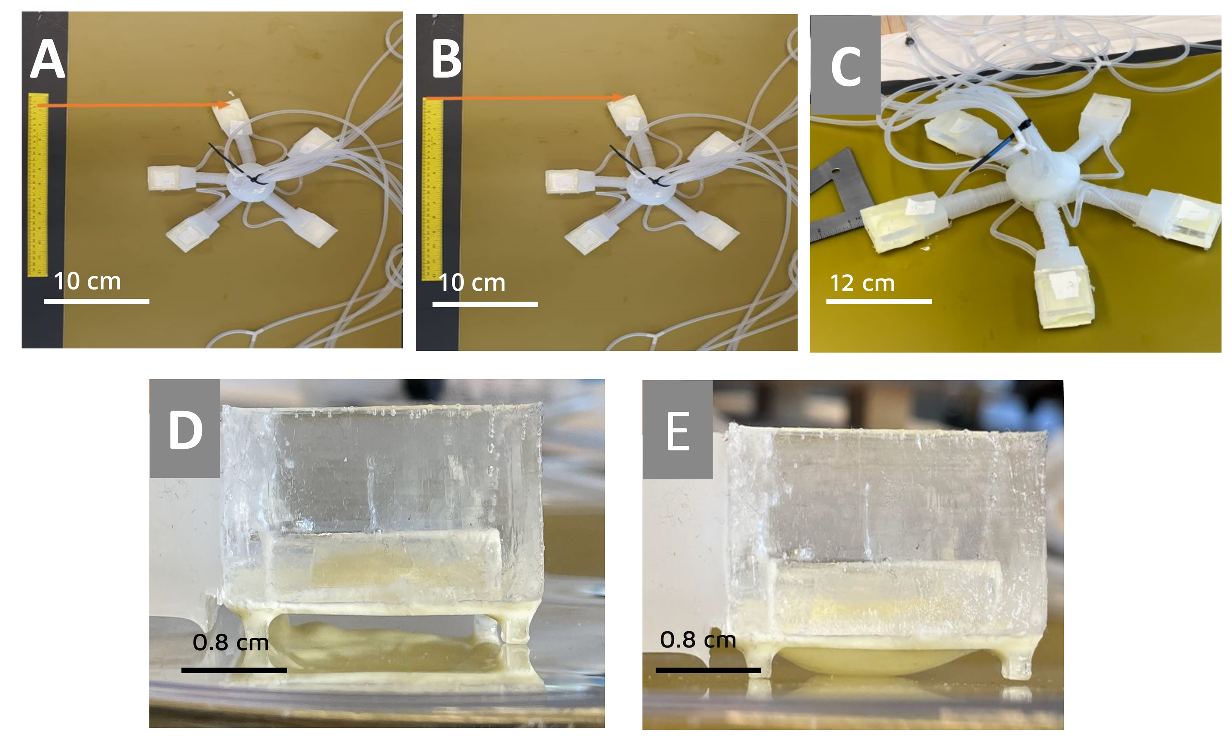

Fig. 8 Robot with all limbs compressed (A). Robot has one limb extended (B). All five limbs are extended (C). Gecko patch disengaged (D). Gecko patch engaged (E).

Conclusion and Future work

- Robot subsystems were tested, showing that they can achieve the proposed objectives.
- From this we can infer that the robot will fulfill the main objective of crawling motion.

FUTURE WORK STATEMENT – WHAT MORE CAN BE ACHIEVED?

- Obstacle avoidance and traversal can be incorporated
- The system can be adapted to work in underwater settings

Acknowledgements

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References: [1] S. Heydari, et al., 2020. [2] K. Autumn and N. Gravish, 2008.