Multifunctional Modular Pneumatic Gripper

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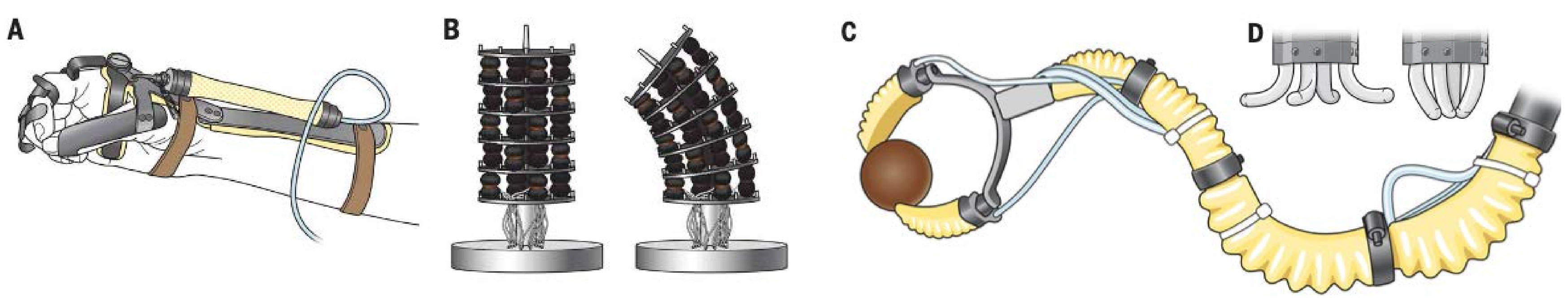
Background

Soft robotics has recently gained attention for its distinctive characteristics that set it apart from traditional rigid robots. With exceptional scalability, high impact resistance, adaptability to extreme conditions, virtually limitless degrees of freedom, and a stiffness akin to human tissue, soft robots emerge as prime contenders in fields like biomedicine and operations in challenging environments.

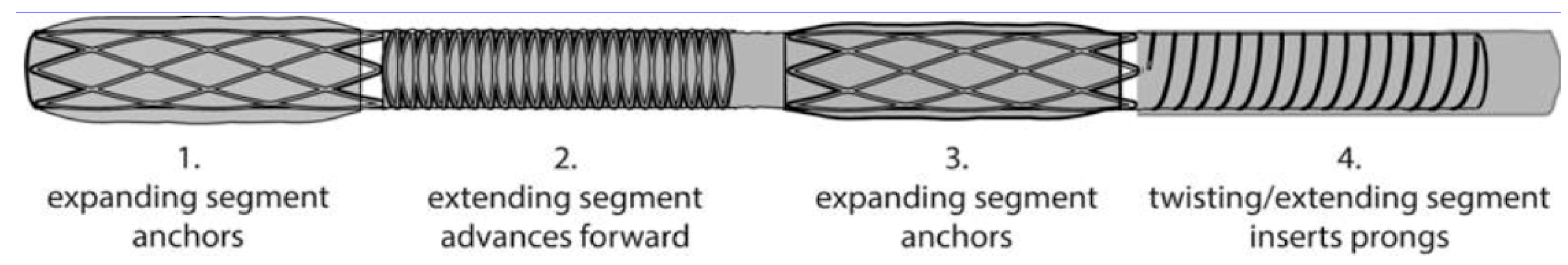


Examples of pneumatic soft robots. Science robotics, 2021, 6(53): eabg6049.

Pneumatic actuation is commonly used in soft robots due to its low cost and mass, fast response time, and easy implementation, allowing for the execution of intricate, designated tasks. Yet once their structural design is finalized, they're limited to a specific actuation mode.

Motivation

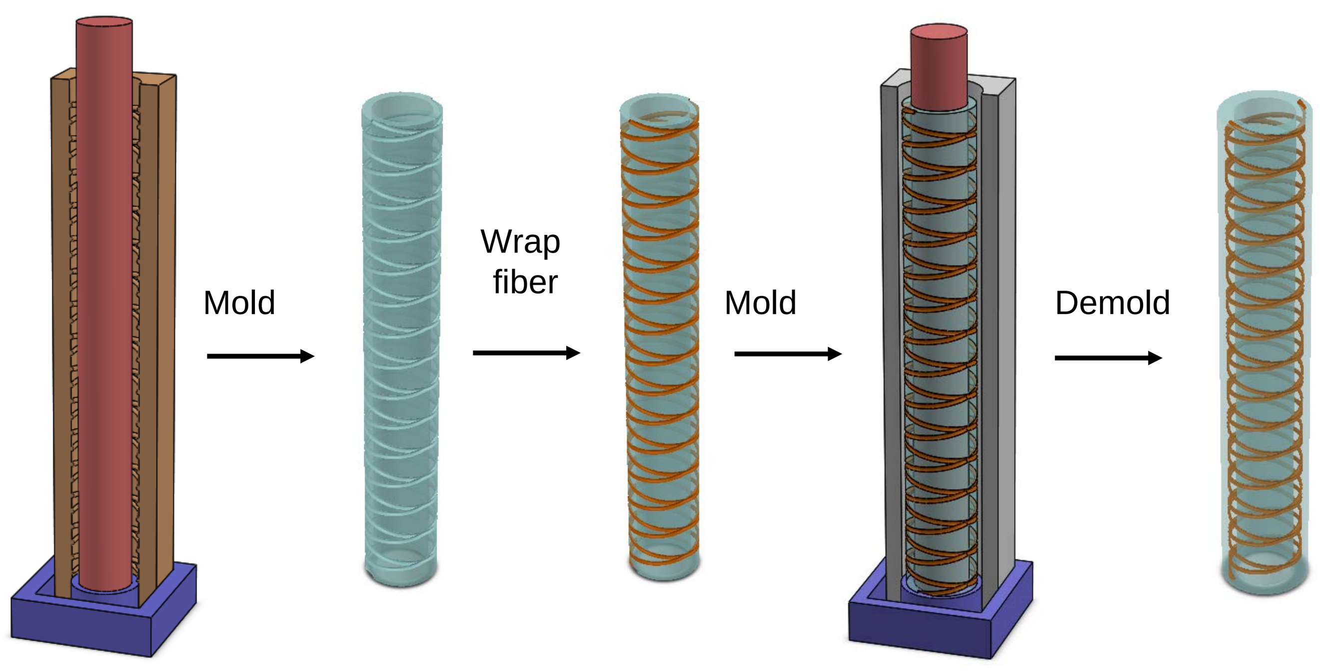
- Grippers are a common application of pneumatic soft robots that have received considerable attention due to their controllable force and minimal risk of causing damage to the target.
- Common functions of the gripper include inward grabbing and outward support by the robotic hand, as well as the extension, retraction, and rotational movement of the robotic arm attached to the gripper, which can all be generated by the McKibben Pneumatic Actuator.
- By assembling the modular McKibben Pneumatic actuators, a multifunctional modular pneumatic gripper can be created. This saves time, materials, and money compared to preparing grippers that can only perform specific tasks.



Example of modular Mckibben pneumatic actuator.
Soft Robotics, 2015, 2(1): 26-32.

Experiment

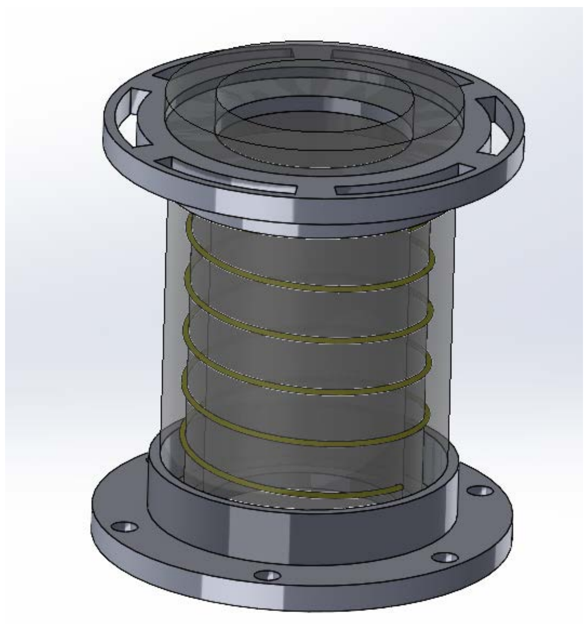
Fabrication of Modular Pneumatic Actuators



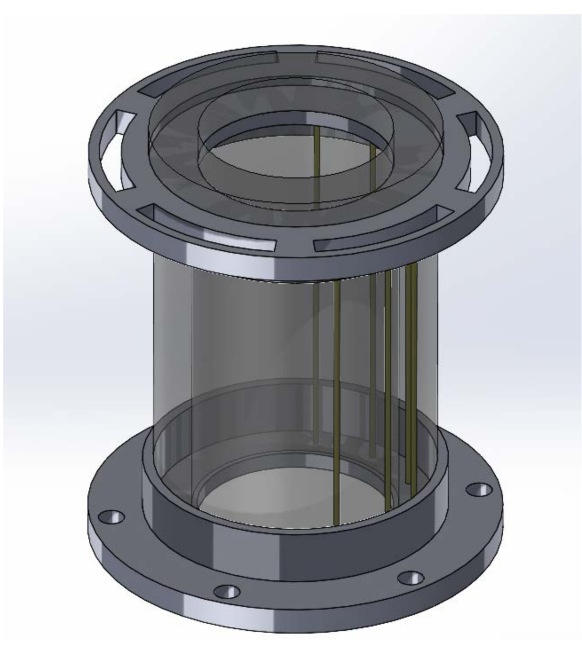
Mold with PDMS. Embed Kevlar fibers to restrict expansion in a specific direction.

Modular McKibben Pneumatic Actuator Units and Assembly

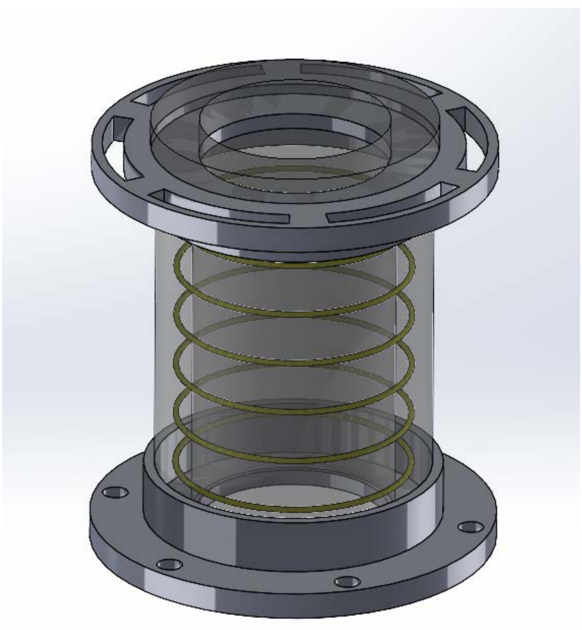
Flange structure ensures air tightness and facilitates connection at any angle



Helix full unit
Enables twisting function



Vertical half unit
Enables bending function



Horizontal full unit
Enables elongation function

Vertical Unit Video Demo

Assemble 3 vertical half units to form a gripper

Actuate with air of 5 psi generated by pump

Grab a smooth-surfaced ping pong ball and lift

Other possible ways to assemble

Outward support of the gripper

Elongation and inward grabbing

Twisting and inward grabbing

References

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Acknowledgements

Thank you to all the researchers at the Architected Materials Lab for their invaluable guidance and to PURM for sponsoring my summer research project. Special thanks goes to my mentor, Yucong Hua, for walking me through every step of the research process while incorporating aspects of my own interests to help challenge my thinking and innovation and craft a personally insightful research experience.

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