Assignment 2: Case Study and Wearable Robot Control System Design

Due Date: Monday, July 13, at 9:30 on Gauchospace

Introduction

In the past week, we have learned sensors, wearables, and materials. During the lab and discussion, we also learned hands-on skills related to computational design and biomimicry. This assignment will bridge the skills and knowledge that we have learned, and ask you to design a wearable robot control system.

Objective

To be able to use the skills and knowledge to carry out a research case study on a soft robotic control system and design a wearable control system.

Assignment

Choose a research project from Appendix I (if you want to work with a project that is not on the list, please confirm with the instructor). Do a case study to understand the system design. Design a wearable control system considering sensors, actuators, and mathematical models, etc.

Format

1. Submit a PDF file of the assignment form on Gauchospace. Name the file "yourname_assignment_2.pdf".
2. Prepare a 3 minutes presentation slides to show your research and the wearable control system. Name the file "yourname_Assignment2_presentation.pdf". Submit a pdf file of the presentation file on Gauchospace. The presentation should be 50% about the case study and 50% about your design.

Assignment II Form (4 pages)

Your Name ____________ Case Study______________

Part I. Case Study

Project Feature

(What is this robot about, its function, what is the sensor/actuator, mechanism, etc.)

_The project feature is the ability for the multi-backbone mechanism is that it has the ability to bend and rotate is every axis which gives it the ability to make certain movements that humans can't make.

Material (What is the material for the robot body)

The backbone is made from two separate segments(backones) where one one of them is functional.

Input / output (What is the control system's input, and what they do)

___The input would be the estimation of the wrench and the friction in the given environment through the use of direct kinematics, Joint-level PID, and the actuation units. The output would be the movements based on the certain wrench and friction estimations. These estimation would affect an array of things such as velocity, speed, and rotation.____

____

____

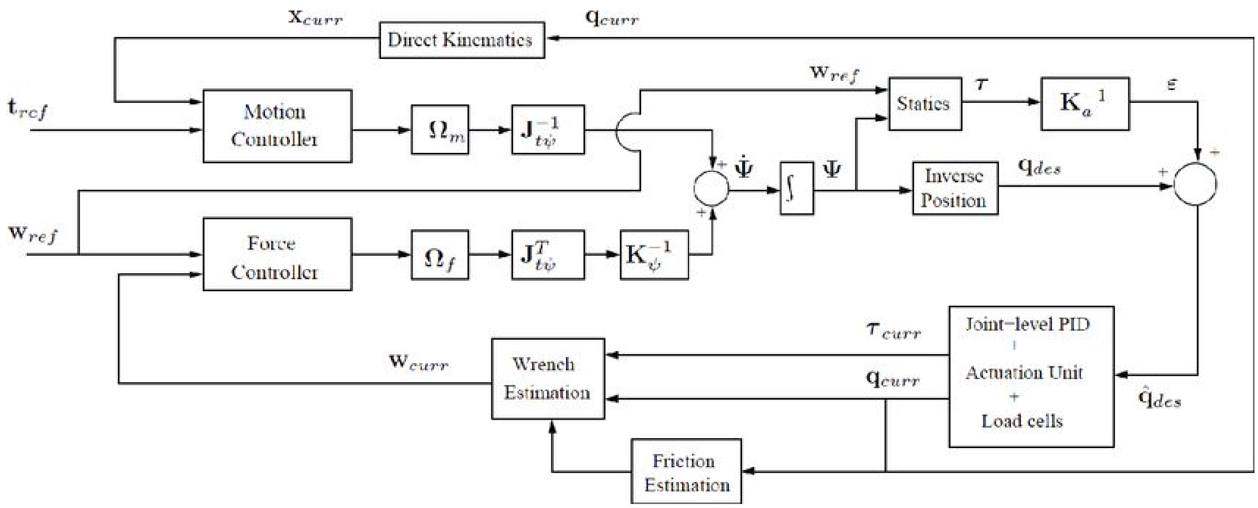
Techniques (model/mathematical function/hardware/algorithm)

There were several mathematical equations which helped them define some relationships between certain factors such as velocity and torque. Additionally, the equations were embedded in C++ code which runs the estimations.

Describe the control system, and how it works

Certain estimations such as wrench and friction are taken into account as the inputs. Additionally, forms of reflective sensors are used to get a general idea of the robot's surroundings. Based on these readings, certain movements and rotations are made in order to carry out the specific goal.

Draw a block diagram of the control system



Part II. Design a Wearable Robot Control System

Function (What does this robot do)

This robot will be a kneepad used in the sport of football to protect one's knee from a potential damaging collision which can cause life-long problems.

Material (what is this robot made of)

The knee pad is made from mostly polyester and the inflatable pad is made from nylon. Inflatable pad is somewhat similar to a car airbag as it inflates in the result of a chemical reaction.

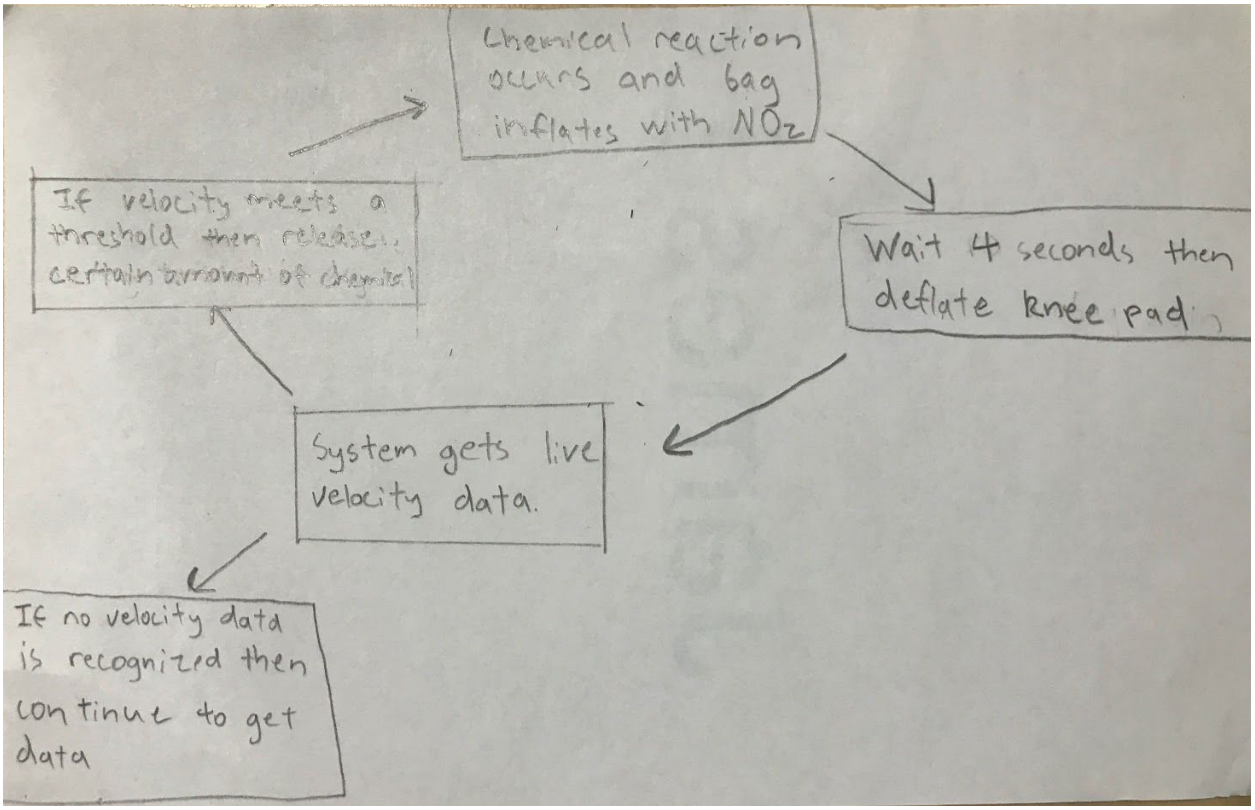
System Input/ Output (what are the sensors and actuators)

There is a radar gun near the waist which will give live data and detect the velocity of incoming players. Depending on how fast the incoming player is moving it will inflate the kneepad to a certain degree.

Describe the control system, and how it works

The radar sensor gives live velocity data to the cloud where the program is connected. If the velocity readings meet a threshold then a certain amount of sodium azide will be released which will result in nitrogen gas therefore inflating the bag. After 4 seconds(because the average NFL play is 4 seconds) the bag will deflate and will go back to getting live data.

Draw a block diagram of the control system



Optional: Part III. Simulation your design in Rhino

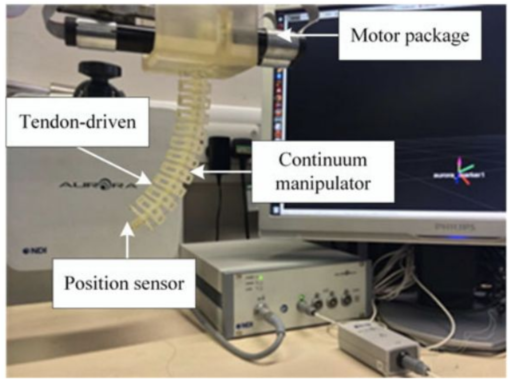
(Extra credit) 5% of the overall course

Based on your control system design, digitally design a wearable device or part of it to simulate its movement or functional performance.

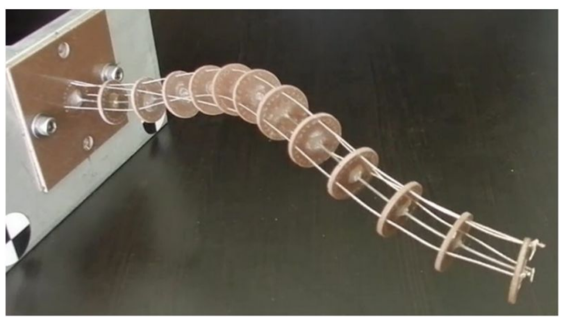
Submit a 10-15 section screen recording of the simulation along with the digital files (.3dm and .gh) on the Gauchospace.

Appendix I.

1. Peng Qi, etc. Kinematic Control of Continuum Manipulators Using a Fuzzy-Model-Based Approach

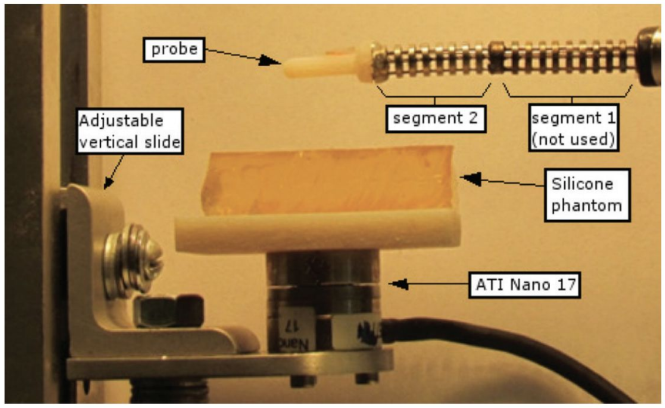


2. John Till , Vincent Aloi and Caleb Rucker. Real-time dynamics of soft and continuum robots based on Cosserat rod models

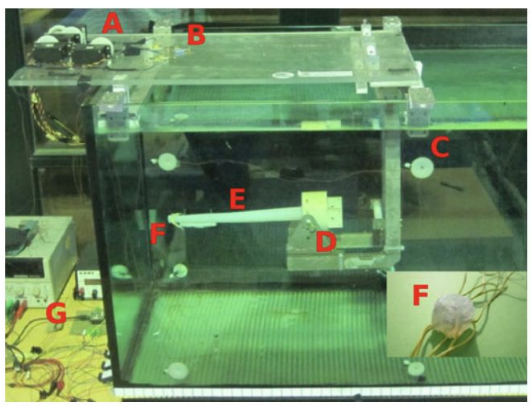


3. Frederick Largilliere, Real-time Control of Soft-Robots using Asynchronous Finite Element Modeling

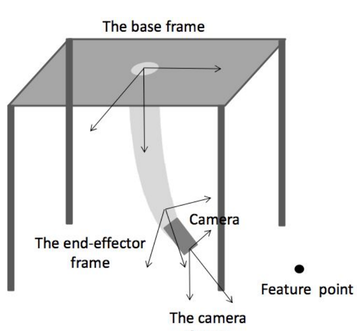
4. Bajo A, Simaan N. Hybrid motion/force control of multi-backbone continuum robots.

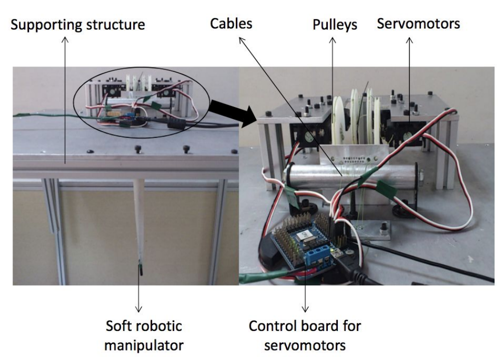


5. Giorelli M. etc. Neural Network and Jacobian Method for Solving the Inverse Statics of a Cable-Driven Soft Arm With Nonconstant Curvature.

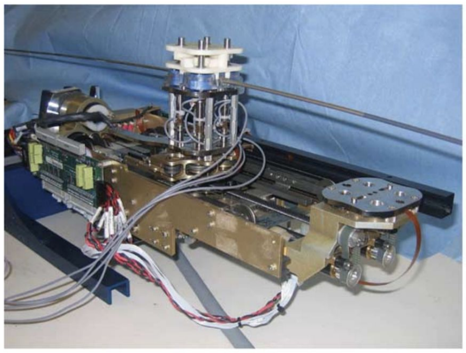
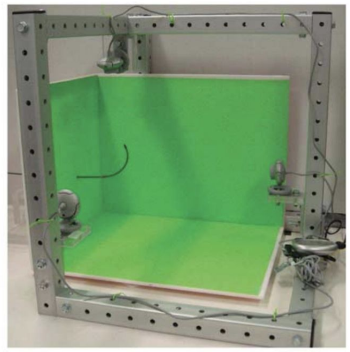


6. Wang, et all. Dynamic Modeling and Image-based Adaptive Visual Servoing of Cable-driven Soft Robotic Manipulator

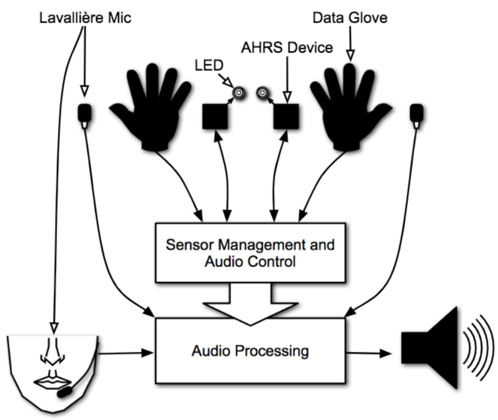




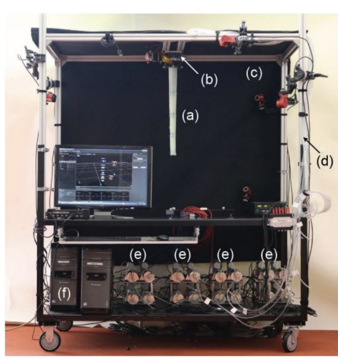
7. Configuration tracking for continuum manipulators with coupled tendon drive

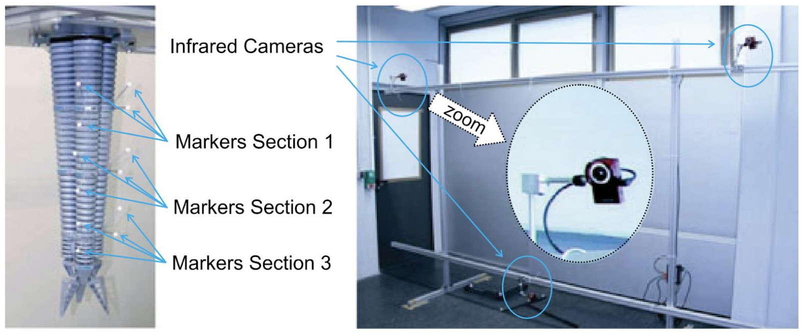
8. Imogen Heap. Musical Interaction with Hand Posture and Orientation: A Toolbox of Gestural Control Mechanisms



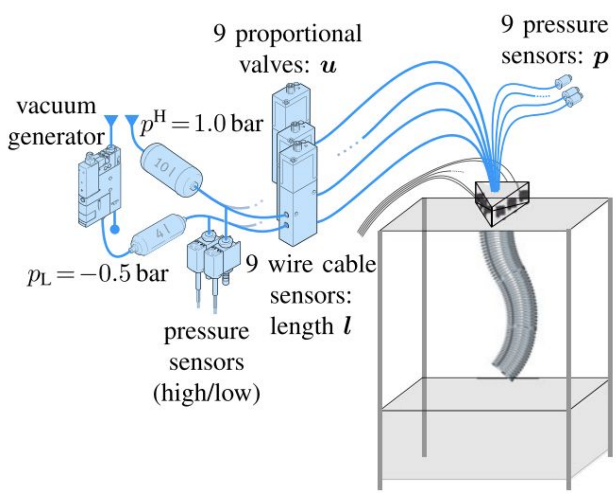
9. Marchese A . Design, kinematics, and control of a soft spatial fluidic elastomer manipulator



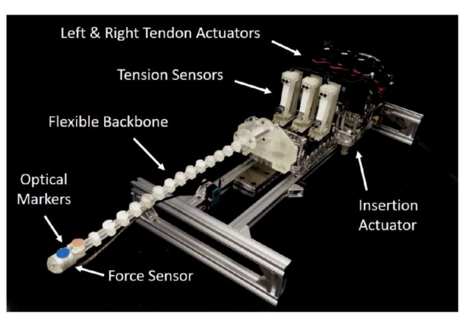
10. Mahl, T. A variable curvature continuum kinematics for kinematic control of the bionic handling assistant.



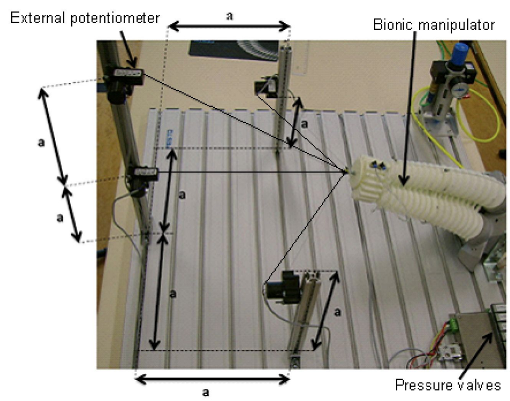
11. Falkenhahn. Dynamic Control of the Bionic Handling Assistant



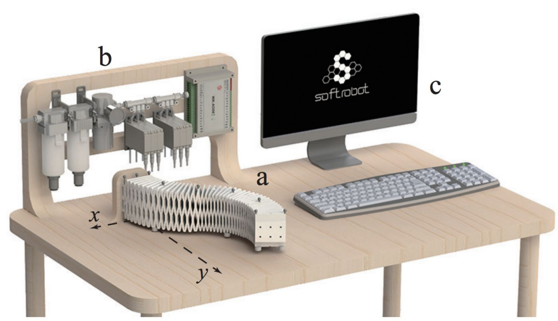
12. Yip. Model-less hybrid position/force control



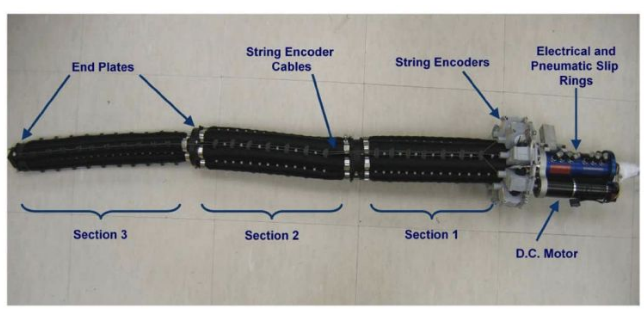
13. MELINGUI. Qualitative approach for inverse kinematic modeling of a Compact Bionic Handling Assistant trunk



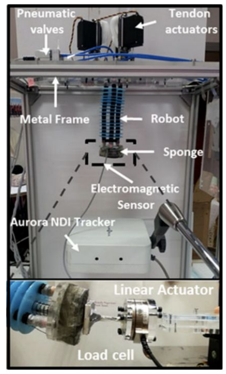
14. Hao Jiang. A two-level approach for solving the inverse kinematics of an extensible soft arm considering viscoelastic behavior.



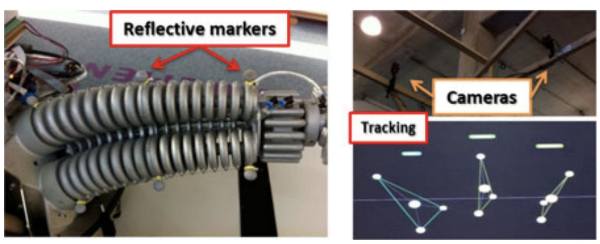
15. David Braganza. A neural network controller for continuum robots



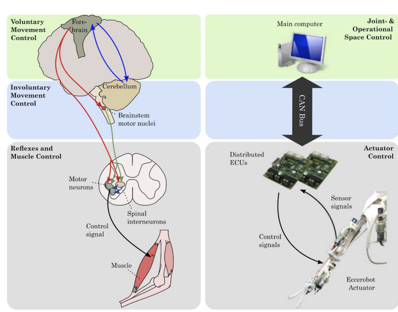
16. Ansari, Y. Multiobjective optimization for stiffness and position con- trol in a soft robot arm module



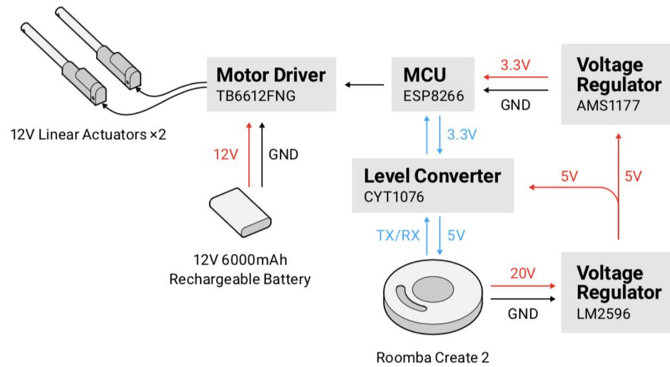
17. Othman Lakhal. Hybrid approach for modeling and solving of kinematics of a compact bionic handling assistant manipulator



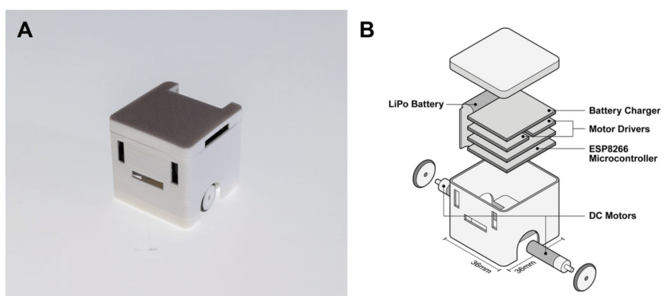
18. Steffen Wittmeier. Toward Anthropomimetic Robotics: Development, Simulation, and Control of a Musculoskeletal Torso



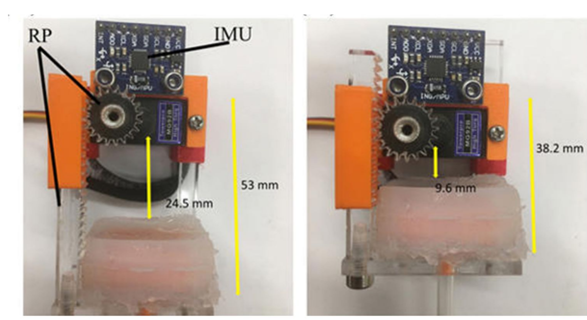
19. RoomShift: Room-scale Dynamic Haptics for VR with Furniture-moving Swarm Robots



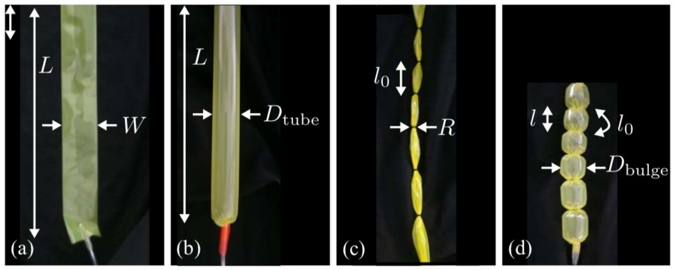
20. Ryo Suzuki. ShapeBots: Shape-changing Swarm Robots



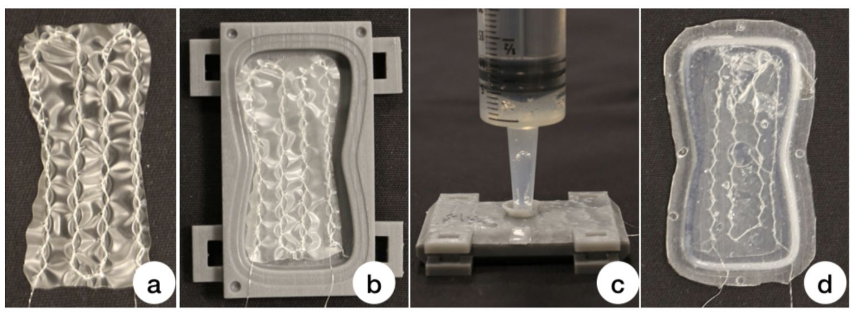
21. Antonia Tzemanaki. Design of a Wearable Fingertip haptic Device for remote Palpation: characterisation and interface with a Virtual environment



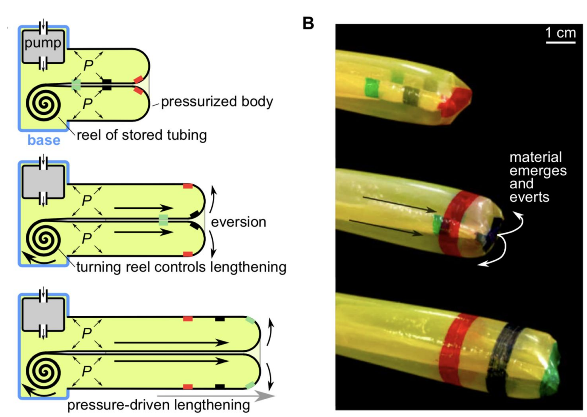
22. Joseph D. Greer. Series Pneumatic Artificial Muscles (sPAMs) and Application to a Soft Continuum Robot



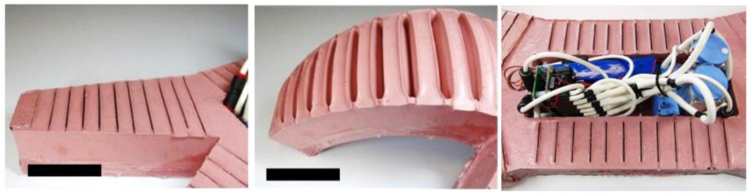
23. Cindy Kao. SkinMorph: Texture-Tunable On-Skin Interface Through Thin, Programmable Gel



24. Elliot W. Hawkes. A soft robot that navigates its environment through growth



25. Tolley, A Resilient, Untethered Soft Robot



26. ambienBeat, Kyung Yun Choi