WPI

Survey on Soft Gripper and Manipulator

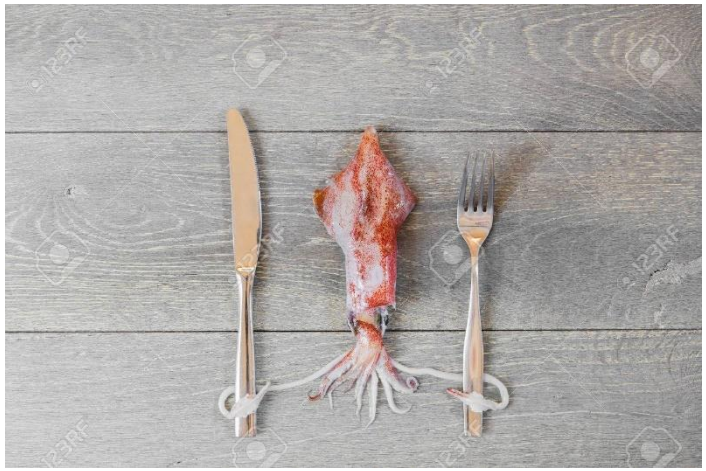
For RBE 595 Soft Robotics Spring 2018

By Rishi Khajuriwala

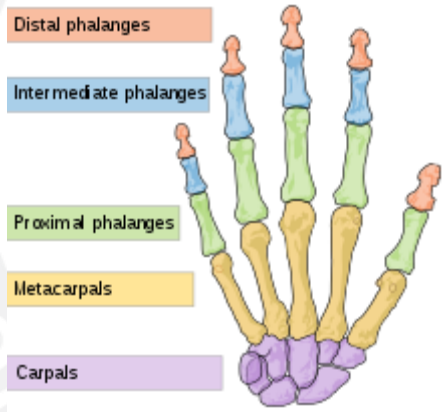
Motivation

- Adaptivity
- Lower Cost
- Complex grasping
- Rise of Service Robots
- Combining Soft robotics with Conventional Robotic designs

Inspiration

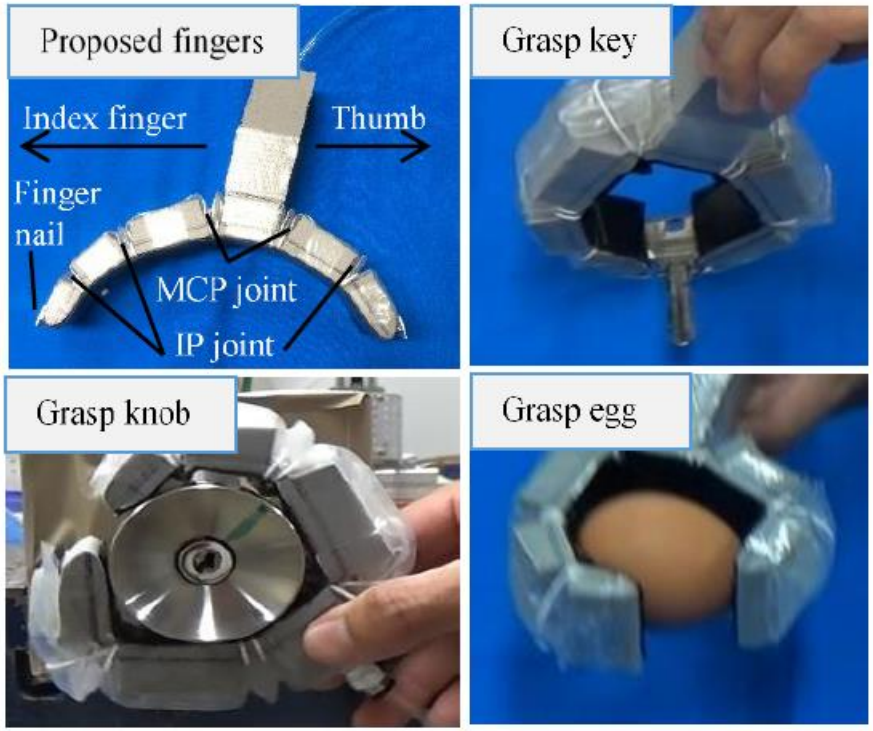


Inspirations[12]

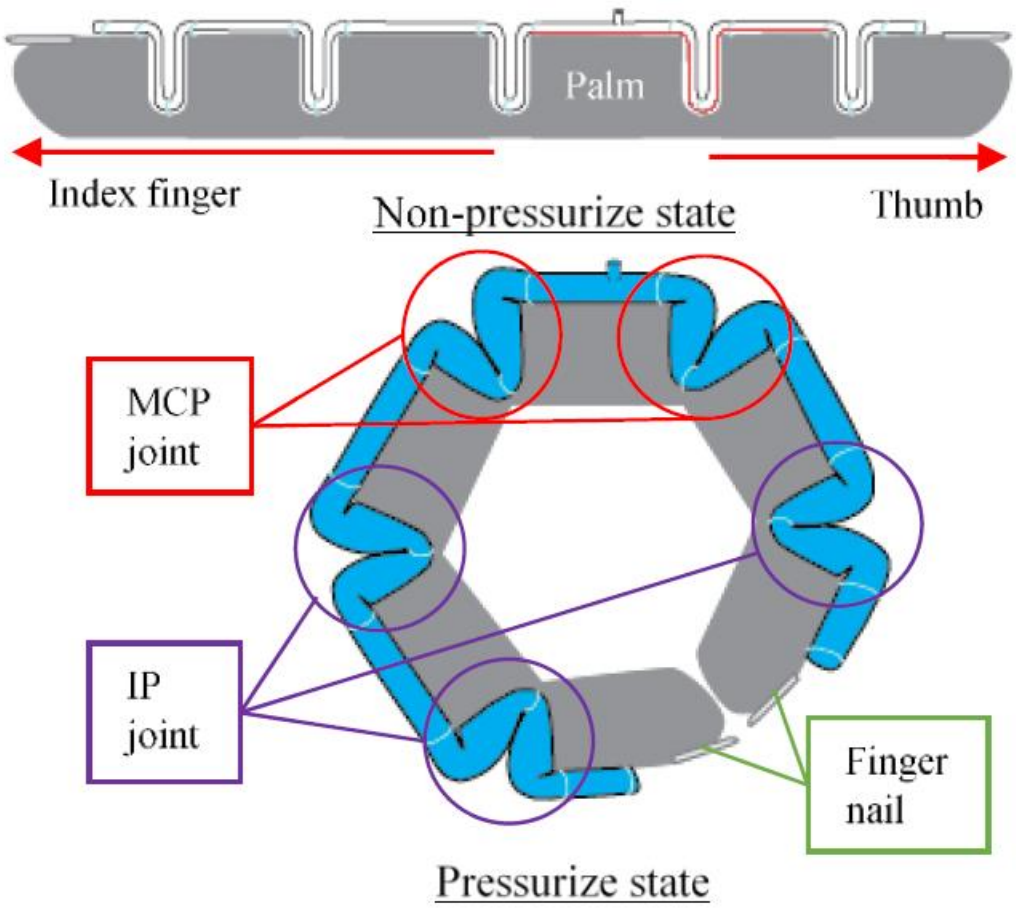


Literature Review

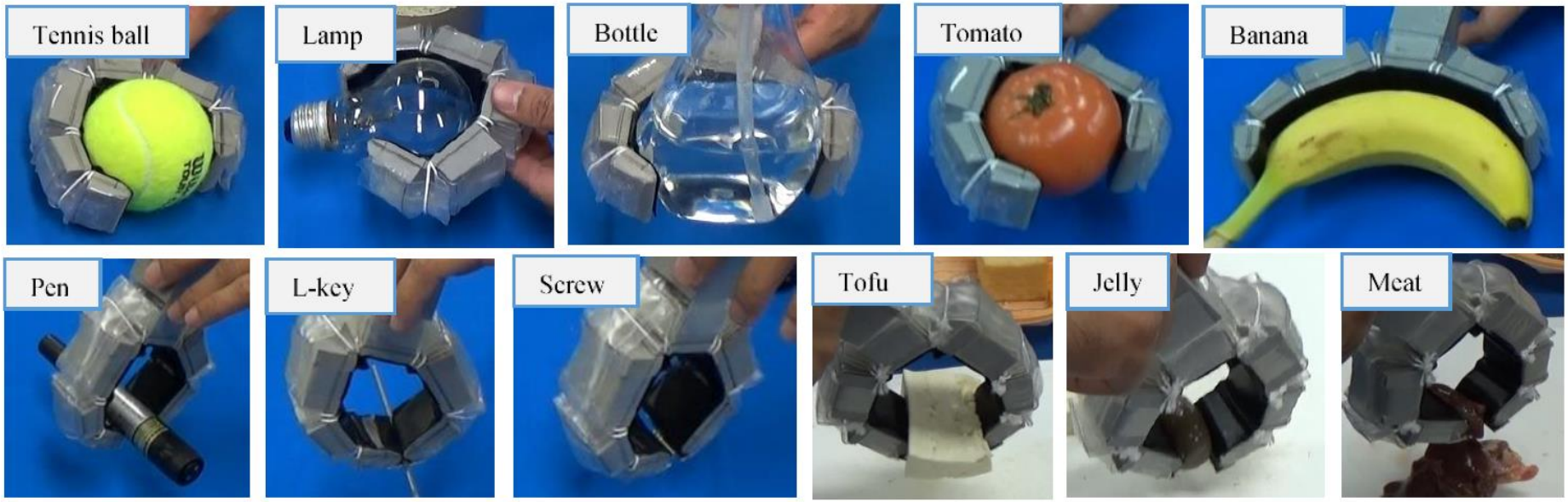
- Lightweight Underactuated Pneumatic Fingers[1]



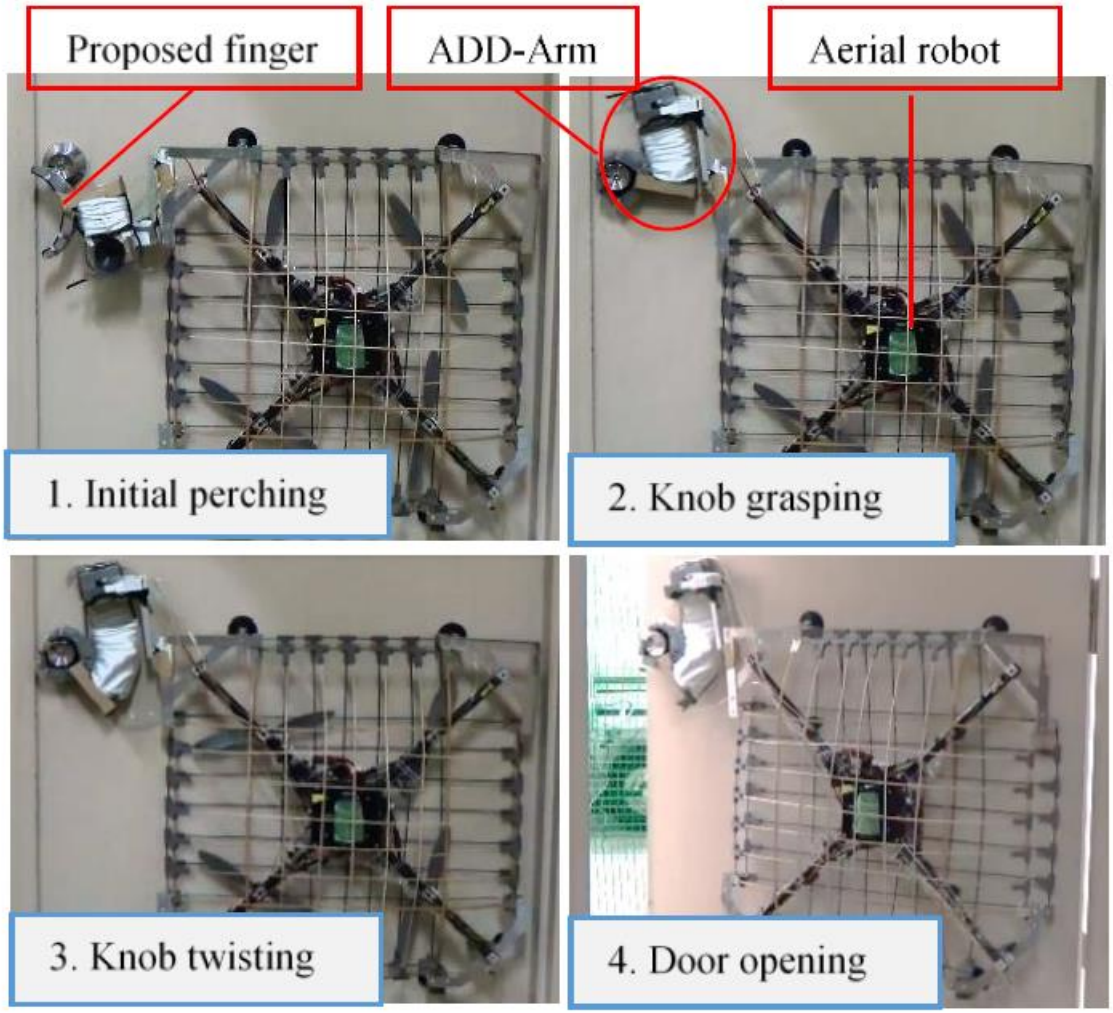
Design:


Palm
Index finger
Thumb
Non-pressurize state
MCP joint
IP joint
Finger nail
Pressurize state

Experiments

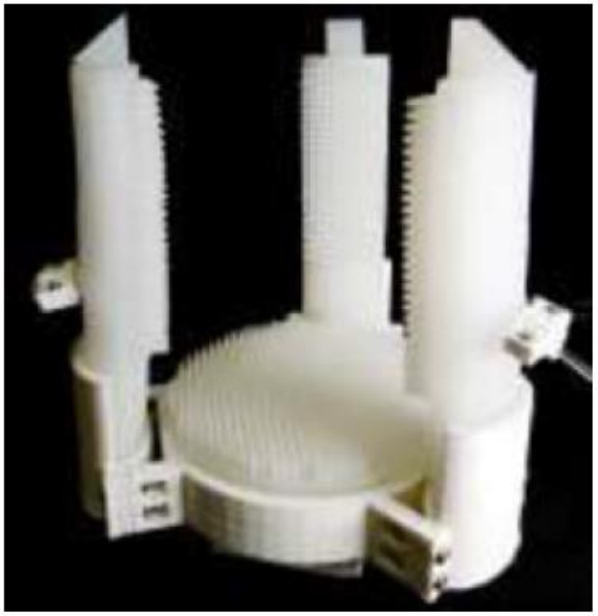


Application

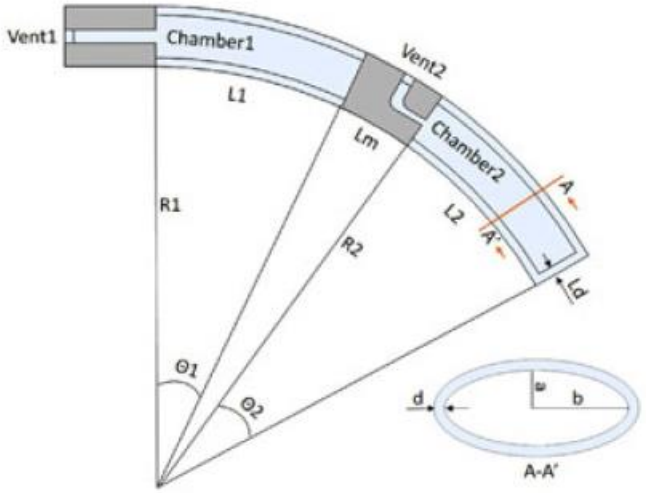


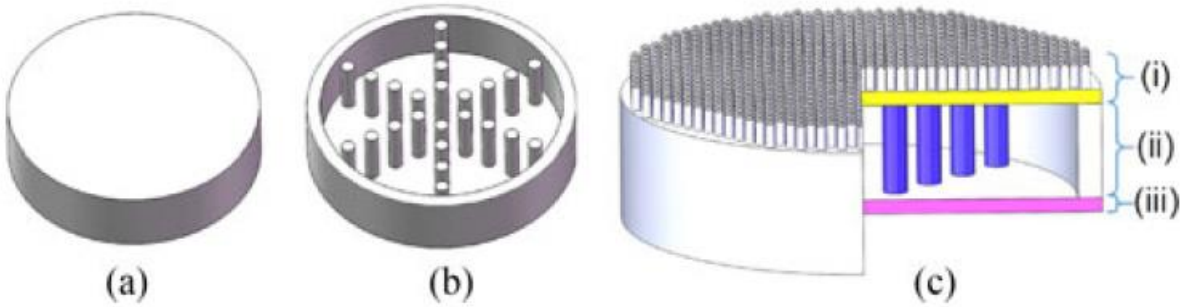
Literature Review

A Soft-Robotic Gripper With Enhanced Object Adaptation and Grasping Reliability[2]

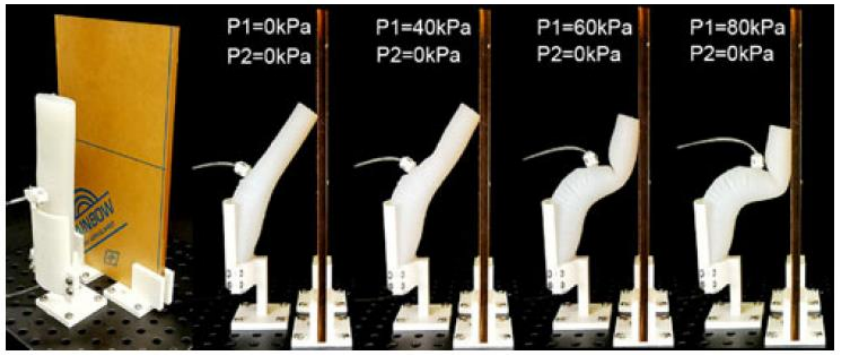


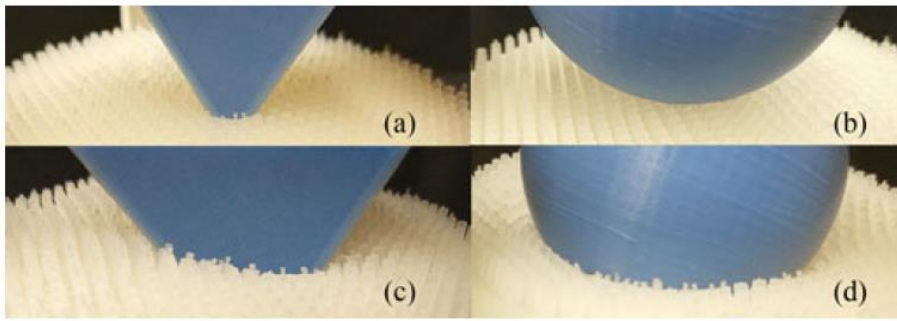
Design


Vent1
Chamber1
Vent2
L1
Lm
Chamber2
R1
R2
L2
A
A'
Ld
Θ1
Θ2
d
w
b
A-A'

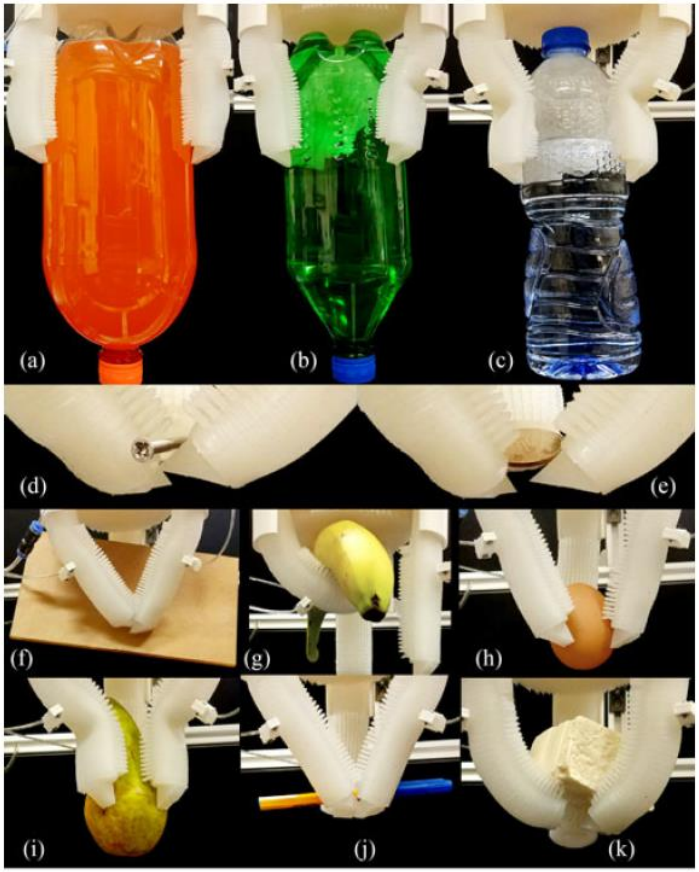

(i)
(ii)
(iii)
(a)
(b)
(c)

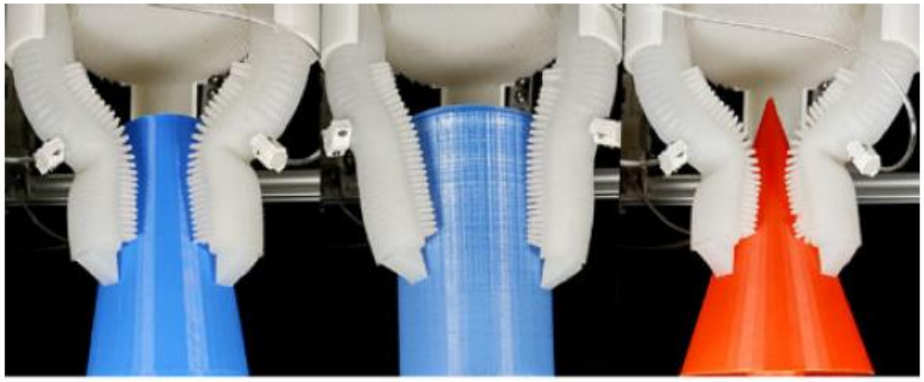
Experiments





Experiments

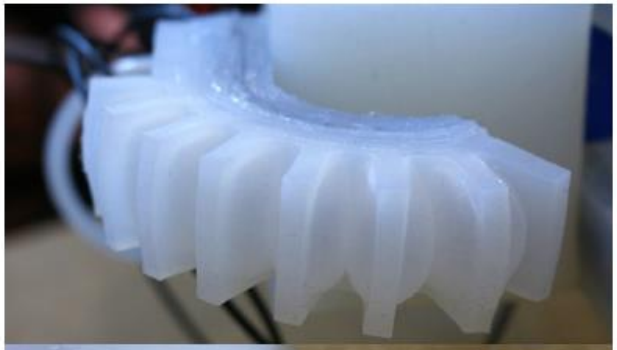
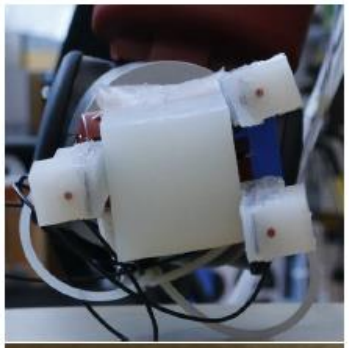


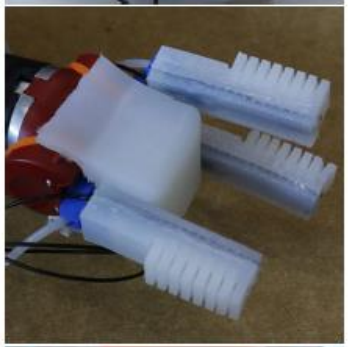
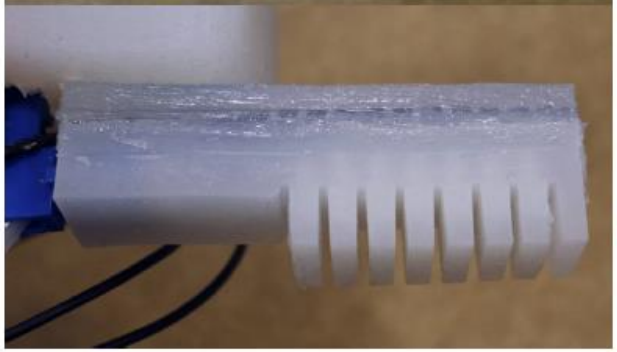
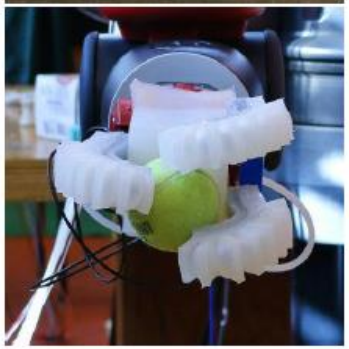
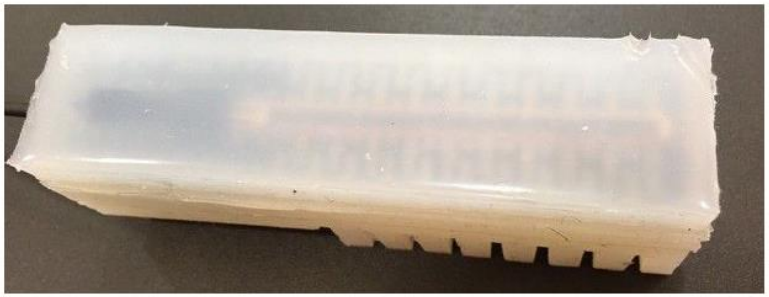
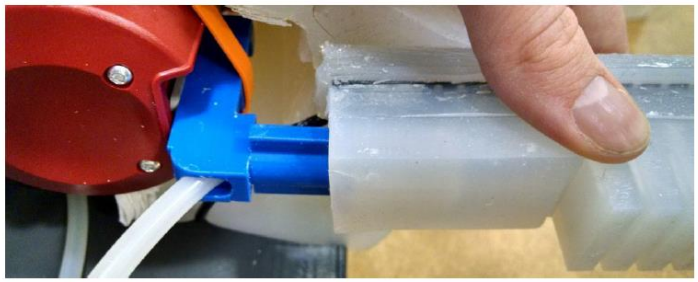


Literature Review

- Haptic Identification of Objects using a Modular Soft Robotic Gripper[3]

Design

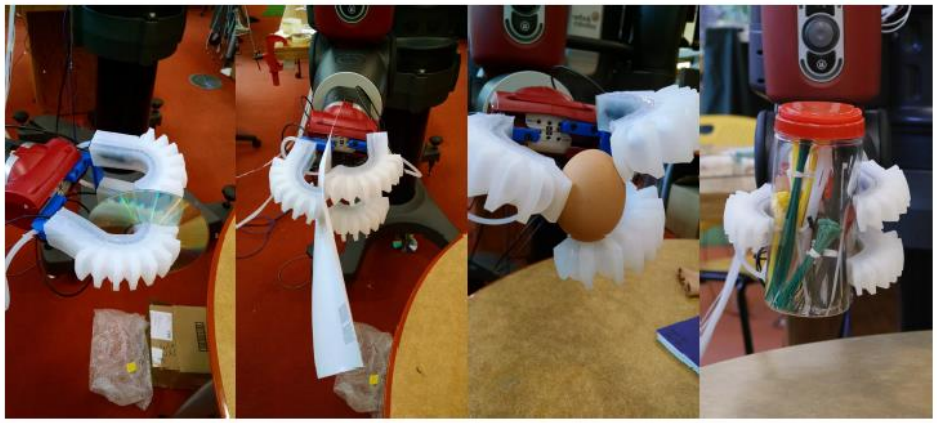



Haptic Object Identification

Import previously recorded grasp data, 10 data points per item
for *all objects to be grasped* **do**
    Grasp item.
    Record sensor values.
    Calculate Euclidean distances to all recorded points
    Find the 5 nearest neighbors.
    Output the identity of the object-based voting from the 5 nearest neighbors.
end

Experiments



(a) CD (b) paper (c) egg (d) container

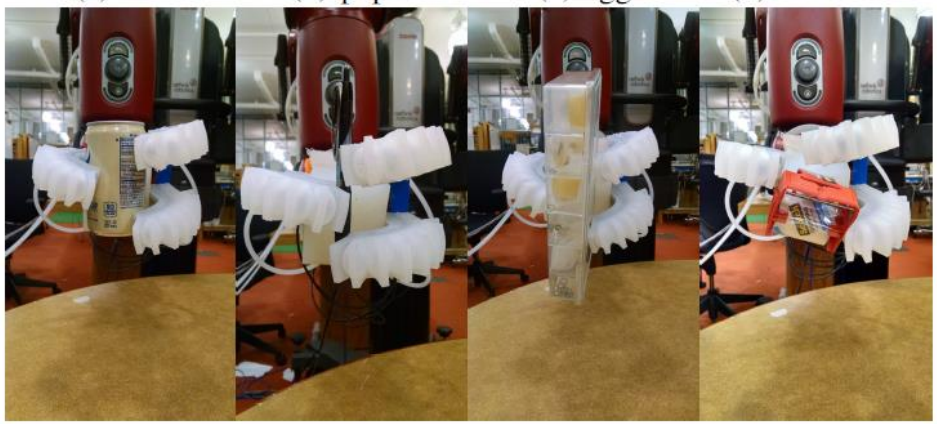
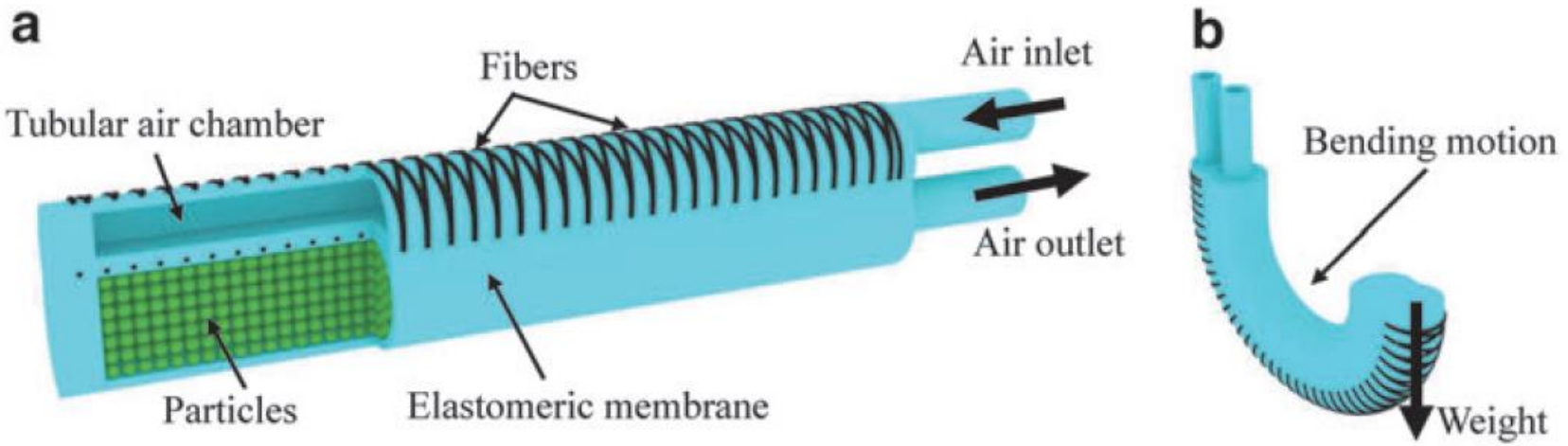


Fig. 11: All of the objects grasped by the soft gripper.

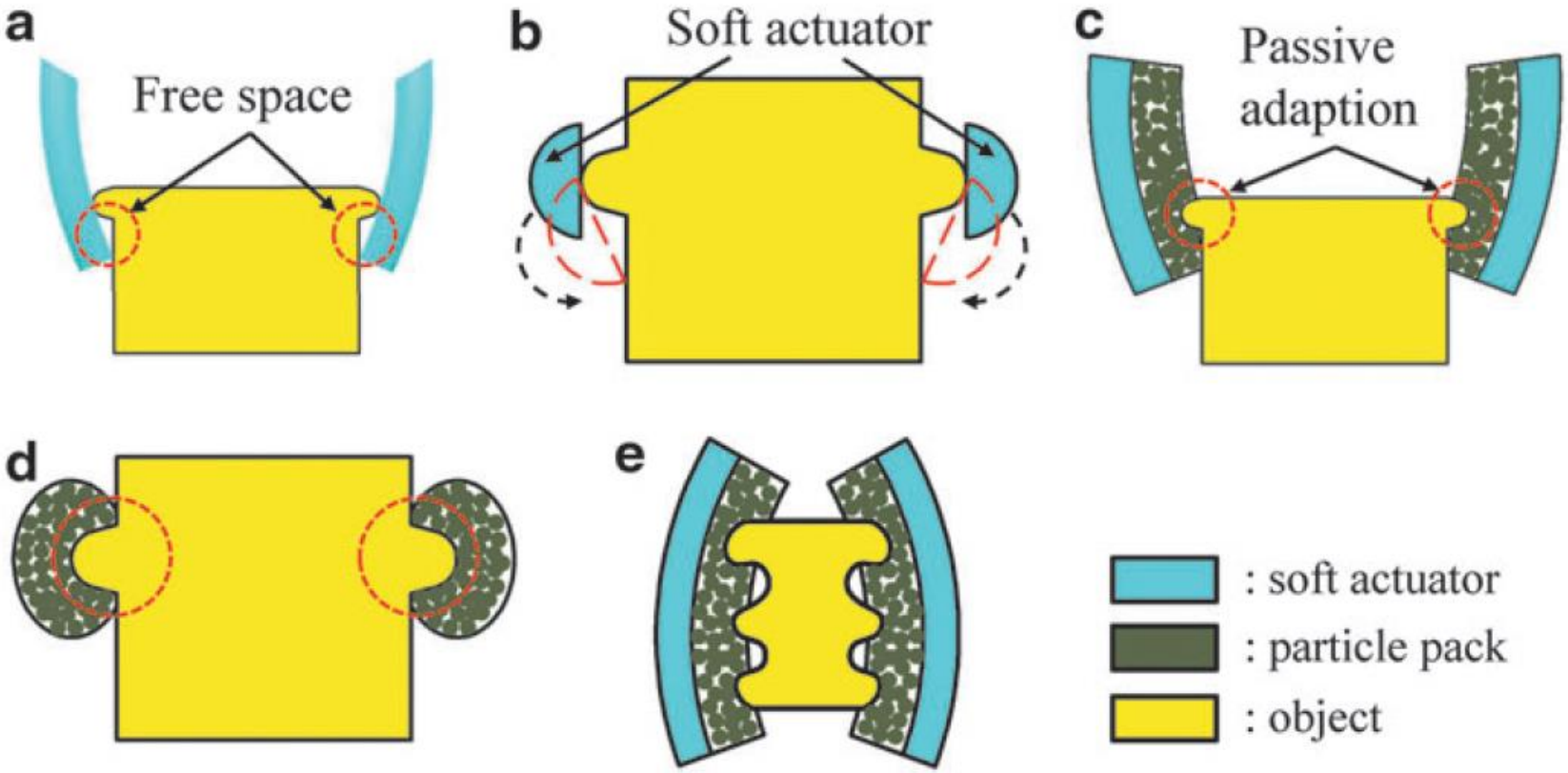
Literature Review

A Novel, Variable Stiffness Robotic Gripper Based on Integrated Soft Actuating and Particle Jamming [4]

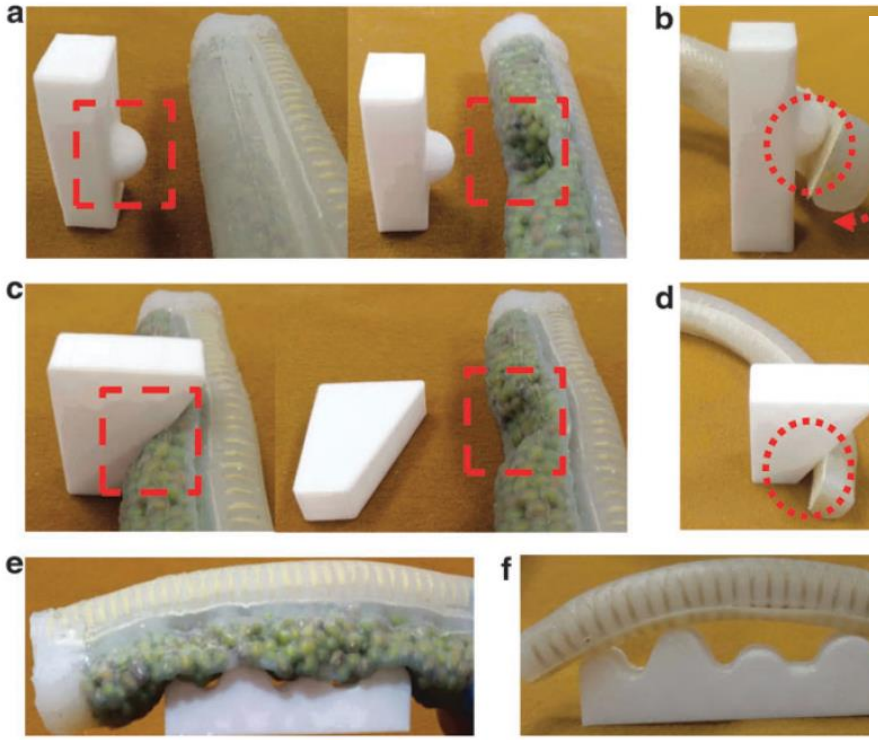
Design

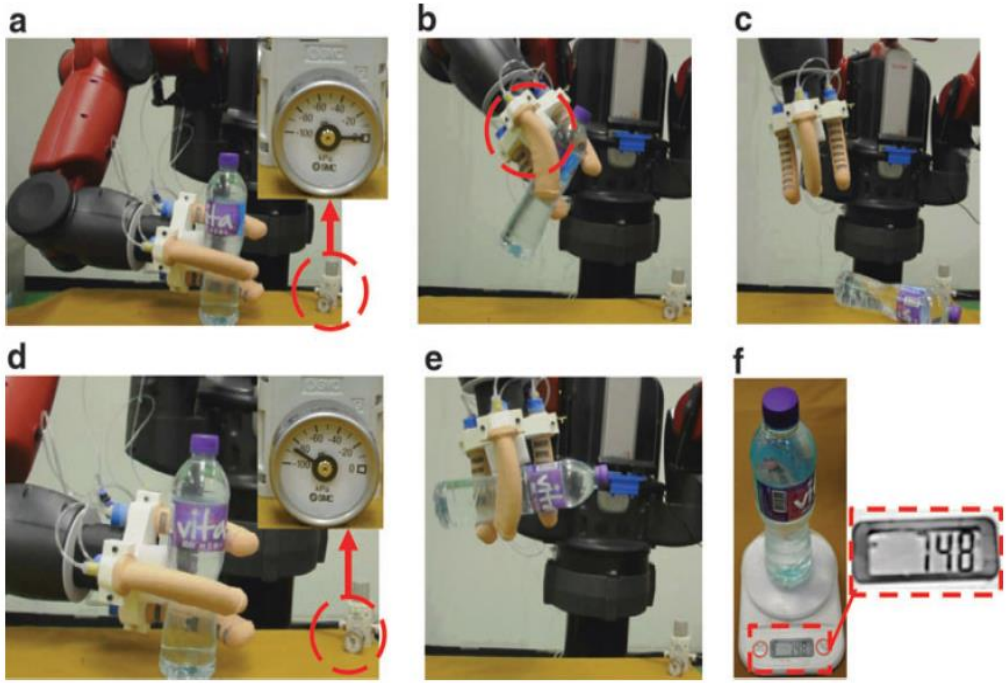

a
Fibers
Air inlet
Tubular air chamber
Air outlet
Particles
Elastomeric membrane
b
Bending motion
Weight

Particle Jamming



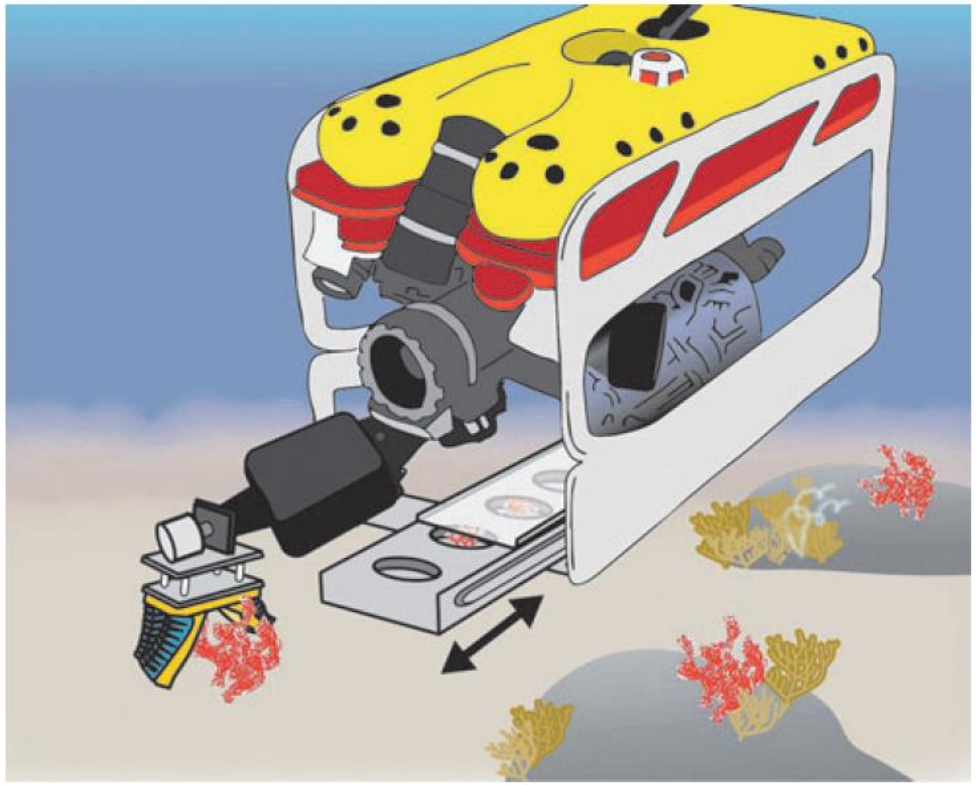
Experiments



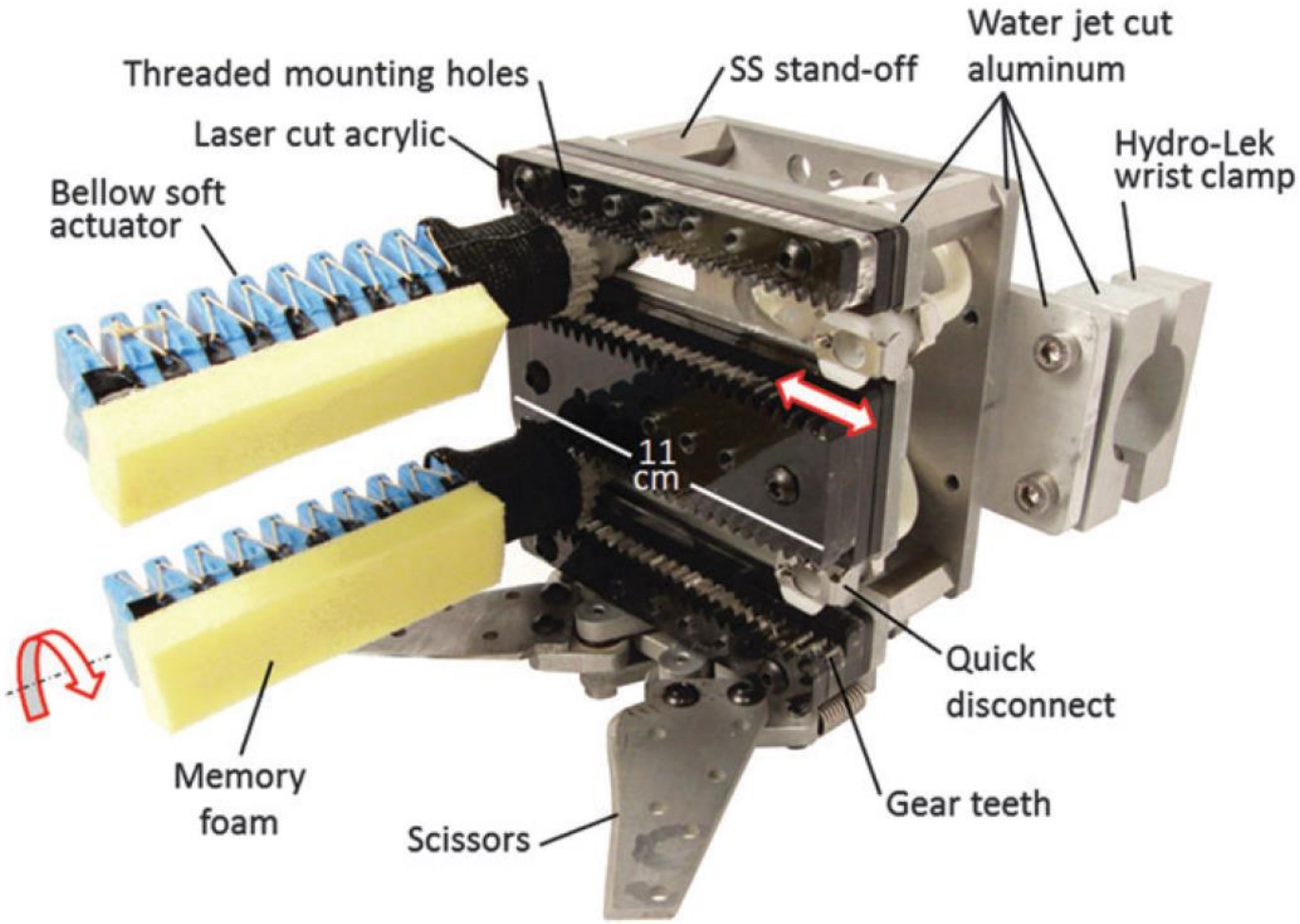


Literature review

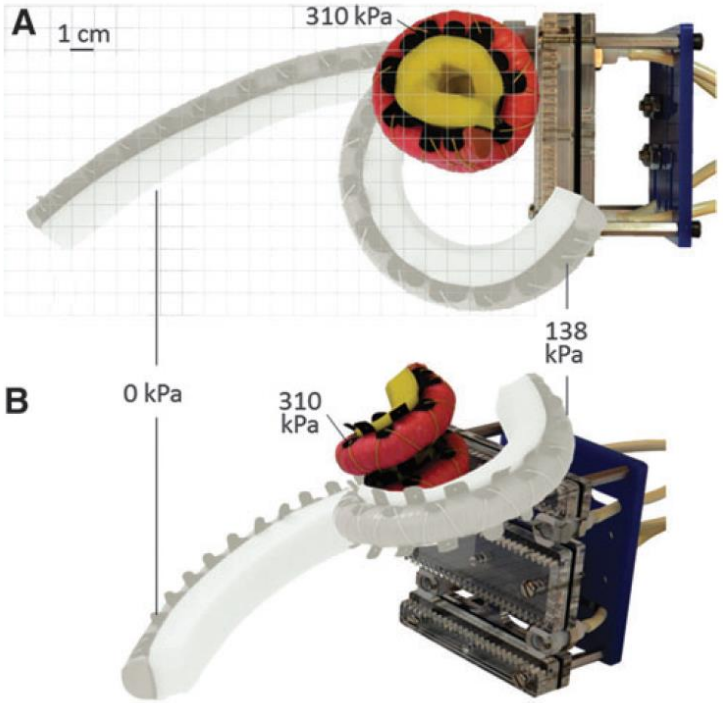
Soft Robotic Grippers for Biological Sampling on Deep Reefs [5]

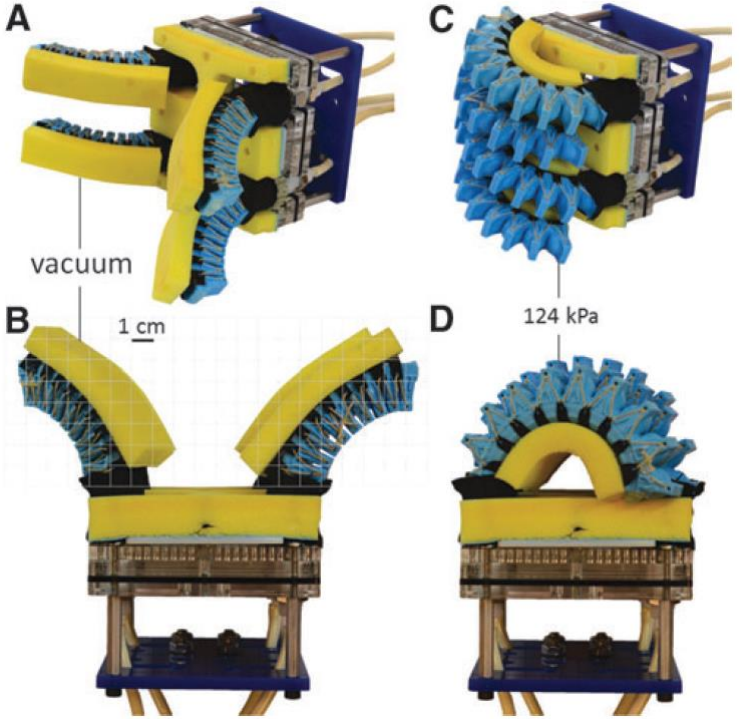


Design

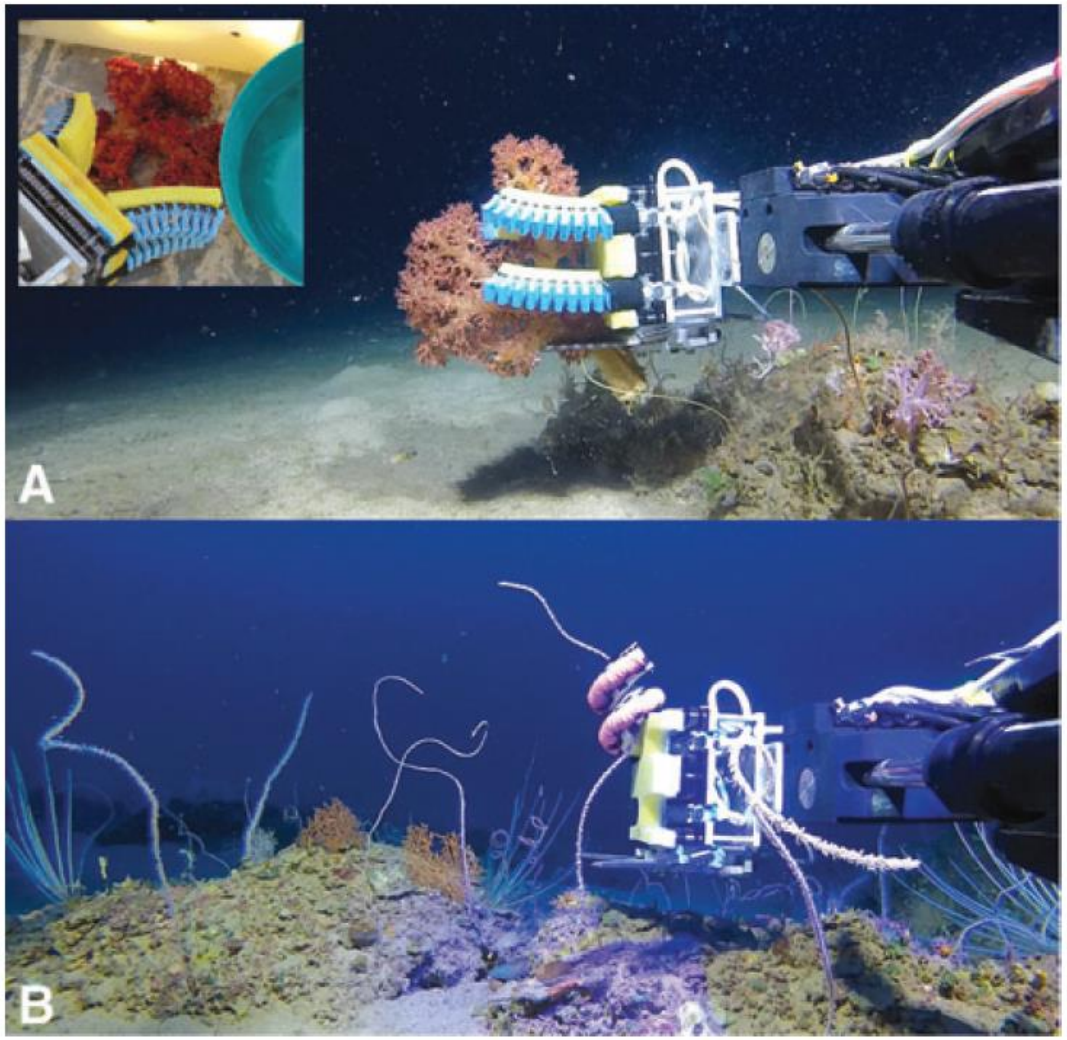

Threaded mounting holes
Laser cut acrylic
Bellow soft actuator
SS stand-off
Water jet cut aluminum
Hydro-Lek wrist clamp
11 cm
Quick disconnect
Gear teeth
Memory foam
Scissors

Actuators



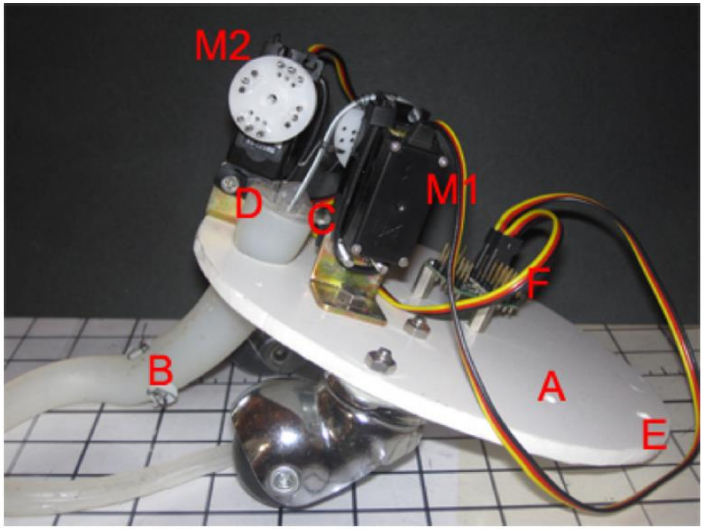


Experiment

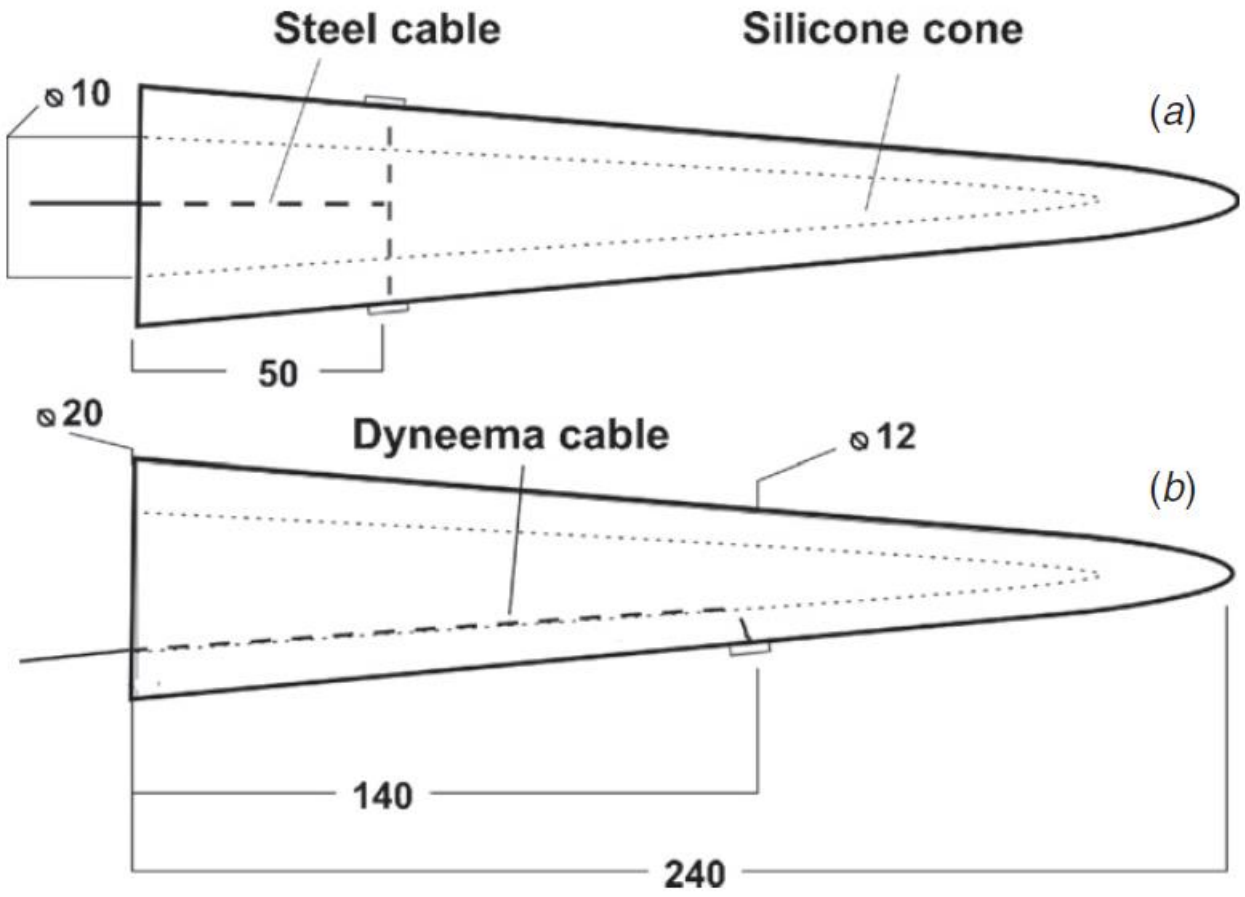


Literature Review

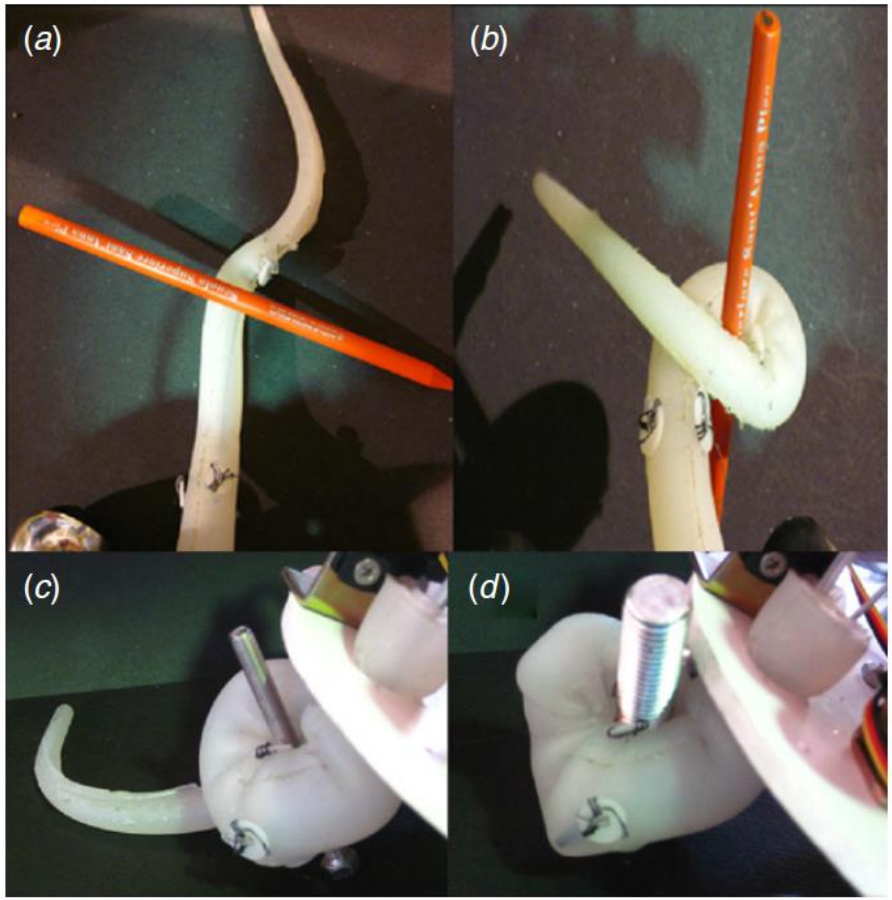
An octopus-bioinspired solution to movement and manipulation for soft robots [6]



Design

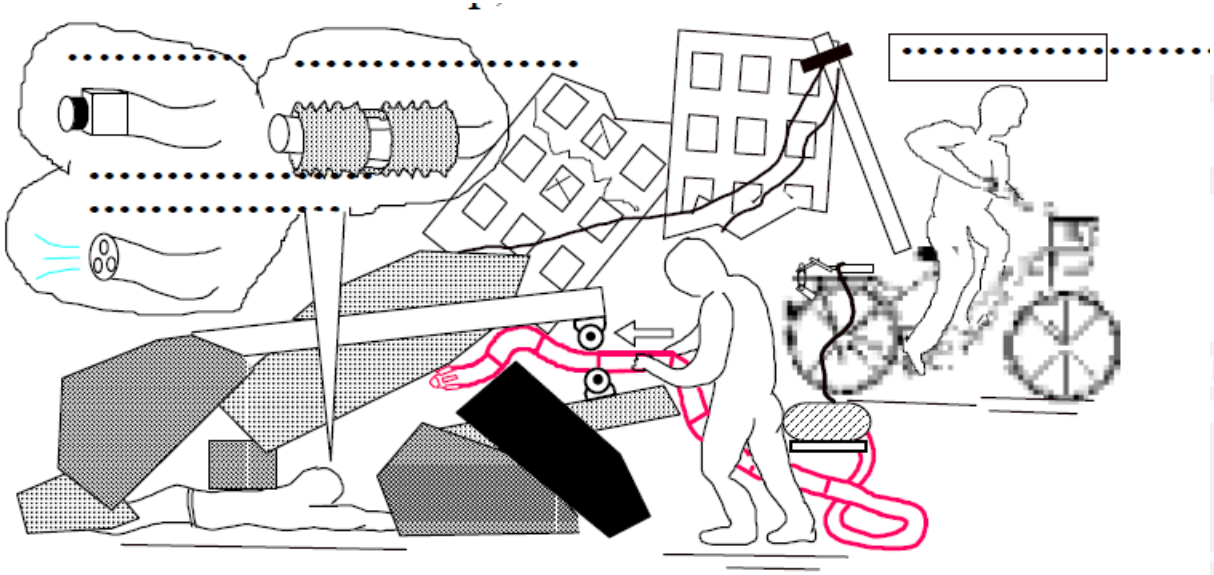

Steel cable
Silicone cone
⌀10
(a)
50
⌀20
Dyneema cable
⌀12
(b)
140
240

Grasping

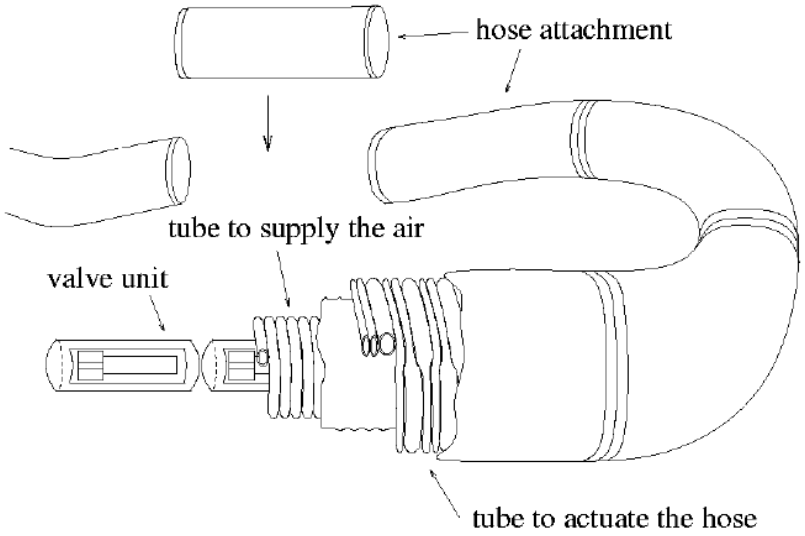


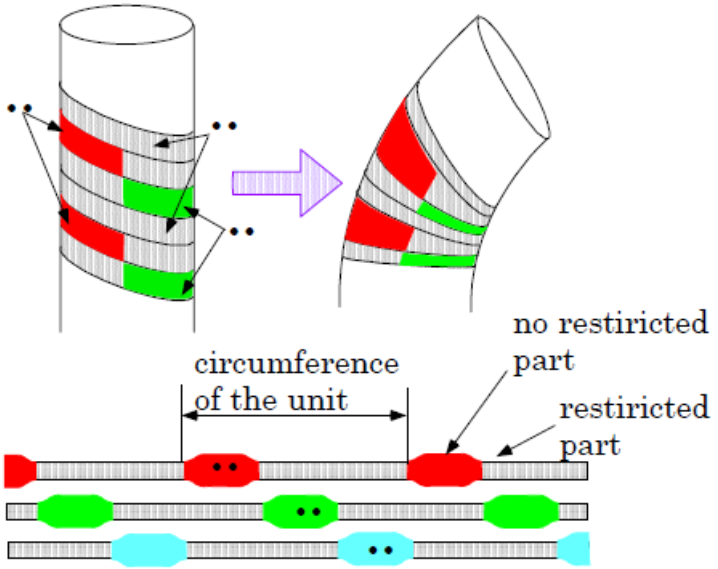
Literature Review

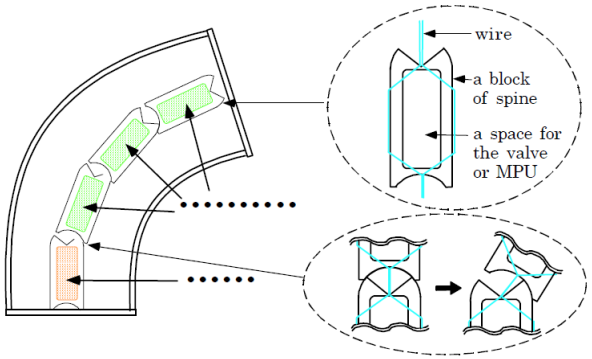
Active Hose: an Artificial Elephant's Nose with Maneuverability for Rescue Operation [7]

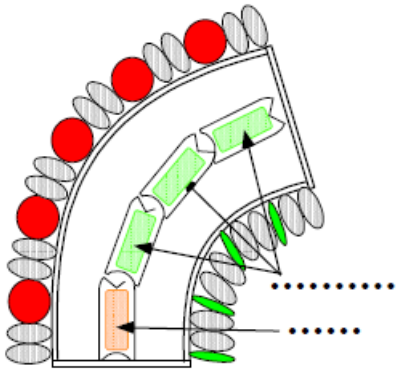


Design

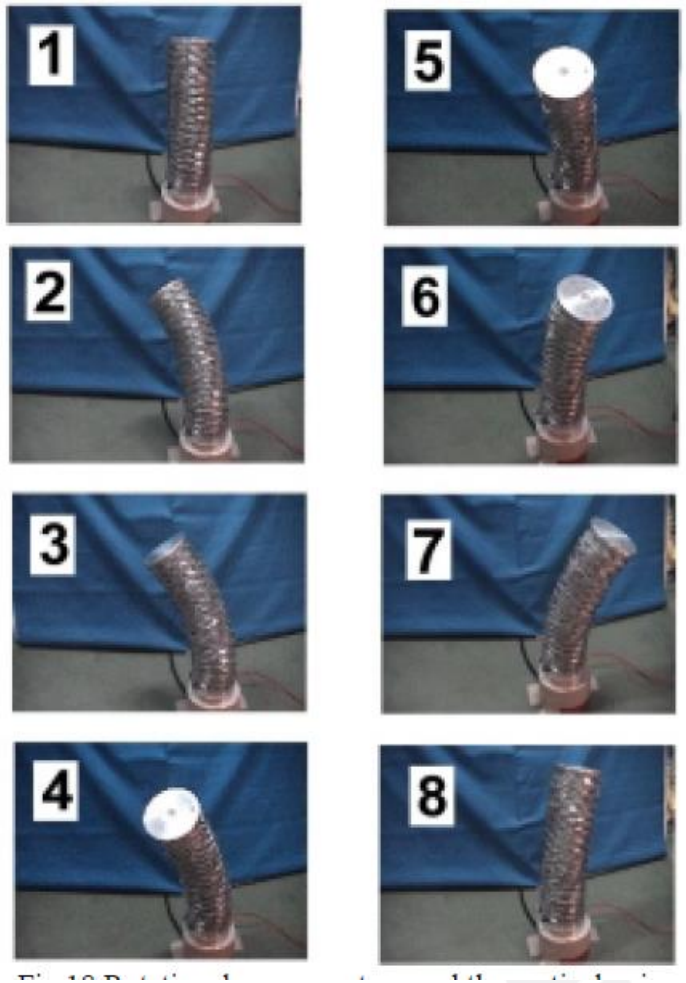

hose attachment
tube to supply the air
valve unit
tube to actuate the hose


no restiricted part
circumference of the unit
restiricted part


wire
a block of spine
a space for the valve or MPU

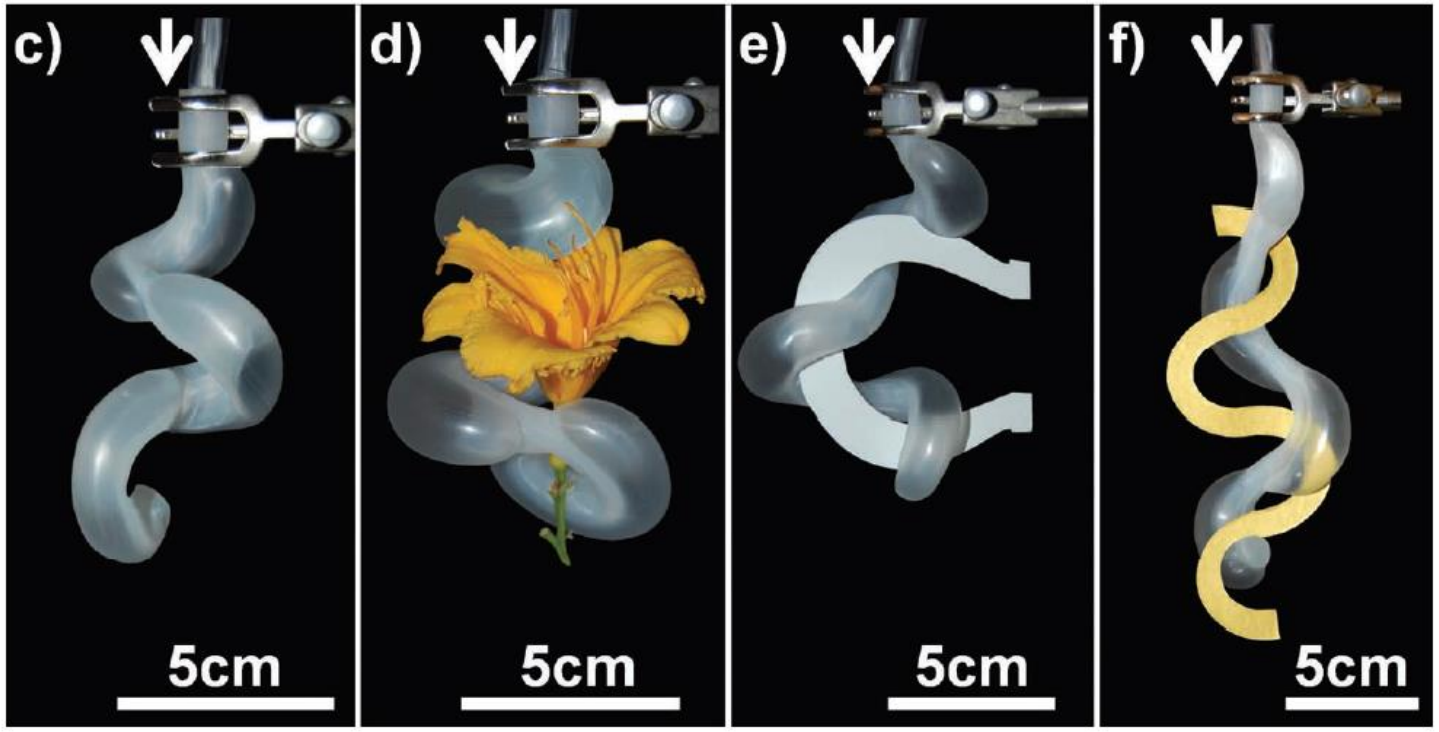


Performance

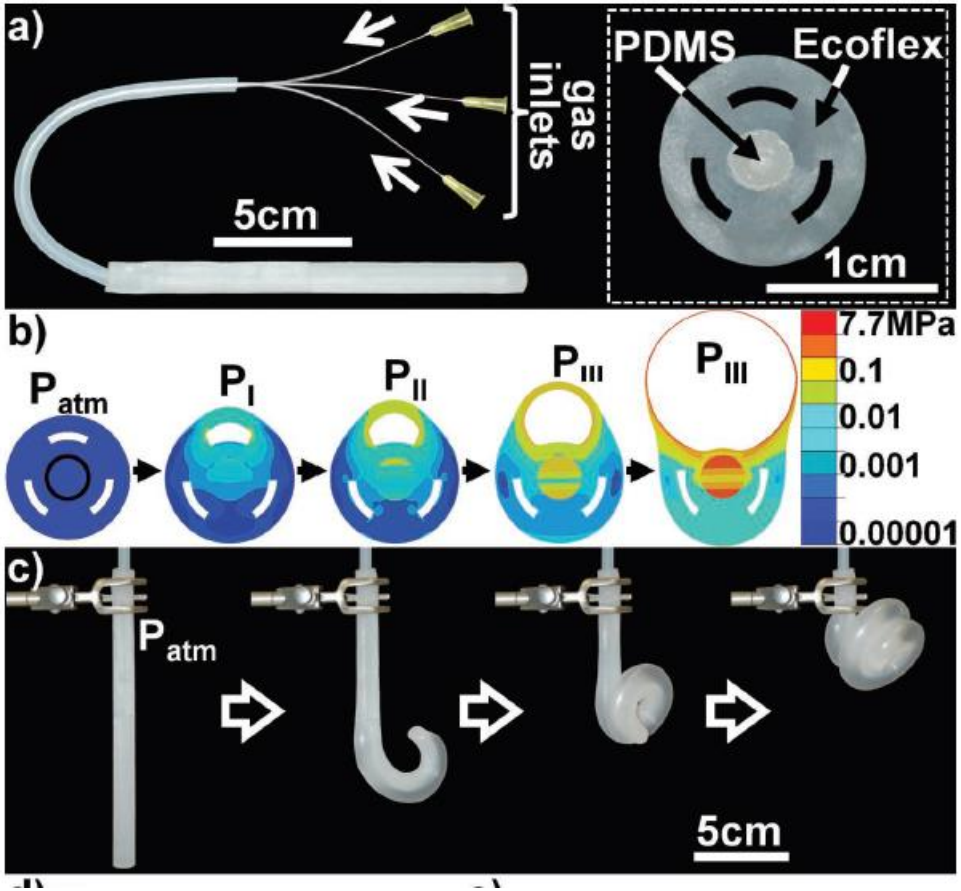


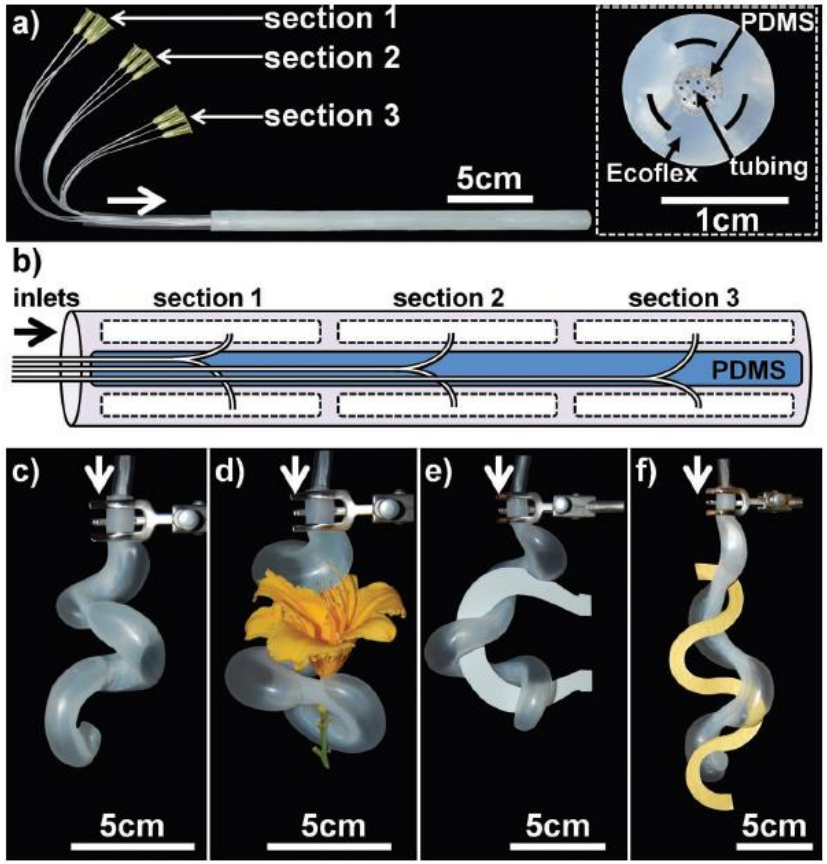
Literature Review

Robotic Tentacles with Three-Dimensional Mobility Based on Flexible Elastomers [8]

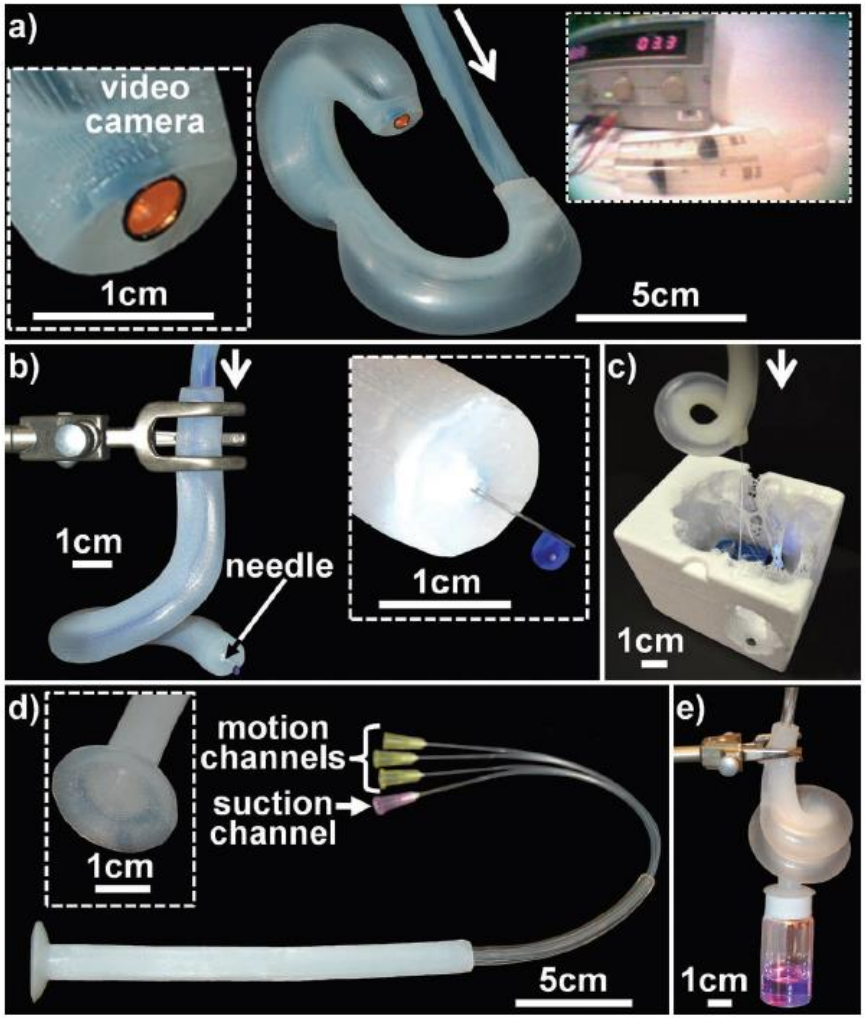


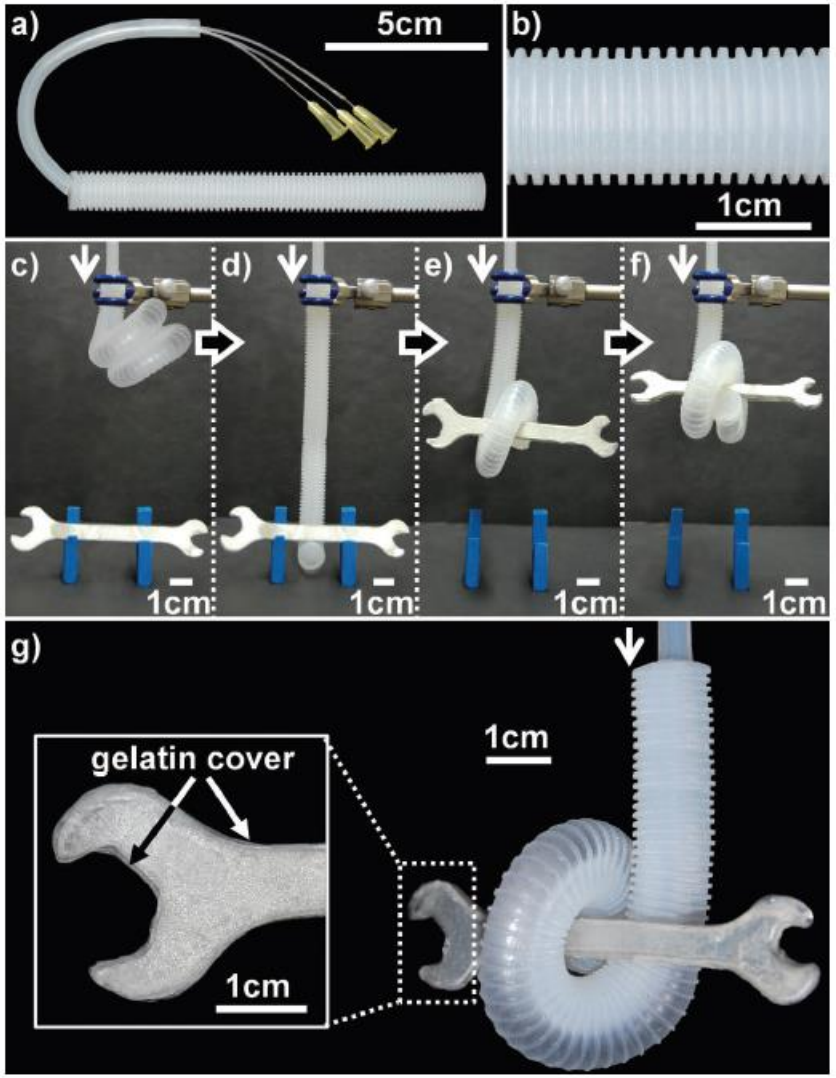
Design


a)
gas inlets
5cm
PDMS
Ecoflex
1cm
b)
P_{atm}
P_I
P_{II}
P_{III}
P_{III}
7.7MPa
0.1
0.01
0.001
0.00001
c)
P_{atm}
5cm


a)
section 1
section 2
section 3
5cm
PDMS
Ecoflex
tubing
1cm
b)
inlets
section 1
section 2
section 3
PDMS
c)
5cm
d)
5cm
e)
5cm
f)
5cm

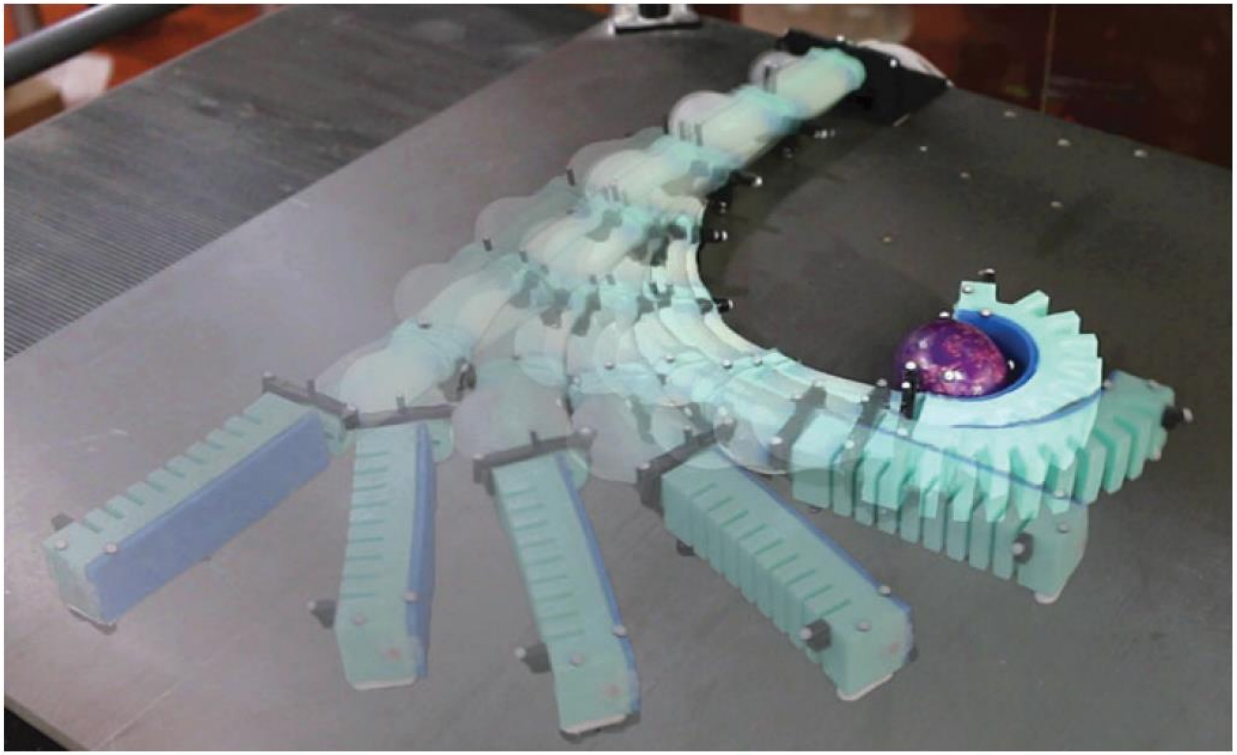
Applications



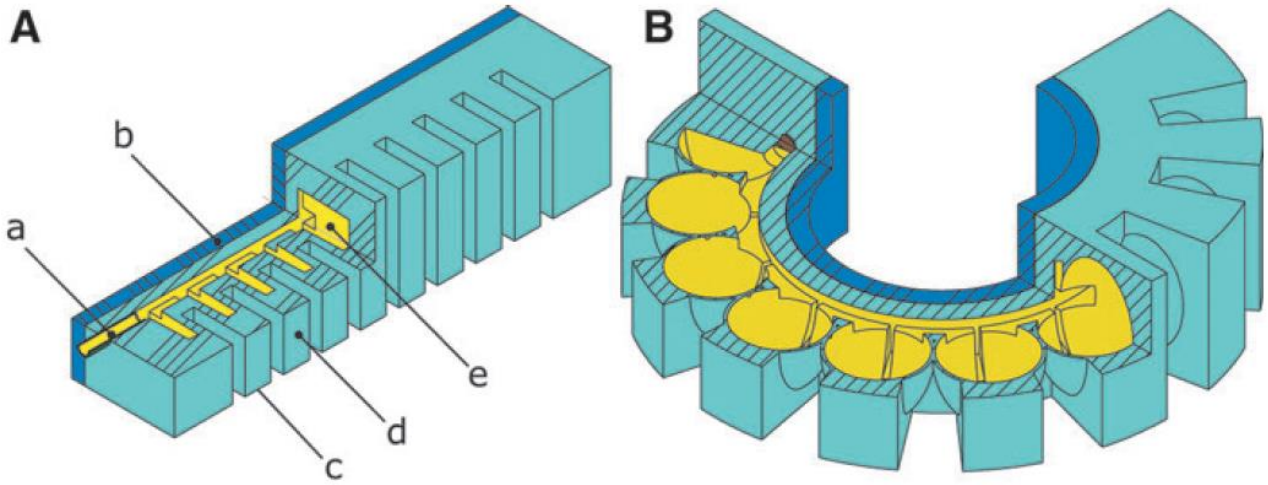


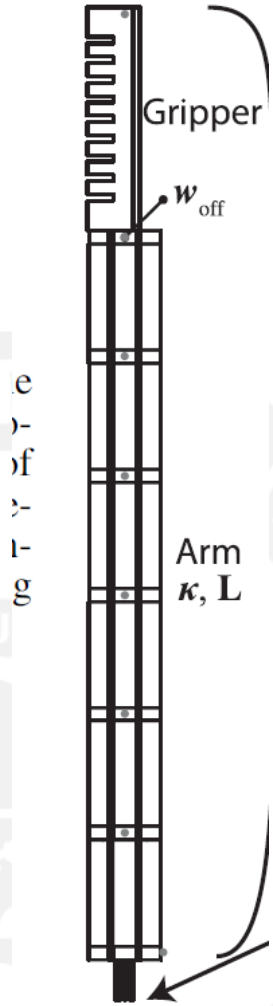
Literature Review

Autonomous Object Manipulation Using a Soft Planar Grasping Manipulator [9]

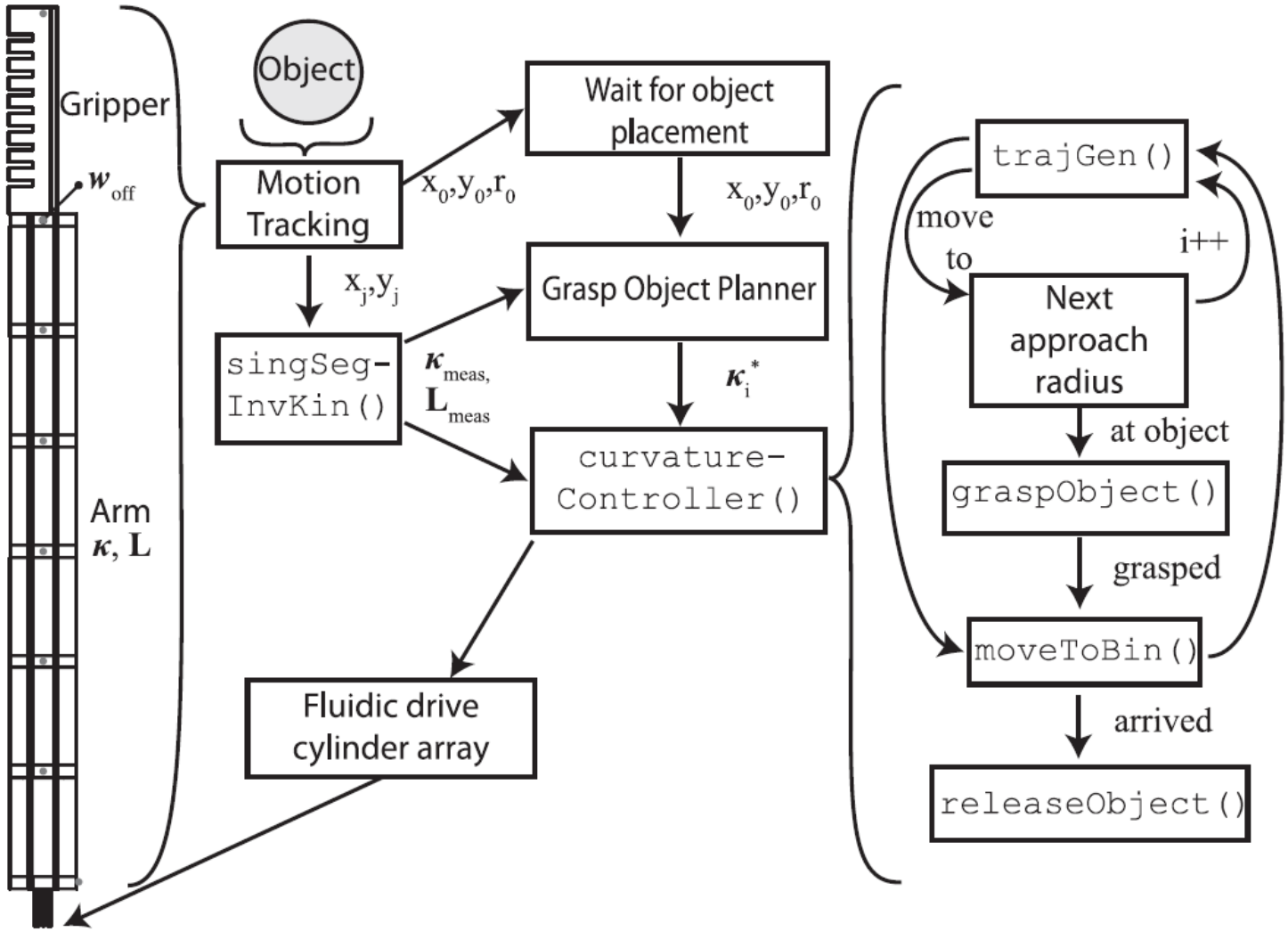


Pneu-nets

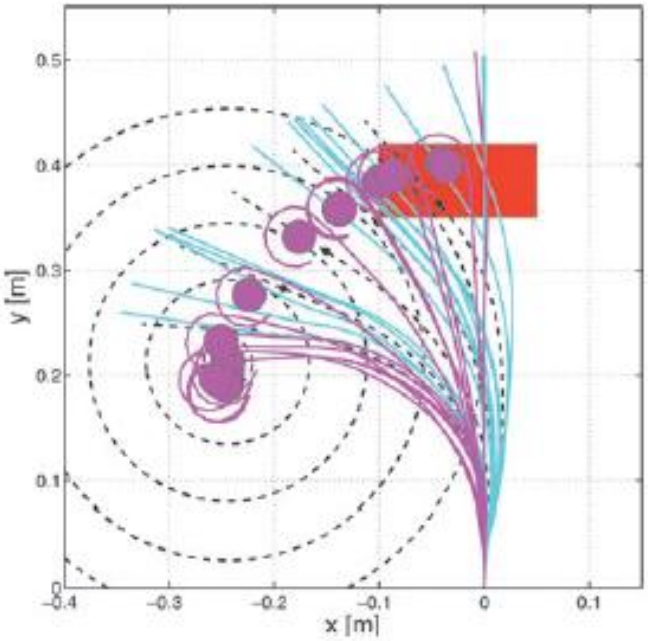




Planner for Grasp and Place



Results



Soft robots are Future[10]

Soft Robotic Systems	Hard Robotic Systems
Made of soft, flexible, stretchable materials with reversible and variable properties	Made of hard materials with invariable properties
Inherent compliance match with its environment	Smooth contact with its environment facilitated by advanced feedback control strategies and sensors
Continuum topology with infinite degrees of freedom (DoF) seamlessly housing all of its essential elements	Discrete topology with a finite DoF consisting of rigid elements connected to each other with single DoF joints.
Inherently safe, adaptive and tolerant to operate in unknown environments, especially for human-machine interaction	Unsafe and intolerant with limited adaptability to operate in unknown environments unless intricate control measures are applied.
Flexible and stretchable electronics and power source	Conventional electronics and power source
High level of behavioural diversity	Low level of behavioural diversity
High level of bio-inspiration	Low level of bio-inspiration
Low accuracy can be tolerated	High accuracy is required
Low speed and force applications	High speed and force applications
Low weight and cost	High weight and cost

References

1. A. Dameitry and H. Tsukagoshi, "Lightweight underactuated pneumatic fingers capable of grasping various objects," 2016 IEEE International Conference on Robotics and Automation (ICRA), Stockholm, 2016, pp. 2009-2014.
2. J. Zhou, S. Chen and Z. Wang, "A Soft-Robotic Gripper With Enhanced Object Adaptation and Grasping Reliability," in IEEE Robotics and Automation Letters, vol. 2, no. 4, pp. 2287-2293, Oct. 2017. doi: 10.1109/LRA.2017.2716445
3. B. S. Homberg, R. K. Katzschmann, M. R. Dogar and D. Rus, "Haptic identification of objects using a modular soft robotic gripper," 2015 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS), Hamburg, 2015, pp. 1698-1705.
4. Y. Wei et al., "A novel, variable stiffness robotic gripper based on integrated soft actuating and particle jamming," Soft Robot., vol. 3, no. 3,pp. 134–143, 2016.
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