ELECTRONIC SKIN-INTEGRATED SOFT ROBOTIC HAND

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謝長宏
Puwarin Wu

Ref:T. Yamaguchi, T. Arie, S. Akita and K. Takei, "**Electronic Skin-Integrated Soft Robotic Hand**," *2019 20th International Conference on Solid-State Sensors, Actuators and Microsystems & Eurosensors XXXIII (TRANSDUCERS & EUROSENSORS XXXIII)*, Berlin, Germany, 2019, pp. 543-546,

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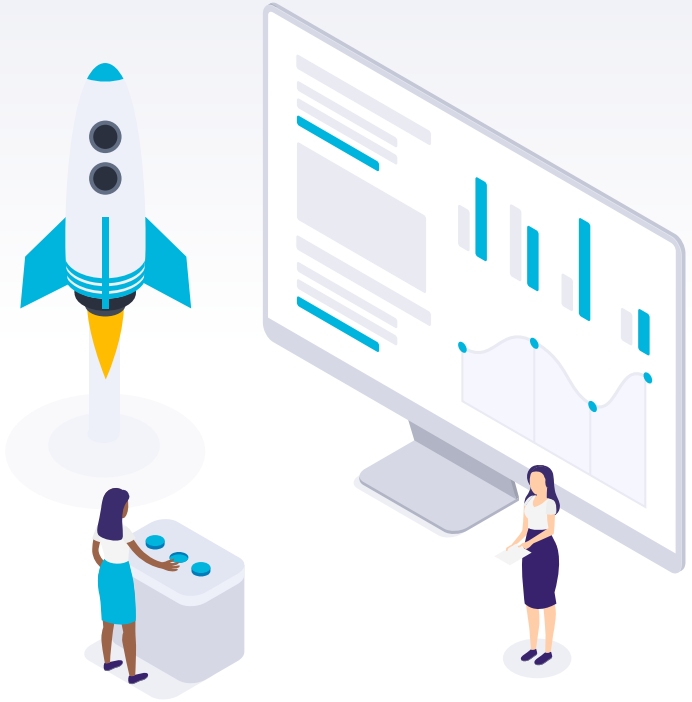
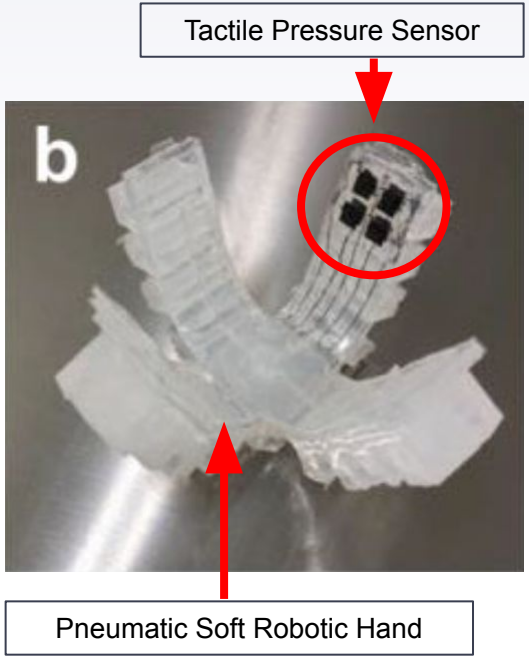
- Fabrication Process
- Pneumatic Balloon Soft Robot Hand
- Tactile Pressure Sensor
- Sensor-Integrated Soft Robot Hand Demonstration
- Conclusion
- Reference

1 Introduction

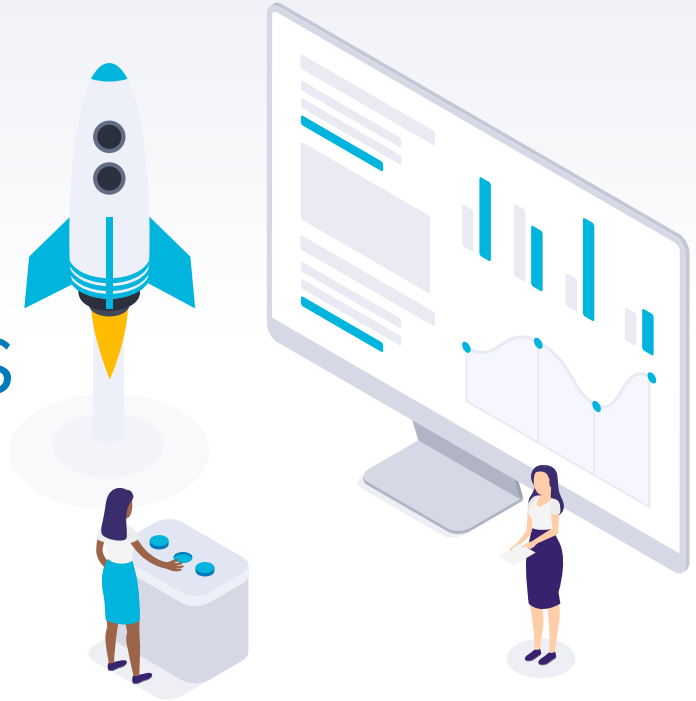


Introduction

- With the development of robotic technology, robots are being used from industrial to home-use applications
- One of the robotic structures is pneumatic balloon type soft robots using mainly silicone rubber operated by compressed air
- In this study, the author develops a tactile pressure sensor array integrated with pneumatic soft robotic hand to monitor tactile pressure like a human skin

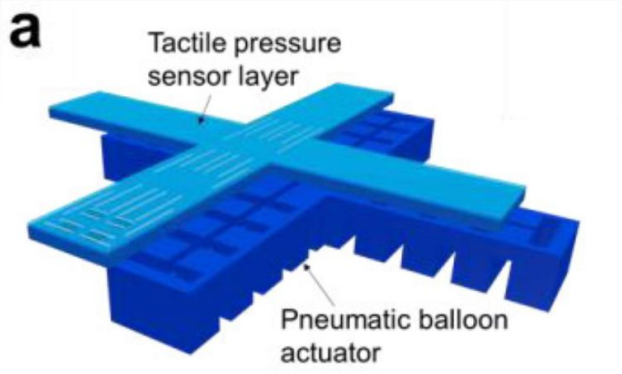


2 Fabrication Process



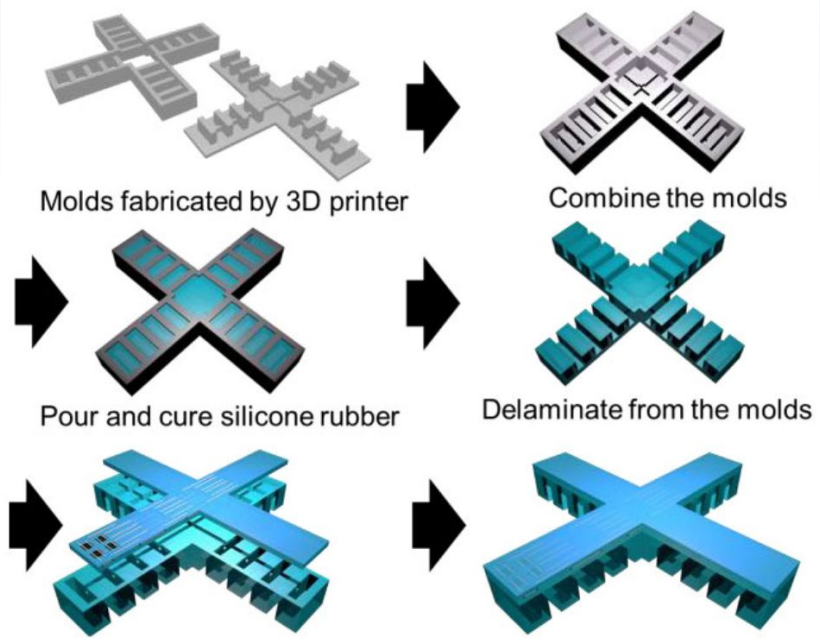
Fabrication Process

- Fabricated by using silicone rubbers
  - Two different hardness of silicone rubbers
- Consist of two layers
  - First layer: Pneumatic balloon actuator layer
  - Second layer: Tactile pressure sensor layer



Fabrication Process

- Pneumatic Balloon Actuator Layer:
  1. Molds were fabricated using a 3D printer
  2. Assembling of the molds
  3. Silicone rubber solution was poured and cured
  4. Remove silicone rubber from the molds
- Tactile Pressure Sensors:
  1. Conductive paper and Ag thread were fabricated by using a silicone rubber sheet
- Assembling:
  1. The sensor sheet and actuator was bonded by using adhesion of uncured silicone rubber solution
  2. Coating is applied using silicone rubber solution over the sensor layer to protect the sensors



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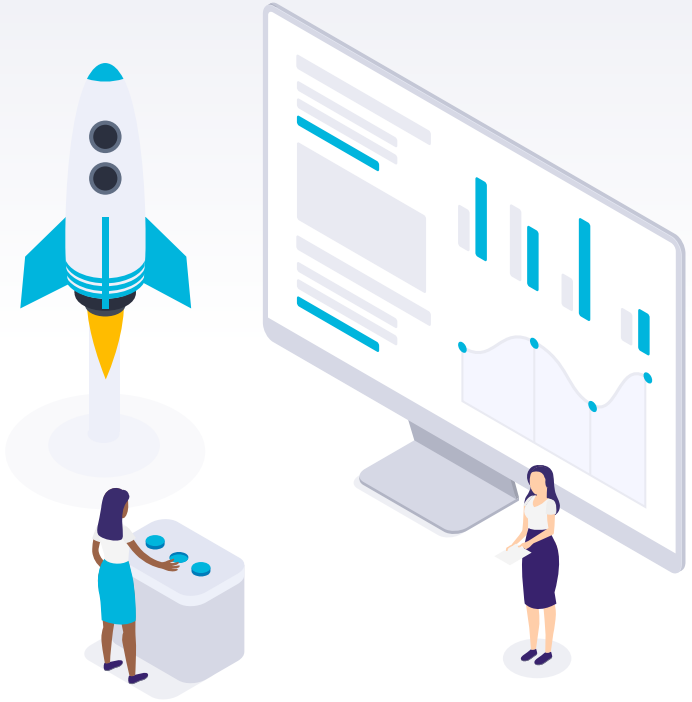
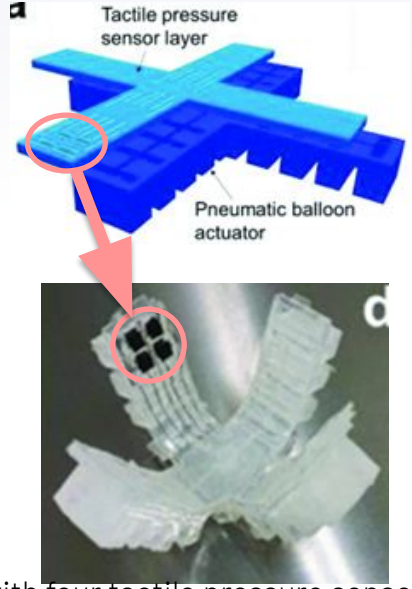
Pneumatic Balloon Soft Robot Hand



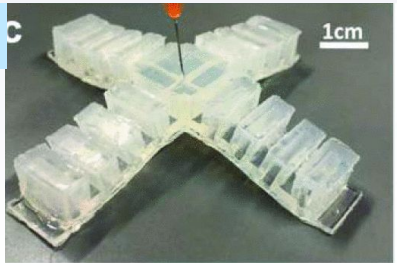
Pneumatic Balloon Soft Robot Hand

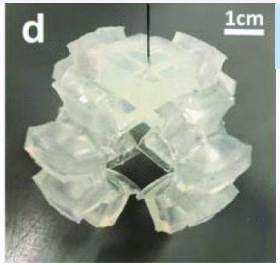
Pneumatic soft robotic hand



A hand with four tactile pressure sensors is to detect force between the conductive paper and silver thread.

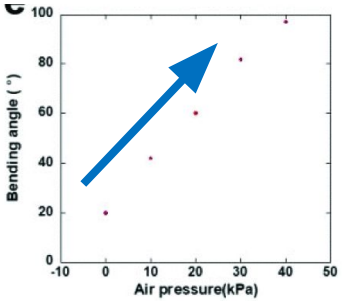
Open

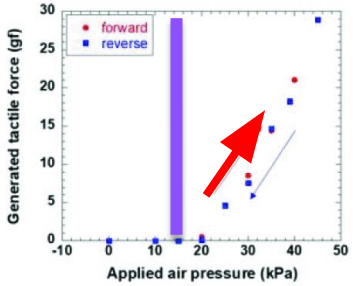




Close

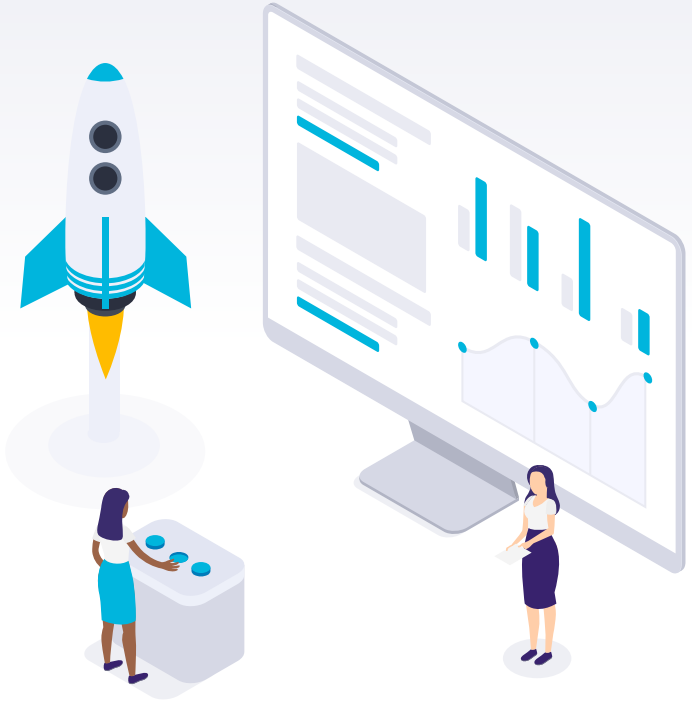
Using the operation of inflation and deflation, the soft robotic hand can grasp and release an object.





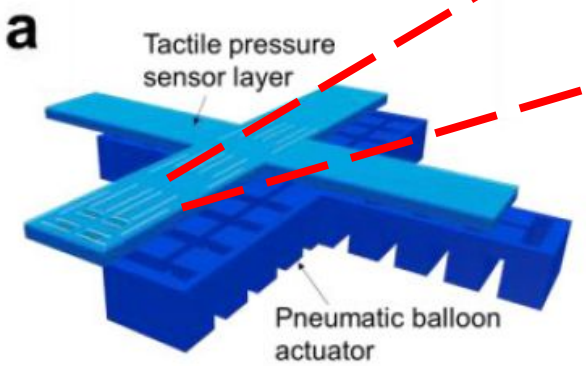
This bending angle depends on the thickness of the sensor layers. The tactile force is increased by increasing air force.

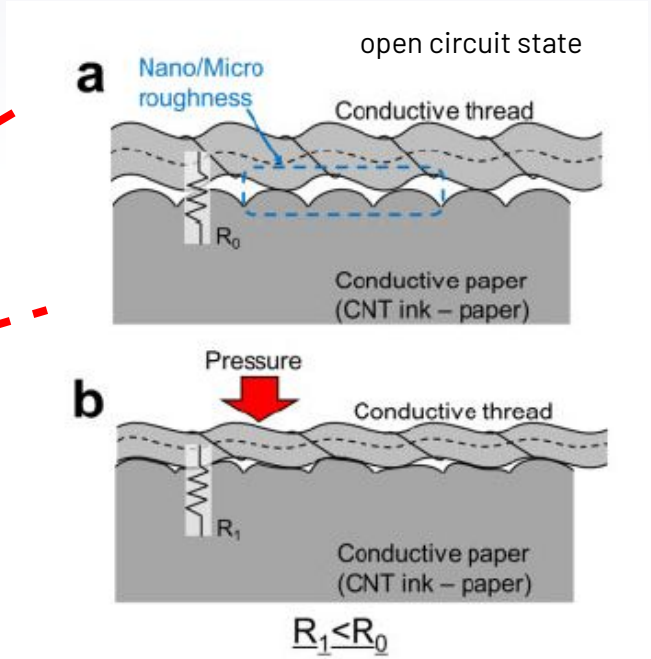
4 Tactile Pressure Sensor



Tactile Pressure Sensor

- Due to surface roughness of Ag thread and conductive paper, contact resistance is varied depending on the applied pressure over the sensor.





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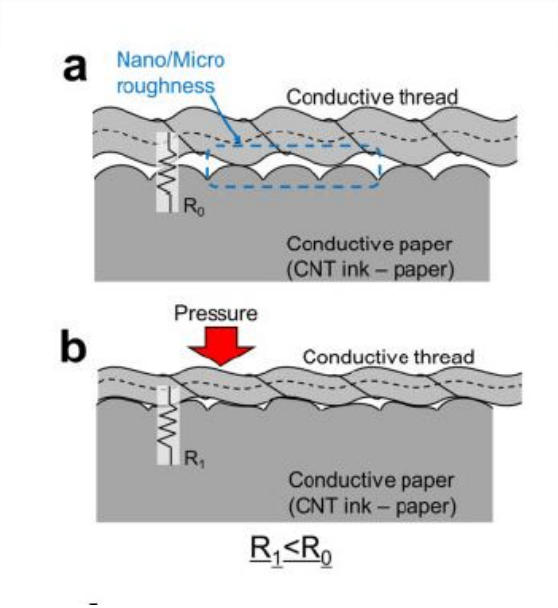
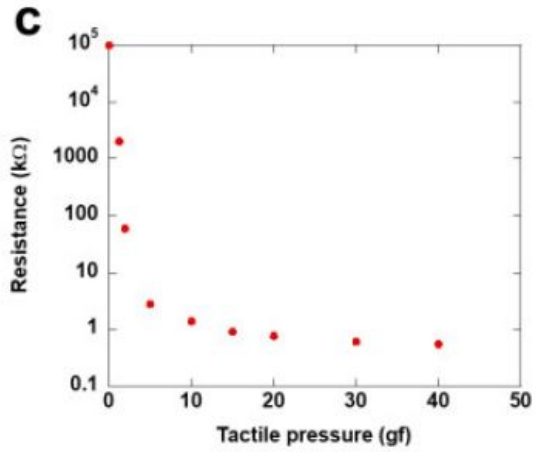
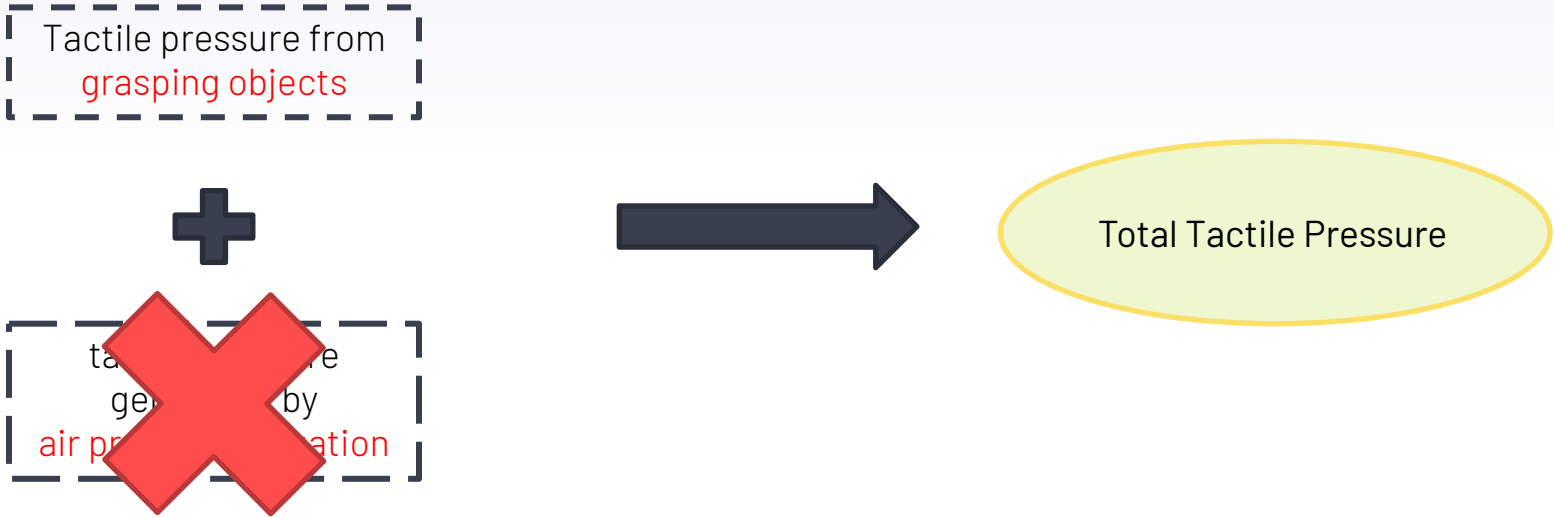


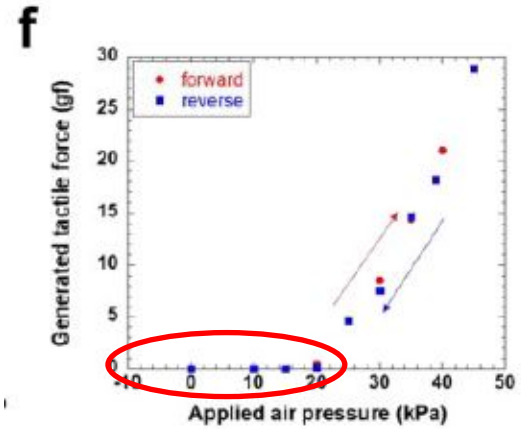


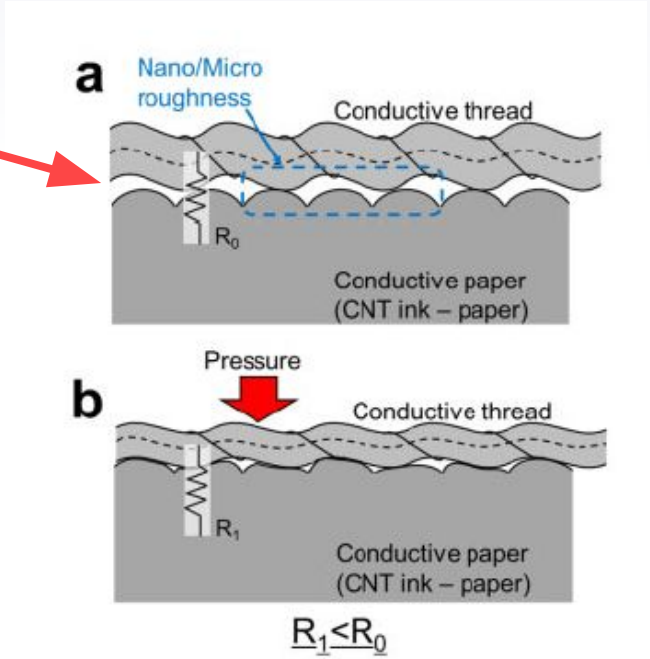
Tactile Pressure Sensor



Tactile Pressure Sensor

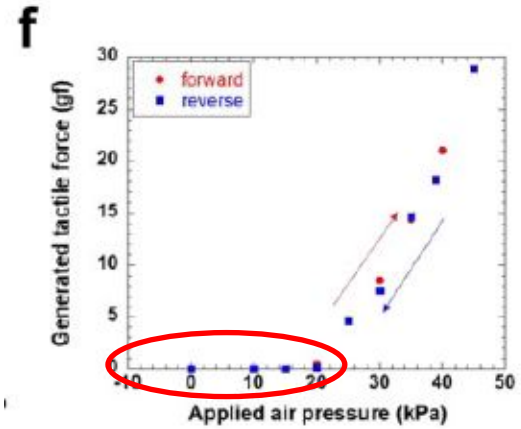
- It should be noted that this tactile pressure sensor has a gap between the silver thread and the conductive paper without applying force.

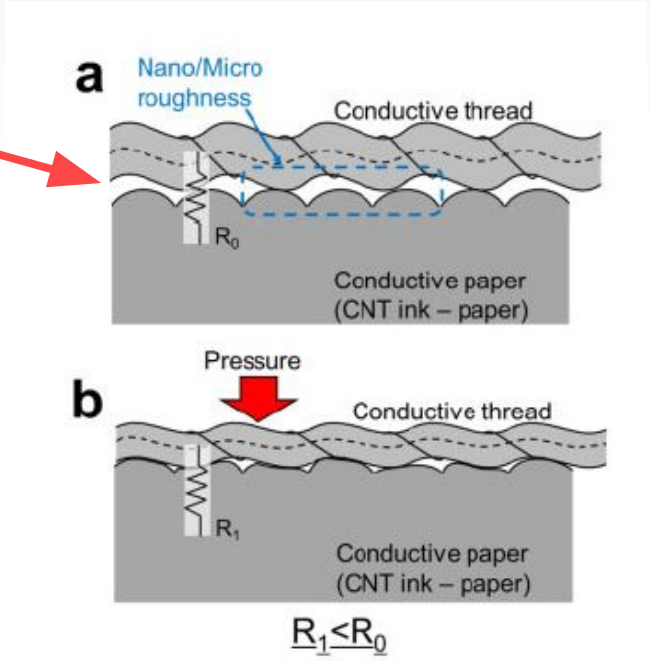




Tactile Pressure Sensor

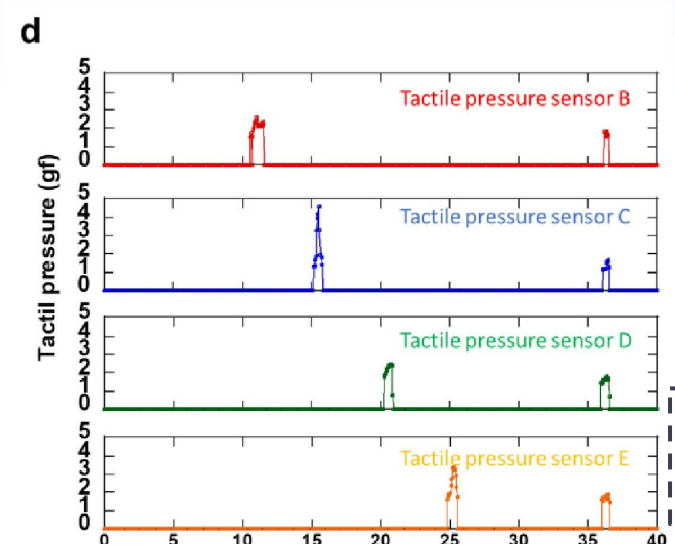
- The advantage of this structure with a gap is that the sensor is insensitive to the bending of the structure.





Tactile Pressure Sensor

- As the results, each sensor can responds separately, and the sensor output is not affected by the movement of the soft robot.



Real-time tactile pressure detections for integrated four sensors under conditions of bending the hand and applications of pressure separately.

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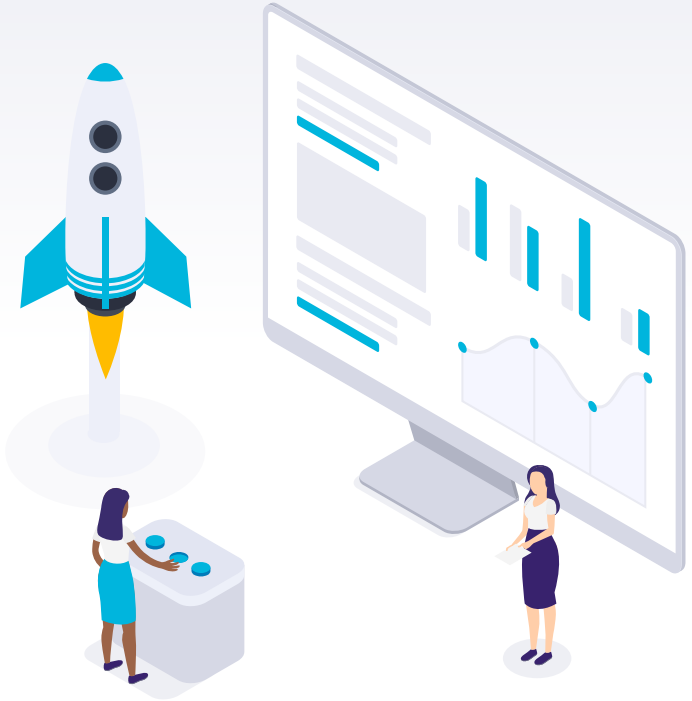
Sensor-Integrated Soft Robot Hand Demonstration



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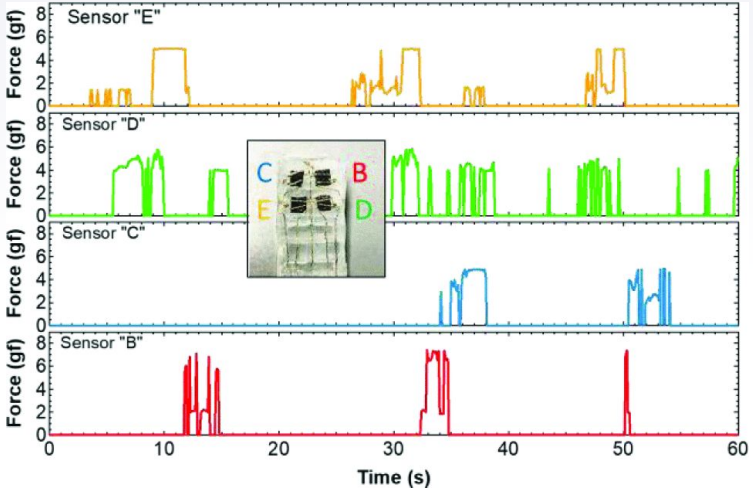
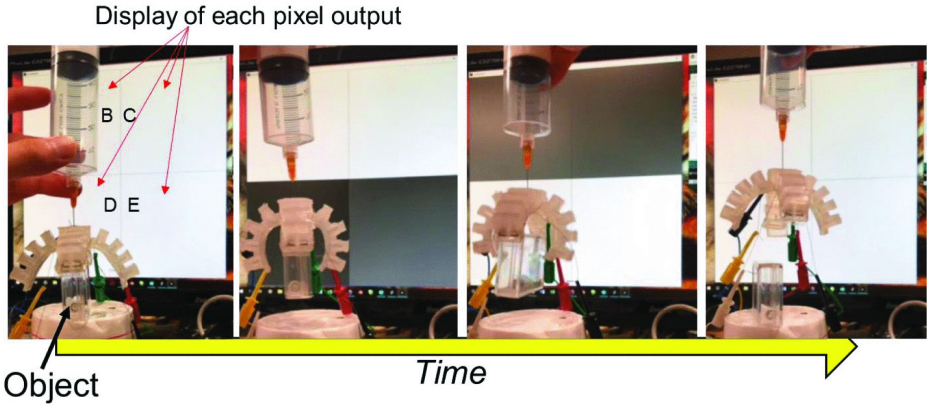


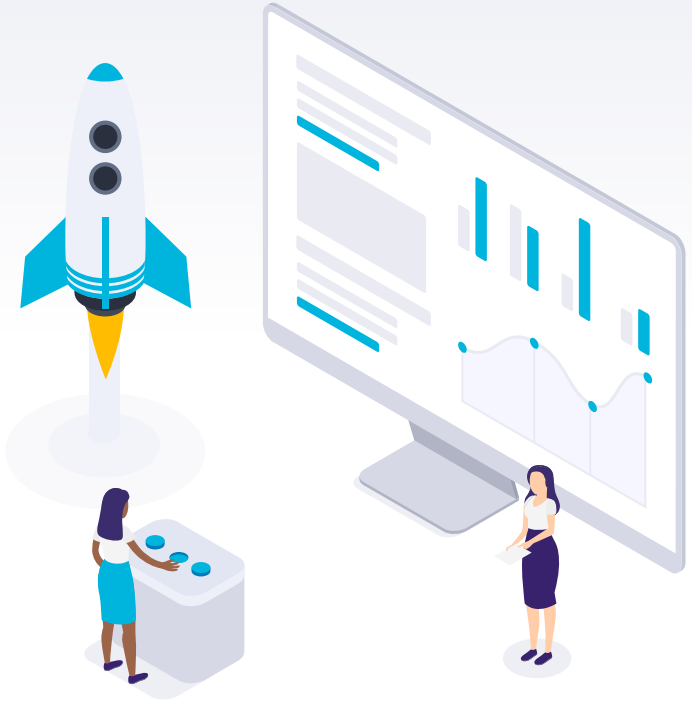
Tactile pressure mapping in a display connected to a computer before and after grabbing an object.

- ✔ All integrated sensor can detect each tactile force.
- ✔ Grasp and hold the object without destroying or dropping the object.



Use pneumatic pressure to grab an object.

6 Conclusion



CONCLUDION

- Integrate flexible sensors embedded in soft robotic hand without sacrificing softness and flexibility.
- The sensor has high sensitivity and long-term stability.
- The sensor is insensitive to the strain caused by the actuation bending of the structures.
- The sensor can monitor tactile force distribution of the object.

Reference

- T. Yamaguchi, T. Arie, S. Akita and K. Takei, "Electronic Skin-Integrated Soft Robotic Hand," *2019 20th International Conference on Solid-State Sensors, Actuators and Microsystems & Eurosensors XXXIII (TRANSDUCERS & EUROSENSORS XXXIII)*, Berlin, Germany, 2019, pp. 543-546,

Q&A

THANKS!