Development of a Customized Multi-Sensory Detection Tactile Sensor Module for Commercial Robot Hands

Authors : Jin-Seok Jang[1], Bo-Gyu Bok[1], Min-Seok Kim[1]

Presenter : Jin-Seok Jang

[1]Convergence Research Center for Meta-Touch,
Korea Research Institute of Standards and Science (KRISS)
jang82@kriss.re.kr

Jin-Seok Jang

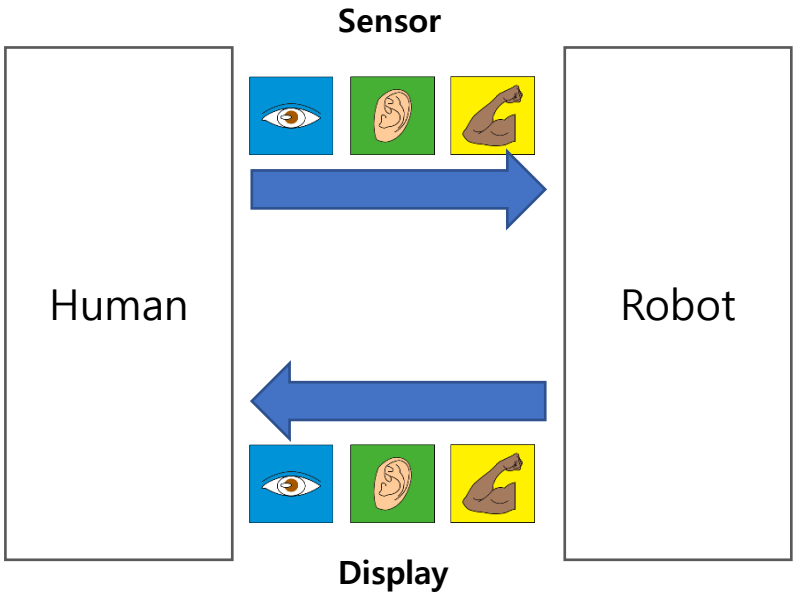
- Master's degree in Korea (2007 ~ 2009)
  - Electrical and Electronic Engineering
- Senior Engineer in KRISS (2014 ~ Current)
- Field : Tactile Sensor Development
  Establishing Force Standards
- Areas of Interest : Sensors that can built into Robot
  Tactile Sensor

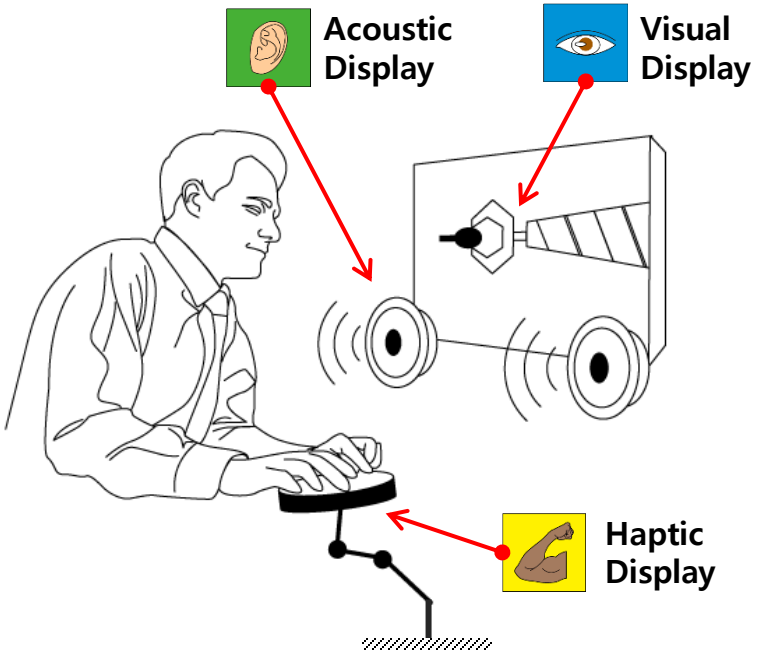
Contents

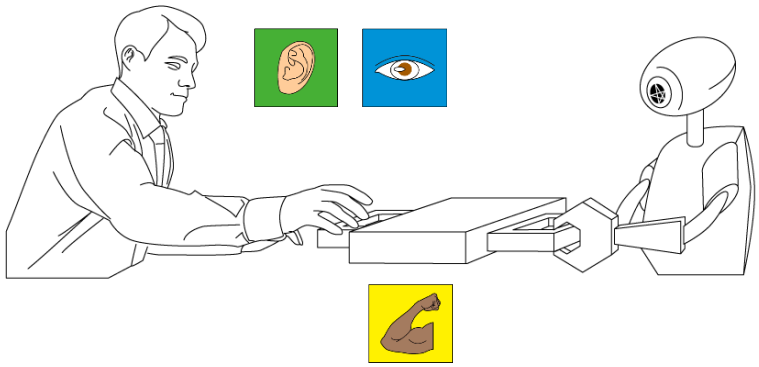
- Introduction
- Design & Fabrication
- Evaluation
- Conclusion & Future Work

Introduction

Background – Multimodal Interaction with Robots

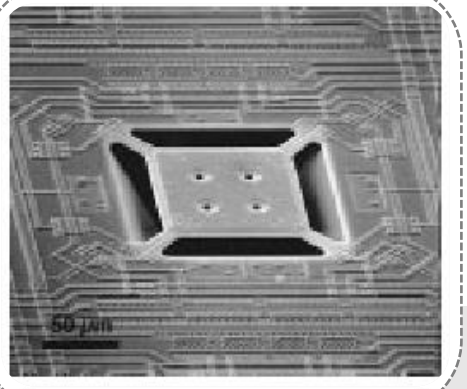






Type of Tactile Sensor

Definition: **Tactile sensing covers any sensing modality which requires physical contact between sensors and an external object**

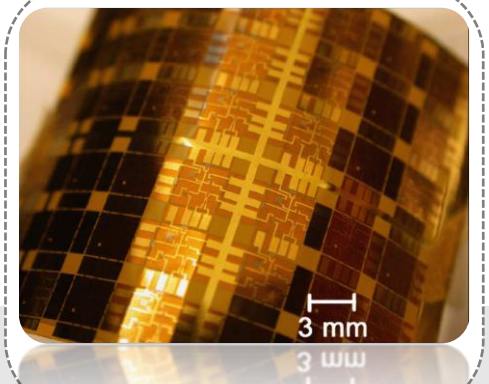


√

Semiconducting Silicon

Silicon Micromachining

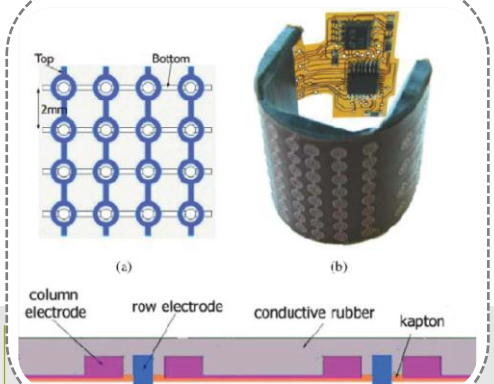
- Semiconducting Strain Gauges (High Gauge Factor = 80 ~ 150)
- High Performances
- On-board Signal Processing
- Not Flexible, Fragile
- Expensive



Organic Materials

Polymer Micromachining

- Metallic Strain Gauges (Low Gauge Factor = 2 ~ 3)
- Flexible
- Moderate Performances
- Fragile (membrane structure)
- Moderate Cost



√

Conductive Polymer

Casting, Screen Printing

- Carbon or Metal Powder Mixed with Polymer Matrix
- Flexible, Robust
- Cheap
- Low Performances
- Nonlinear Output

Design & Fabrication

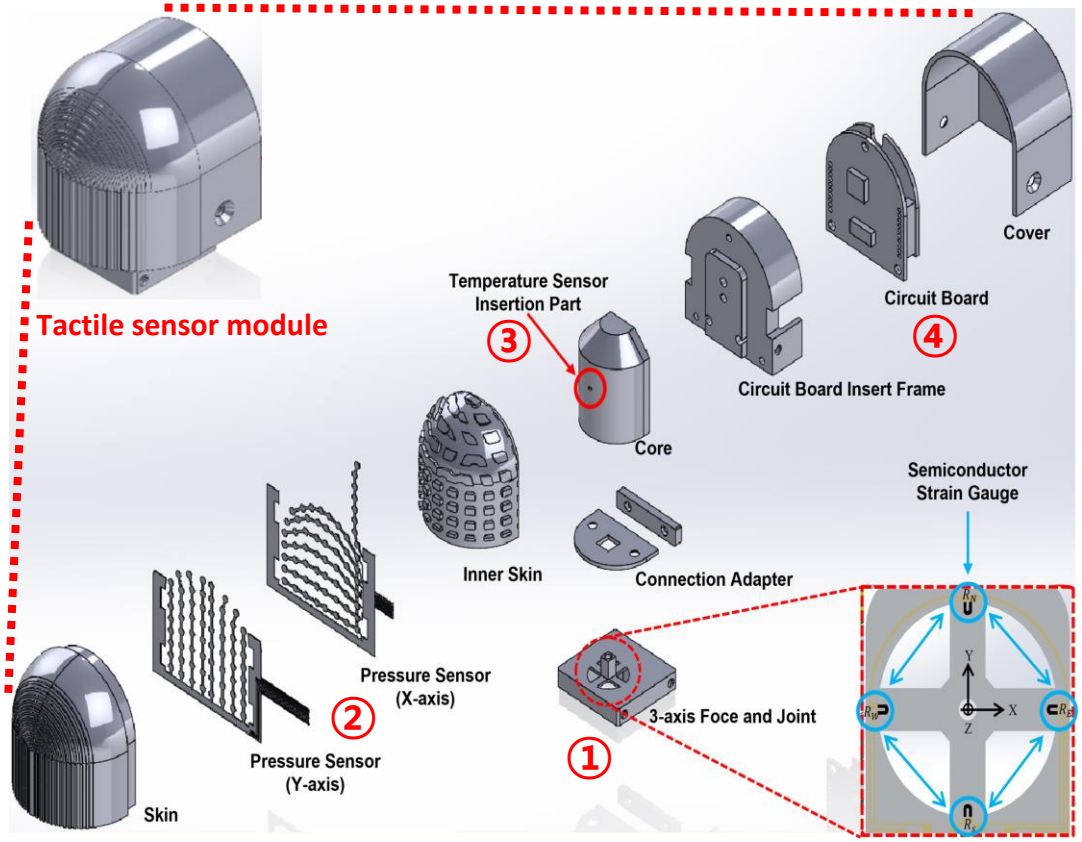
Tactile Sensor Module

Robot fingertip type hybrid tactile sensor module for commercial robot hands

- **Customization possible according to Robot Hand Shape**

  ➔ **Used robot hand : Wonik Robotics's Allegro Hand**

- **Built-in 1 : Pressure · 3-Axis force · Temperature sensor ➔ Multi-sensory feedback possible**
- **Built-in 2 : Circuit board made of multi-layered ➔ Miniaturization possible**



1. 3-axis force sensor part
- : Maltese cross type's metal frame
- : Using four commercial U-shaped semiconductor strain gauges
- : Central pillar part for high sensitivity

2. Pressure sensor part
- : Composed of X-axis and Y-axis Layers
- : Integrated 64 pressure cells
- : Designed to be attached to 3D curvature
- : Measurement of pressure distribution across the entire fingertip

3. Temperature sensor part
- : Commercial thermistor
- : Measurable from -10 ℃ to 80 ℃

4. Circuit board part
- : Composed of multi-layers
- : Sampling rate ➔ 500 Hz
- : Total area ➔ about 26 x 29 mm

Tactile Sensor Module

Fabrication

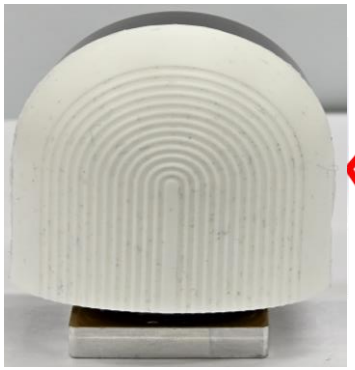
- **Total area : 30 x 30 x25 mm**

  ➔ Tactile sensor module designed specifically for the Allegro hand

- **Characteristic**

  ➔ Custom orders available

Components of Module



Assembled Module

Tactile Sensor Module Mounted on Robot Hand

Evaluation

Evaluation

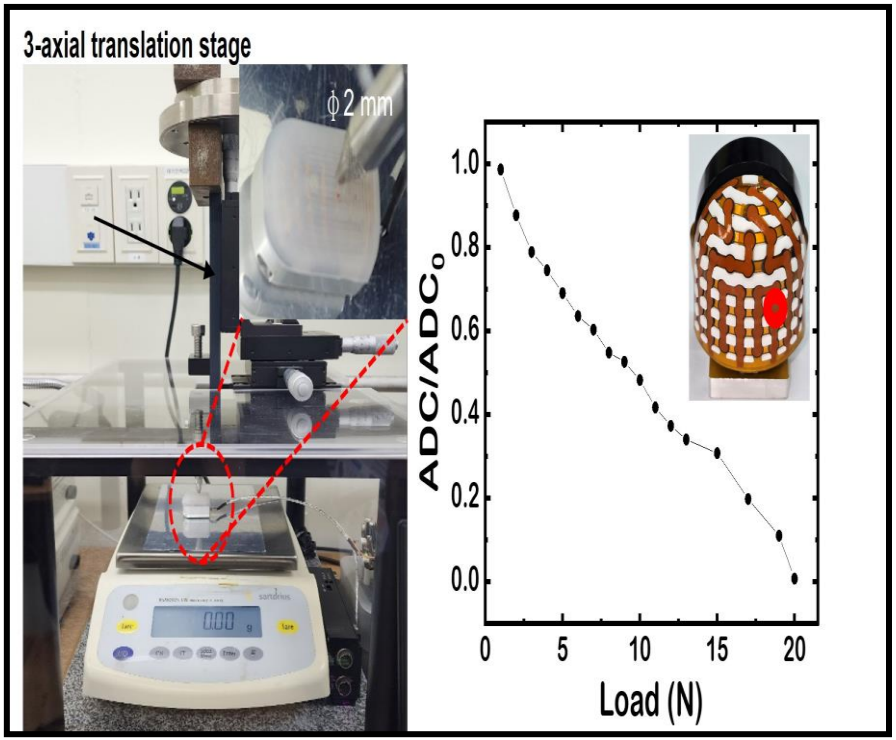
Sensor's detection characteristic tests

- Using a 20 N deadweight force standard device at the KRISS (3-axis force sensor)

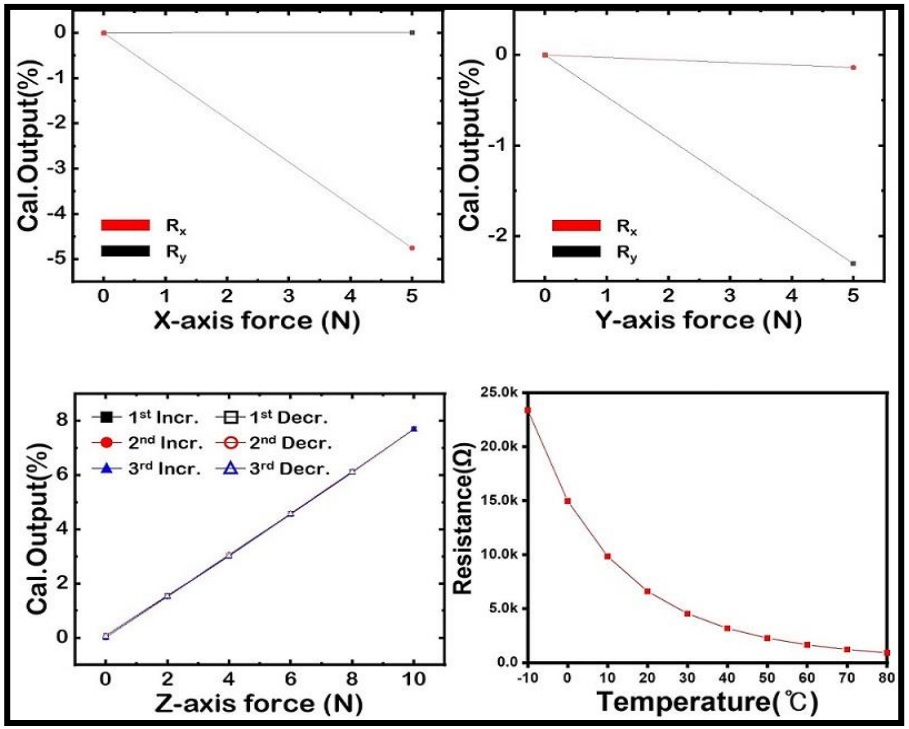
  ➔ Evaluation conducted according to ISO 376 international standard calibration procedure

- Using a constant temperature and humidity chamber at the KRISS (Temperature sensor)

  ➔ Evaluation conducted according to ISO 386 international standard calibration procedure



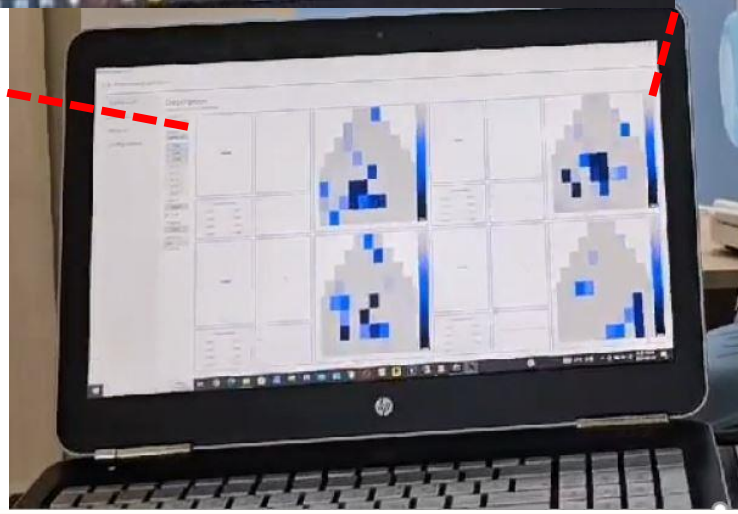
Pressure sensor's detection characteristic



3-axis force and temperature sensor's detection characteristic

Evaluation

Tectile sensor module demonstration



Conclusion & Future work

Conclusion & Future Work

Conclusion

- We have developed a tactile sensor module for robot fingertips that can be attached to a robot hands.
- This technologies offer the advantage of customization to accommodate the forms of various robot hands.
- A comprehensive evaluation of the robot fingertip tactile sensor module confirmed its high performance and reliability, meeting the requirements for accurate tactile feedback.
- Currently, the module is designed to be mounted on the Allegro Hand by Wonik Robotics, and it is being tested in various applications to assess the durability of the module and the additional performance of each sensor.

Future work

- In near future studies, we aim to address current issues, further miniaturize the module, improve sensor accuracy, and explore additional sensory capabilities to expand the module's functionality.

Thank You!