



ISTITUTO ITALIANO
DI TECNOLOGIA

Integrating Tactile Sensors into the Hands of the Humanoid Robot iCub

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Outline

- Motivation
- Description of the sensor
- Experiments to characterize the sensor

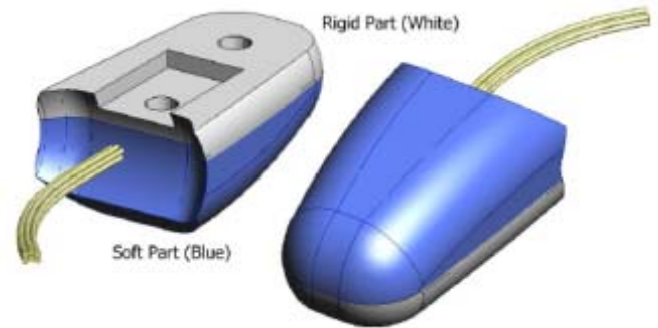
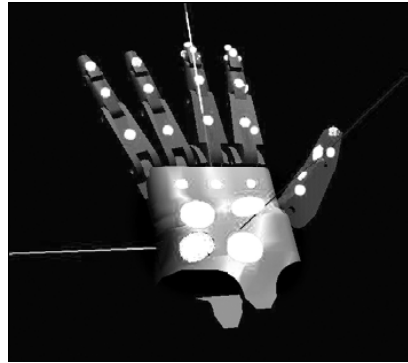
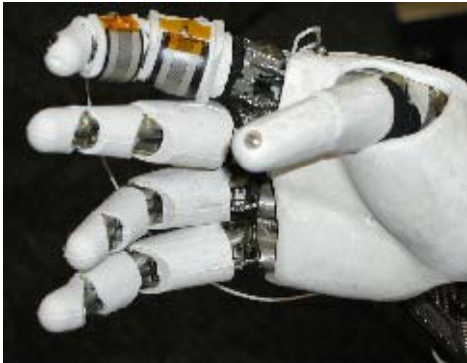
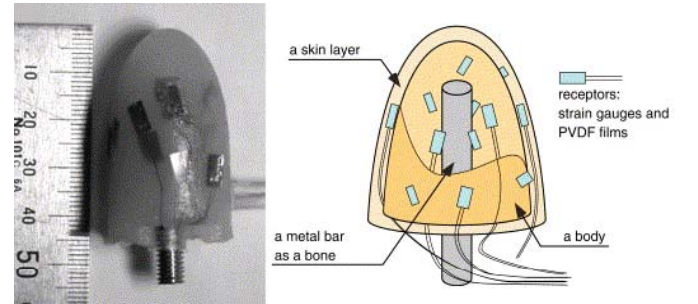
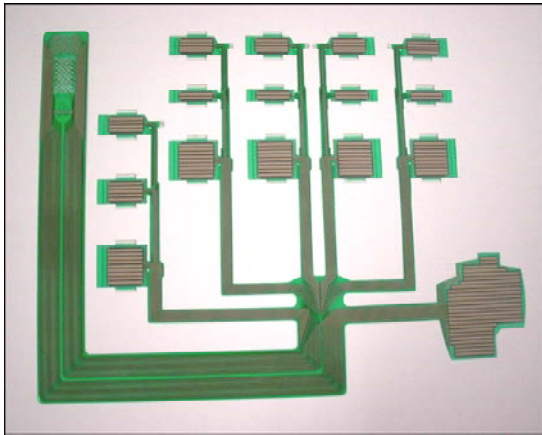
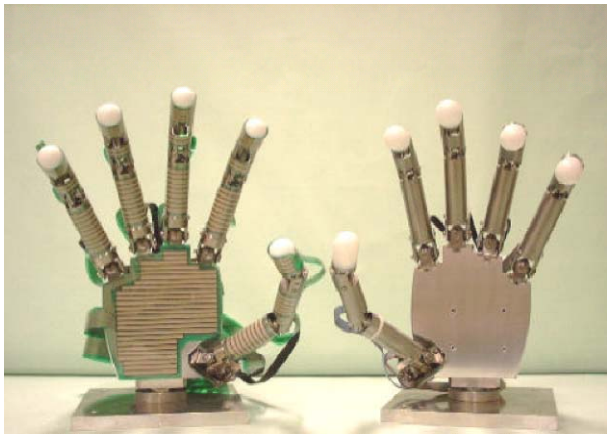
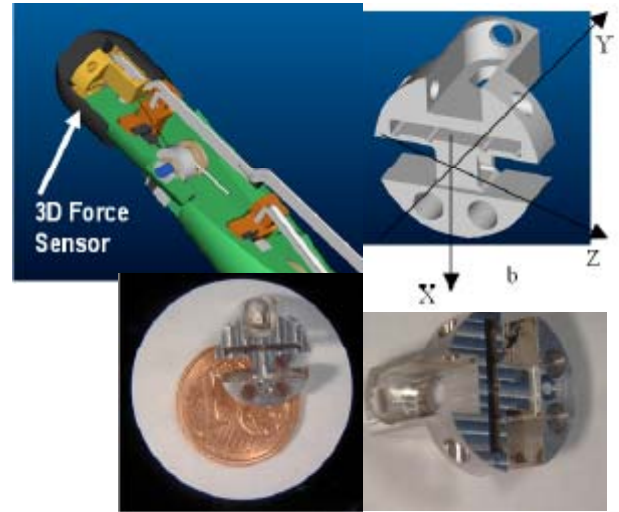
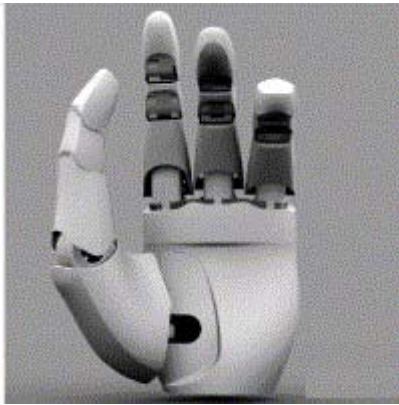
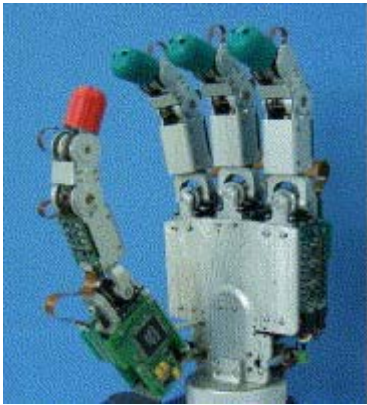
Motivation

- Important for feedback control and learning / adaptation
- Many transduction technologies: Resistive, QTC, capacitive, optical, ultrasonic, magnetism, piezoelectric, pressure sensitive ink ...
- Few have been integrated, few have gone beyond the prototype stage



Requirements for Integration

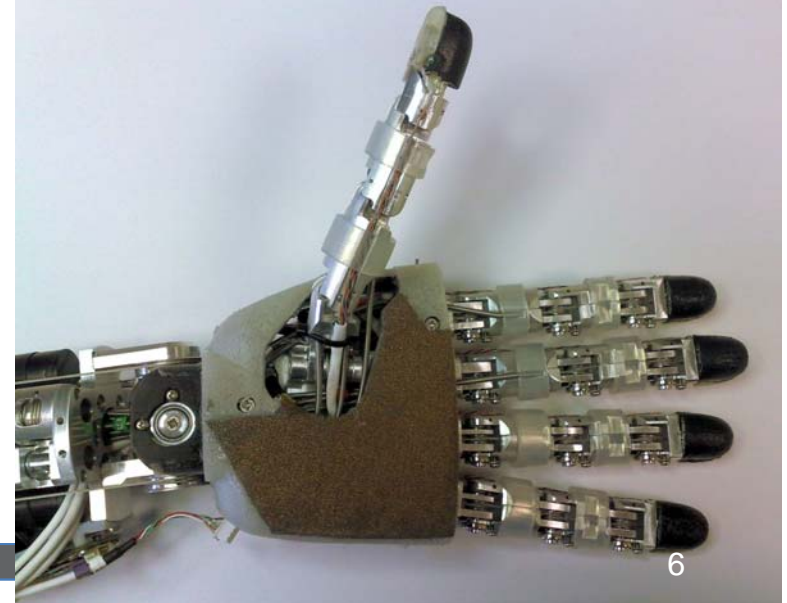
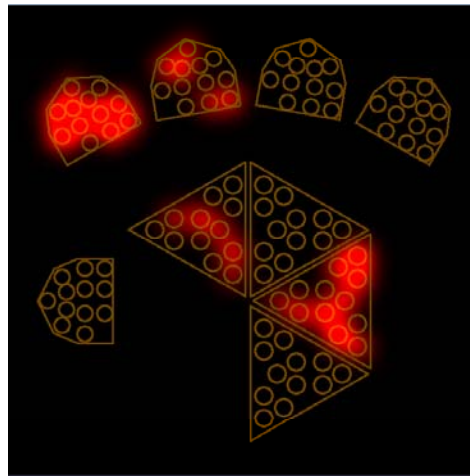
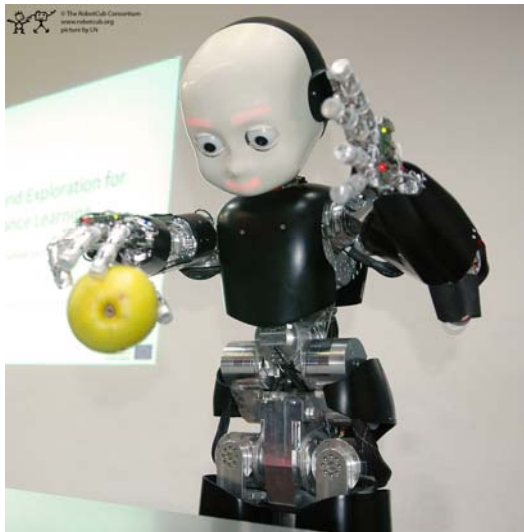
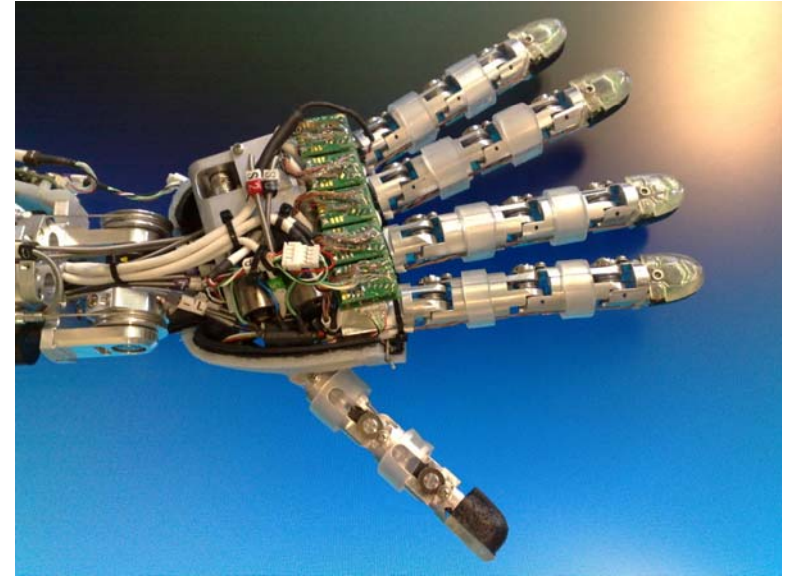
- Small, cabling, robustness, conformed to curved shapes, compliance, ease of production, repair/replace
- Moreover: low noise/creep/hysteresis/drift, good sensitivity, wide dynamic range, temporal resolution, spatial resolution, sensed area





Capacitive Pressure Sensor for the iCub

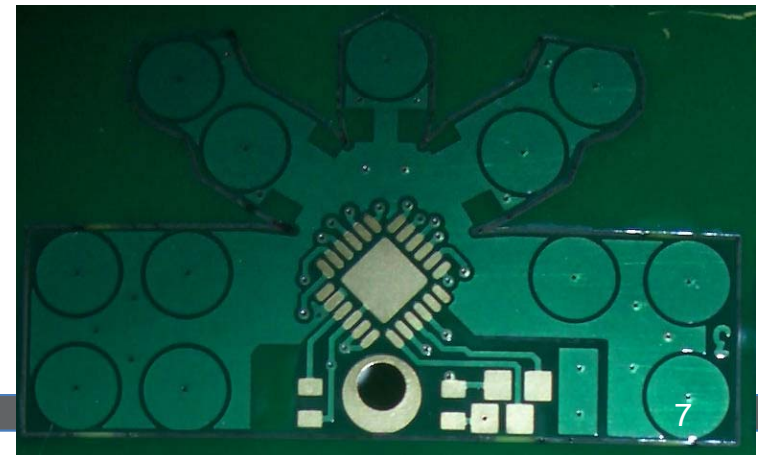
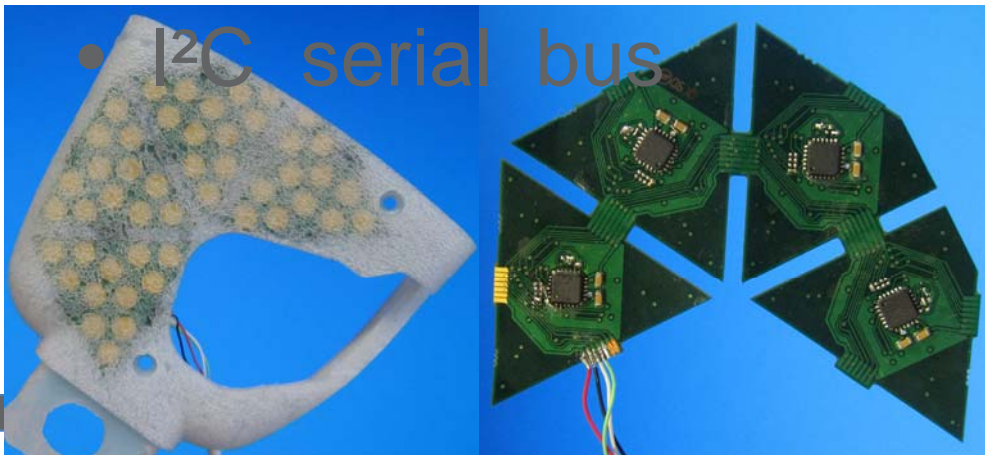
- 108 sensitive zones
- 4 triangular modules in the palm
- 5 fingertips



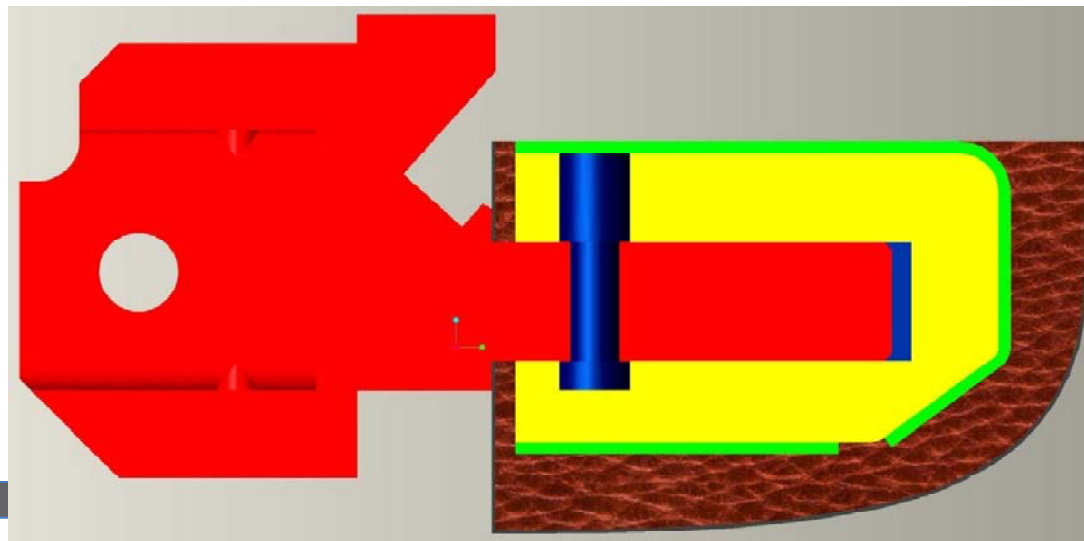
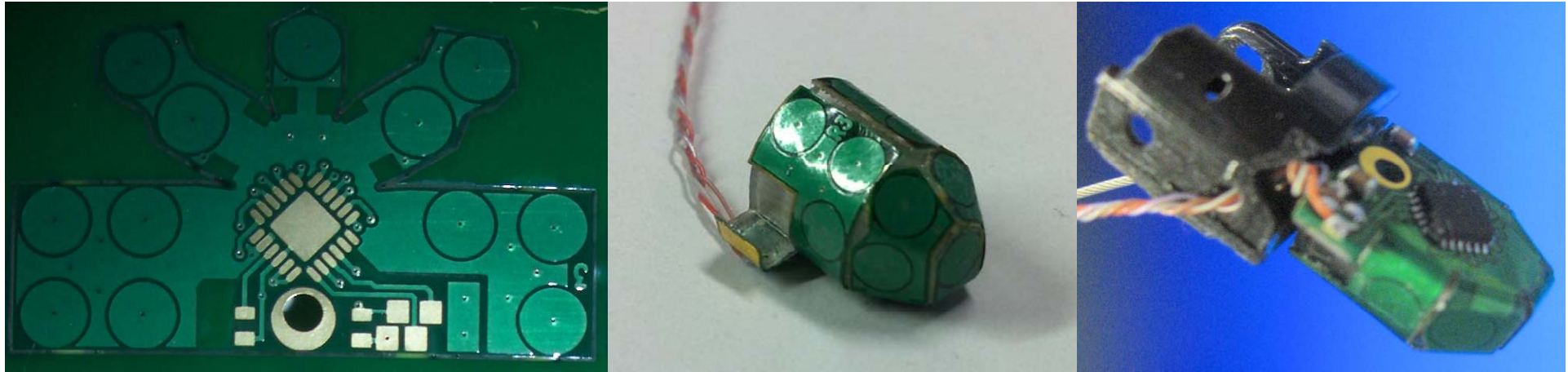
Flexible PCB

- Generic for the palm; specialized for the fingertips
- 12 round pads that act as taxels
- Capacitance to digital converter (AD7147)
- Twelve 16-bits measurements of capacitance
- Independently at 50 Hz or an average at about 500 Hz

- I²C serial bus

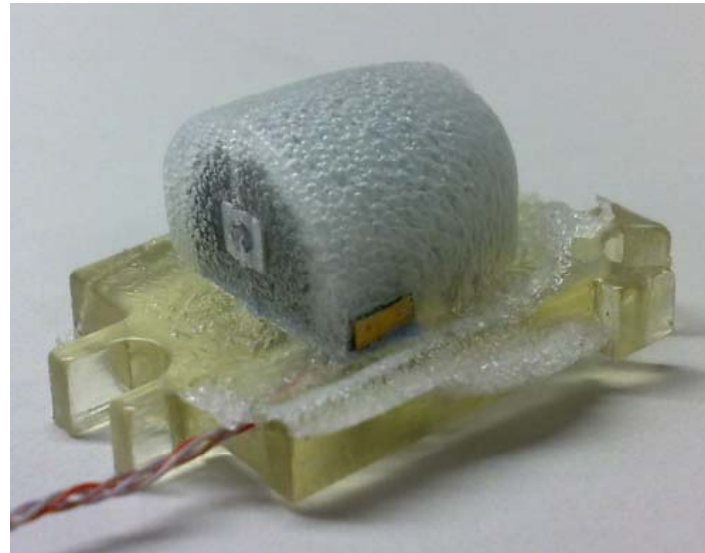
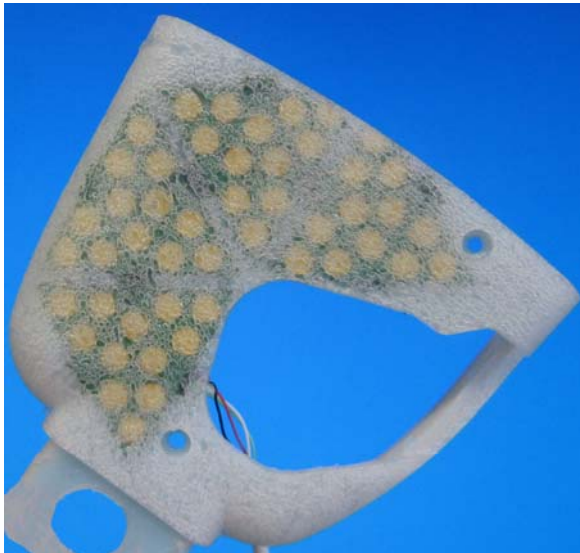


Structure of the Fingertip



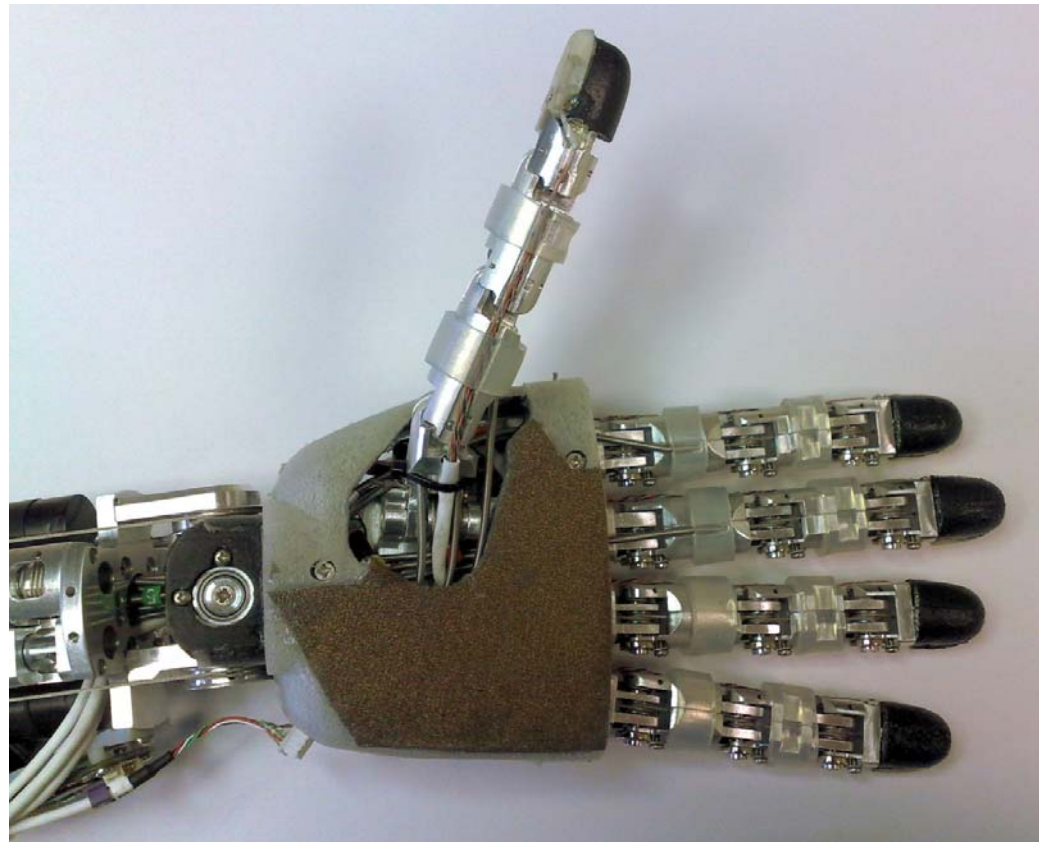
Silicone Foam

- Softer in the beginning → nonlinear
- Guarantees compliance



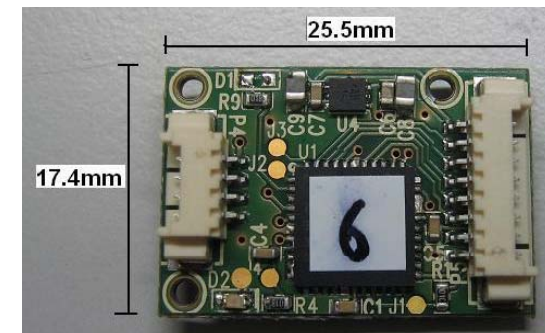
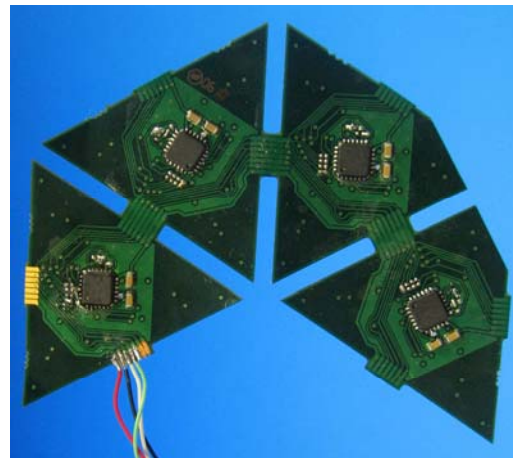
2nd Conductive Layer

- Conductive Lycra, conductive silicone



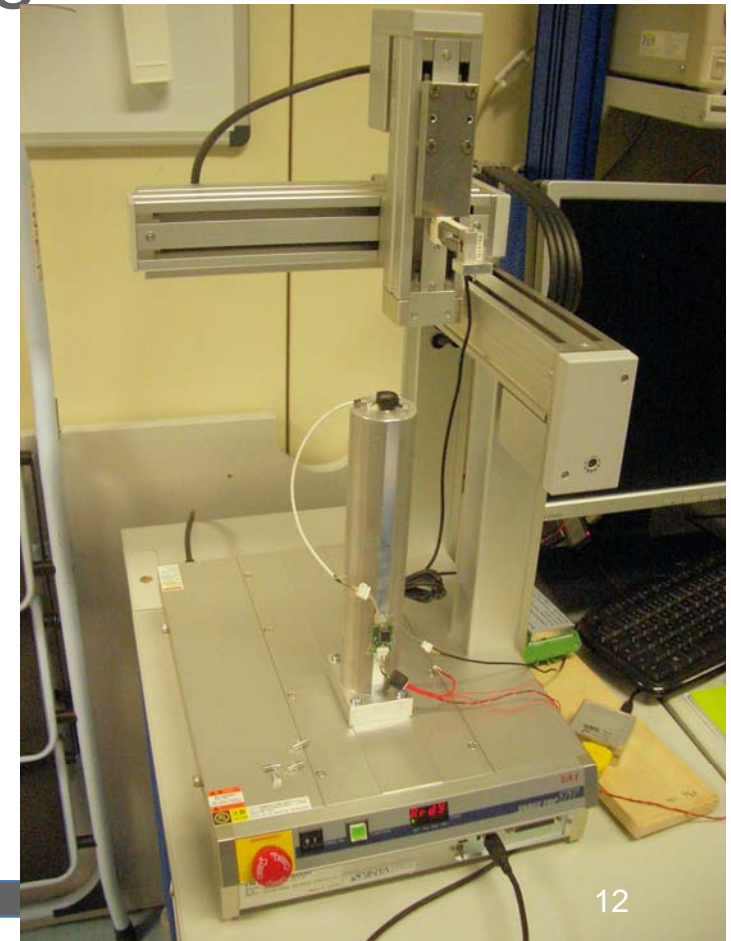
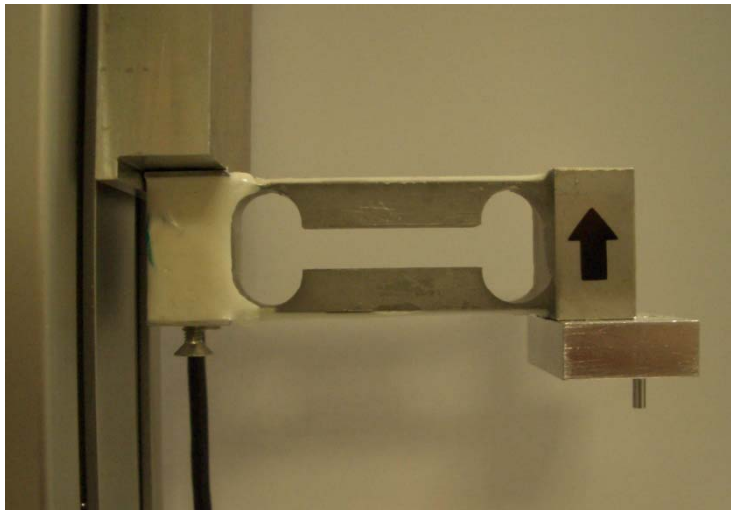
Cabling

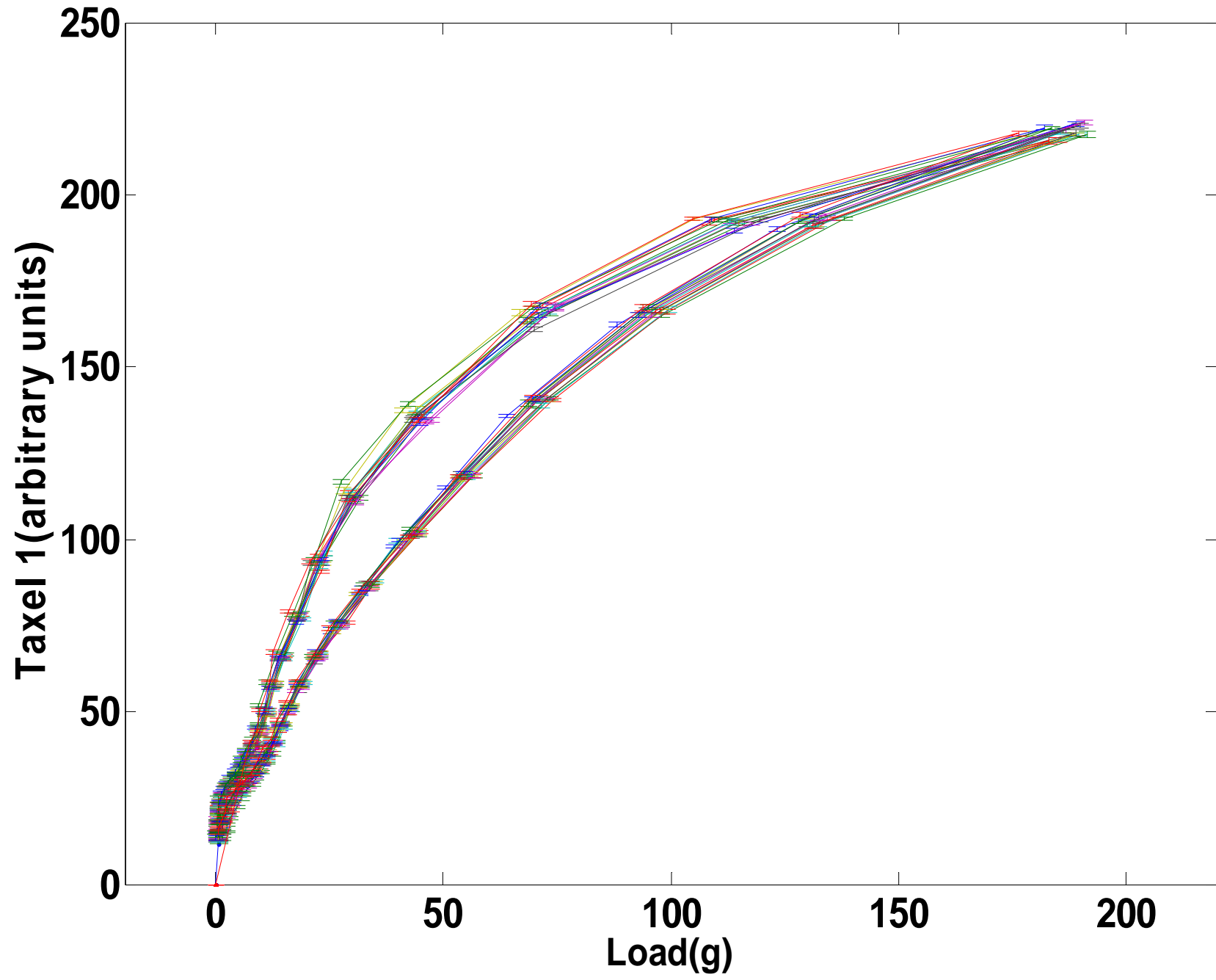
- Fingertip: 4 wires
- Triangles communicate between themselves
- Microcontroller board



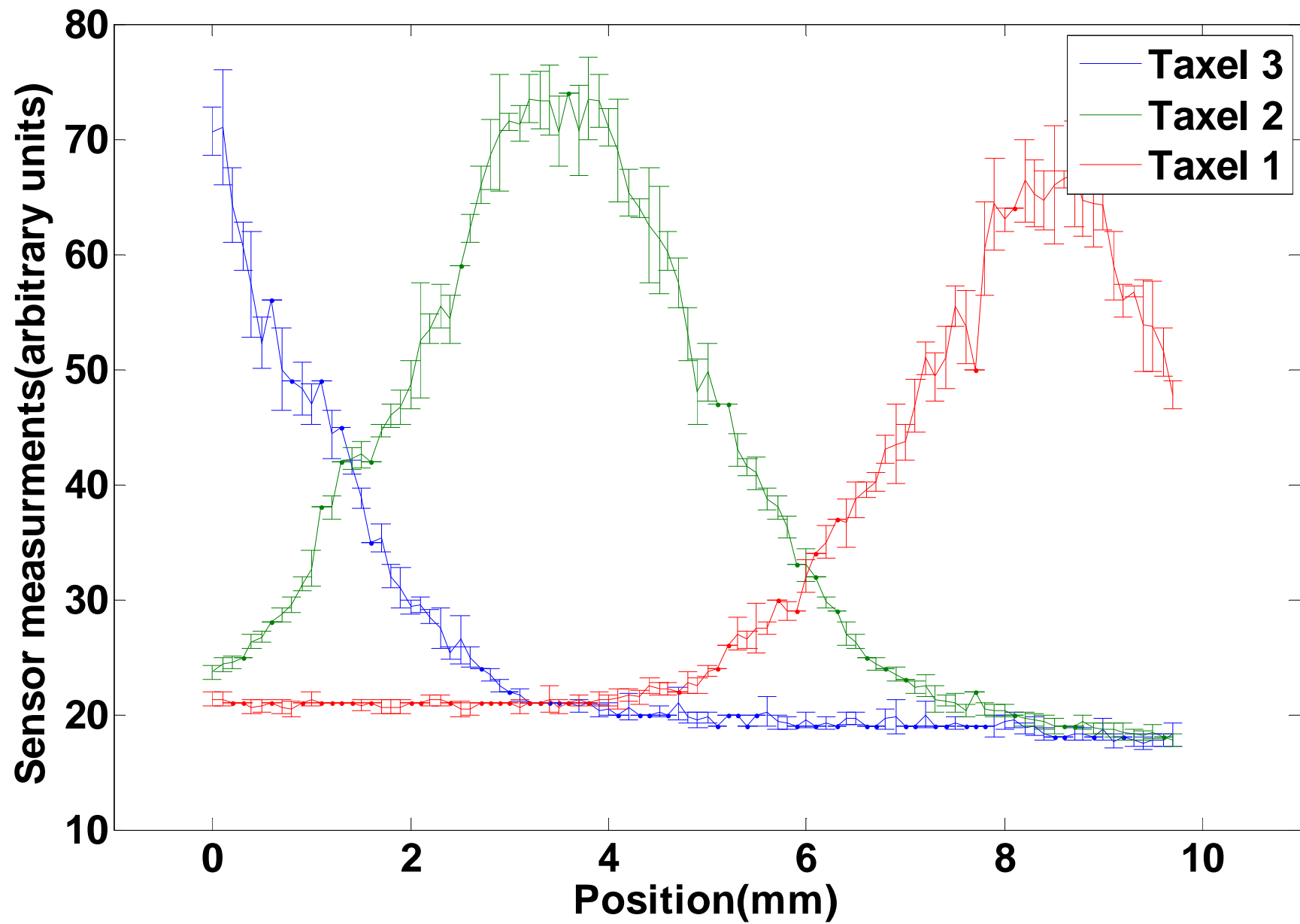
Test setup

- Cartesian robot: TT-C3-2020 from IAI
- Loadcell: AS1 from Laumas





The measurements of taxel 1,2,3 for different positions



Summary

- Cutaneous sensor which can localize touch
- Small, easy to mount, A/D conversion included, only 4 wires, curved shape, ease of production
- Compliant

- Fast initial response
- Range
- All the surface is covered with sensors
- Repeatability over trials
- Sensitive (less than 1 gram)
- Drift, stability, hysteresis, creep



Future Work

- Testing (especially use them for grasping)
- Integration with other sensor modalities



Thank you for your attention!