Tactile Sensor Network System

(1) Potential markets having strong pains (needs)

Instead of humans, robots with high-performance multi-sensors will handle various types of things including goods, foods, humans, and virtual ones.

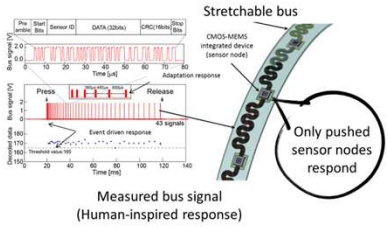
Piece picking at distribution centers, especially EC related ones

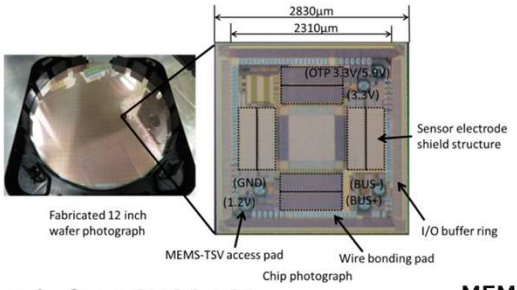
Food handling for lunchbox, fruit, vegetable, and so on

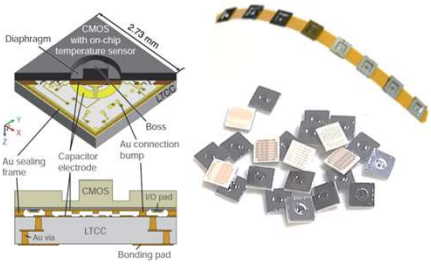
Nursing care and daily life support for comfortable activity of elderly people

Virtual reality and/or mixed reality with new type of human motion sensing systems

(2) Solution by human inspired system with sensor platform CMOS-LSI and MEMS integration technology







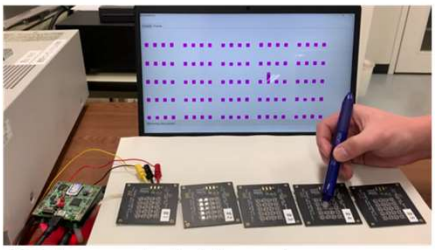
Basic concept:
Event-driven response with serial bus communication can realize fast response with small number of wiring for large scale sensor distribution

Patents:
Domestic issued patents: 9
International ones: 11

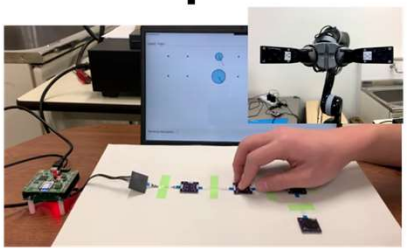
Sensor platform CMOS-LSI:
- Sensor interface as platform
  Cap./analog sensor 8ch readout circuits
- Communication interface as platform
  High-reliable clock and data recovery circuit over RS485 differential signaling for 256 sensor connection on 1 bus line
- Integration interface as platform
  Sensor noise shielding, MEMS integration area, access pads for through Si vias

MEMS integration technology:
- Flipped CMOS-LSI diaphragm with LTCC interposer, Au bump and Au seal-ring
- 3-axis force sensing with high-sensitivity, low-hysteresis, and digital output
- Embedded temperature sensing for compensation and thermal and force sensing
- 4-inch batch fabrication processing with over 90% high-yield by using our supply chain

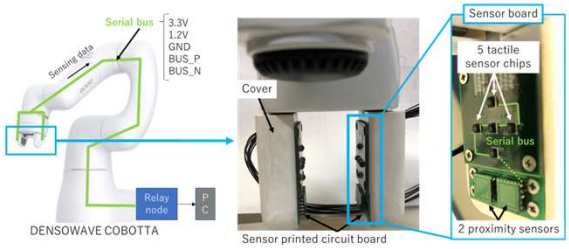
(3) Results and future plan



100 integrated chip system:
- 20 integrated chip/PCB × 5 boards
- 100 Z-axis force display S/W



Standard tactile module system:
- 5 chips/board
- Can be assembled like LEGO block
- 3-axis force display S/W
- Can be used for hardness recognition



Prox. + tactile sensor fusion system:
- Proximity sensor array for fine finger alignment
- Soft touch for grasping objects w/ tact. sensors
- Cap. change of the proximity and tactile sensors may be used for object recognition

C. Shao, H. Hirano, H. Miyaguchi, M. Nomoto, M. Muroyama and S. Tanaka, "Event-Driven Tactile Sensing System Including 100 CMOS-MEMS Integrated 3-Axis Force Sensors Based on Asynchronous Serial Bus Communication," in *IEEE Sensors Journal*, vol. 20, no. 17, pp. 10159-10169, 1 Sept.1, 2020, doi: 10.1109/JSEN.2020.2991259.

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