Capacitive Sensing 3D-printed Wristband for Enriched Hand Gesture Recognition

Hoang Truong, Phuc Nguyen, Anh Nguyen, Nam Bui, Tam Vu

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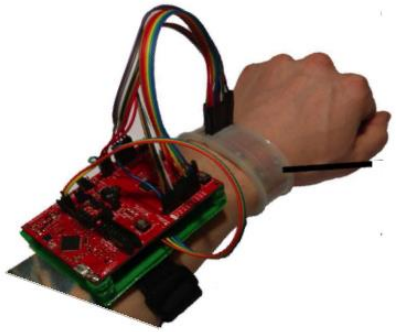
Motivation for hand gesture recognition

+ User interacts more seamlessly
+ User does not need to click/drag/touch/press on his/her devices

Criteria for hand gesture wearable devices



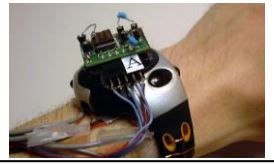
- Support large number of gestures
- Continuous and real-time tracking
- Unobtrusive device
- Low power (Battery Free)
- User friendly
- Enable various applications

Sensitive and reliable sensing technique

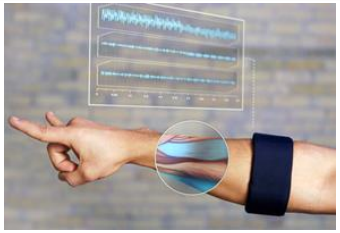
Gesture-based Energy Harvesting

Compact and simple hardware-software interface design

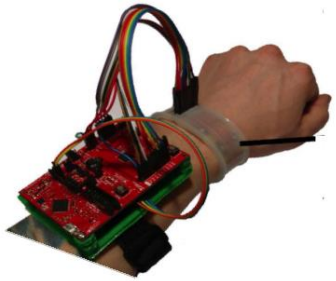
Existing hand gesture recognition technologies

Product	Position	Technique	Disadvantages
GestureWrist 	Wristband	Capacitive sensor	No accuracy stated
Tomo 	Wristband	Impedance tomography	• Closed source • High power consumption
Backhand 	Back-hand	Strain gauge sensor	• Limited number of hand gesture • High power consumption

Existing hand gesture recognition technologies

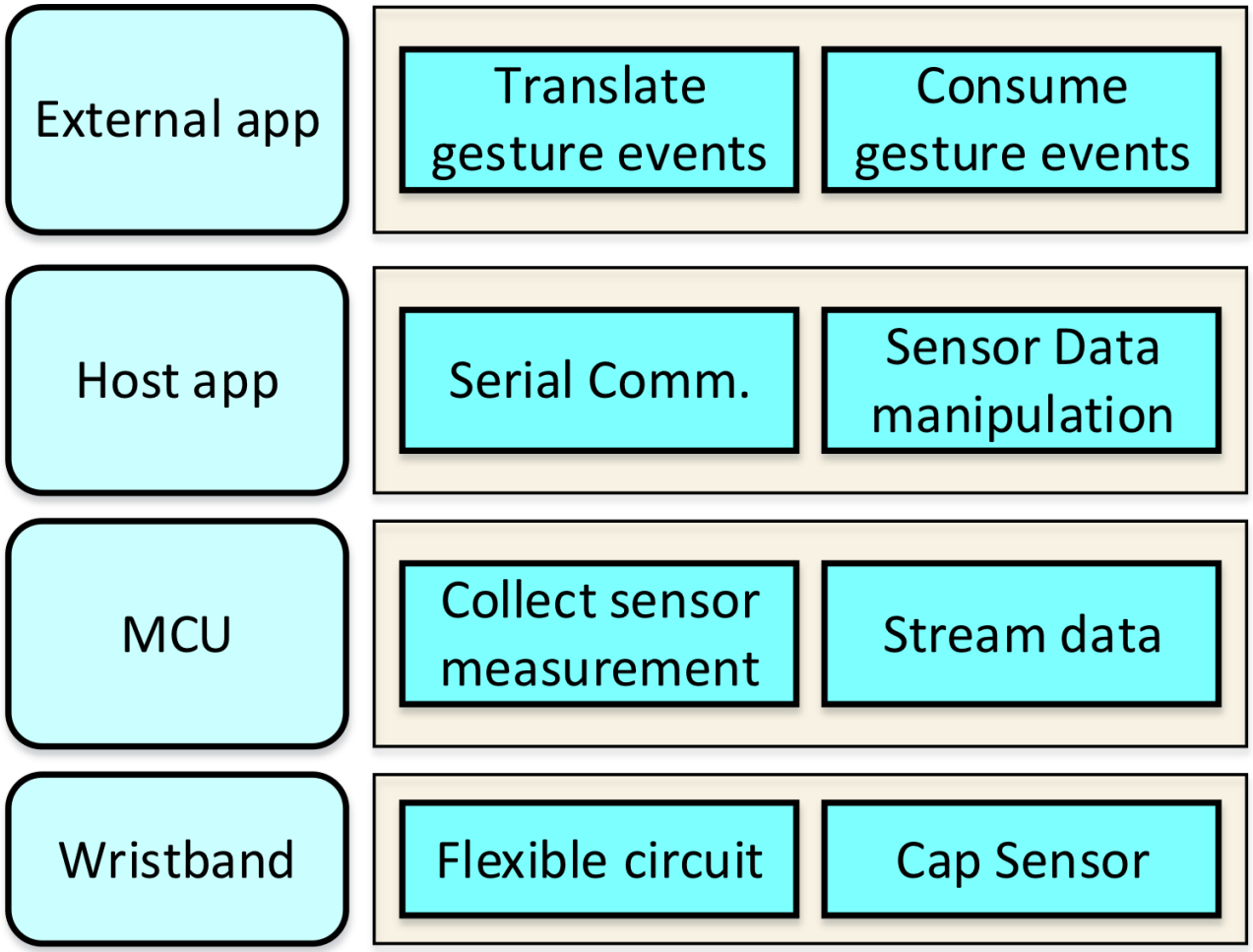
Product	Position	Technique	Cons
Myo 	Armband	EMG signal	• Inaccurate • Re-calibrate every time
Leap motion 	External	Camera + IR light	• Sensitive to noise from external light bulb, LEDs, white objects
Wristflex 	Wrist	Pressure resistor	• Closed source • High power consumption

Progress

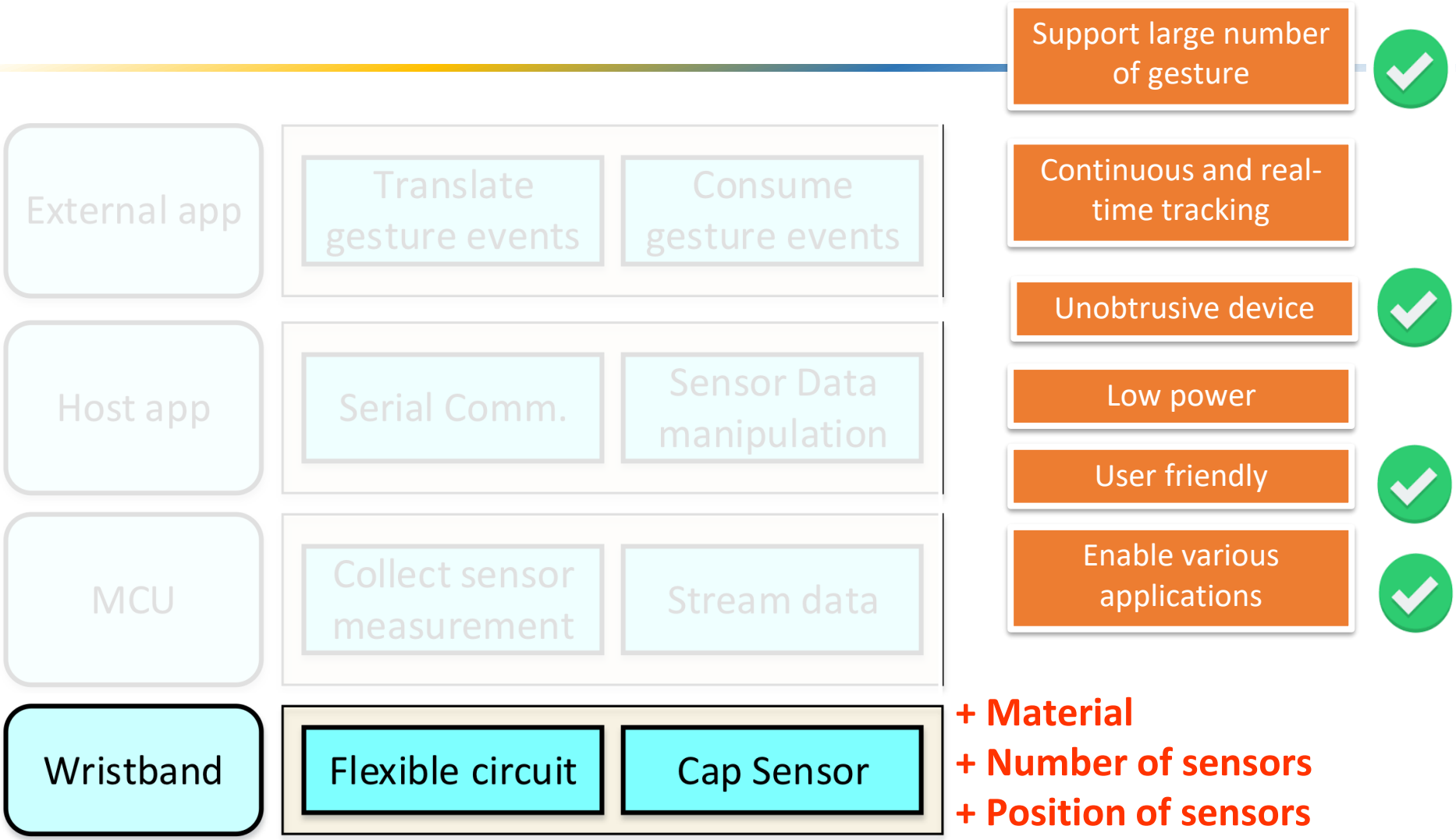


Support large number of gesture	✓	Extendable HW-SW design and user defined gestures
Continuous and real-time tracking	✓	Light-weight HW-SW stack
Unobtrusive device	✓	Wristband wearable design
Low power (Battery Free)	✗	• Special ADC design • Efficient gesture-based energy harvesting
User friendly	✓	Open source HW-SW design
Enable various applications	✓	HW-SW stack design

Hand gesture sensing platform



Design concern & decision



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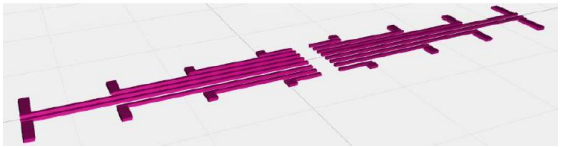
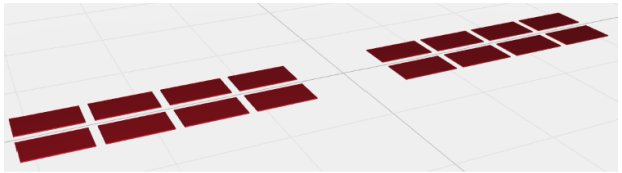
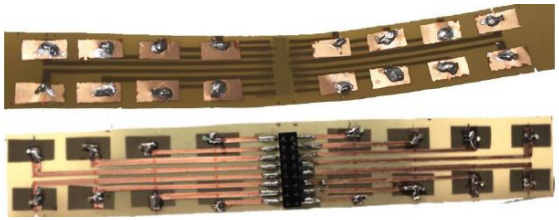


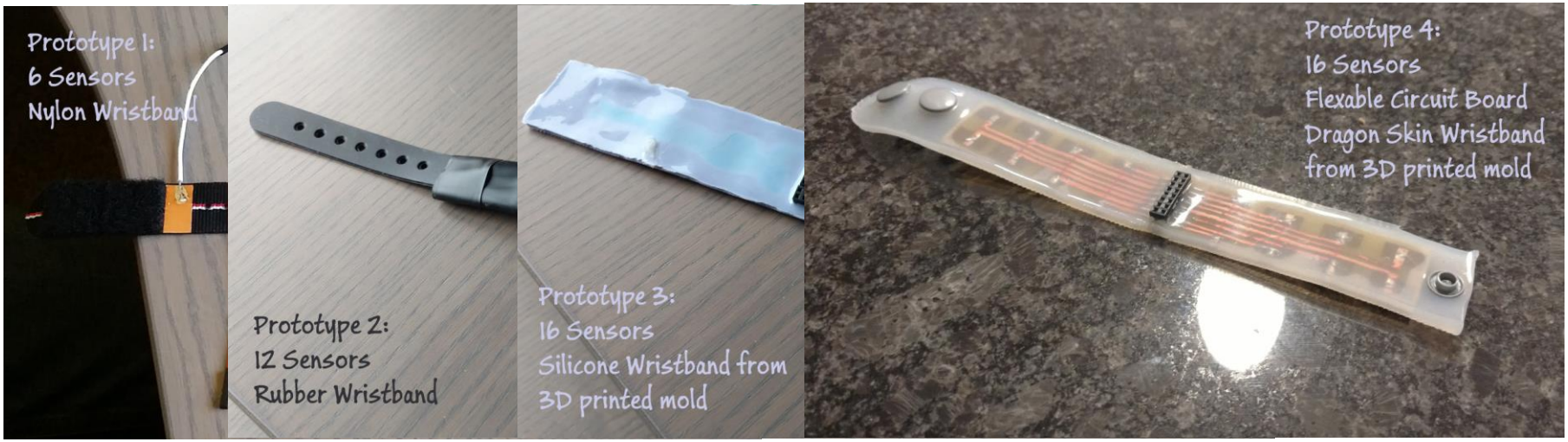
Wiring



Sensor placement



Flex PCB



Prototype evolution

Design concern & decision

Support large number of gesture

Continuous and real-time tracking

Unobtrusive device

Low power

User friendly

Enable various applications

External app

Translate gesture events

Consume gesture events

Host app

Serial Comm.

Sensor Data manipulation

MCU

Collect sensor measurement

Stream data

Wristband

Flexible circuit

Cap Sensor

TI MSP430FR5969

Design concern & decision

External app

Translate gesture events

Consume gesture events

Host app

Serial Comm.

Sensor Data manipulation

MCU

Collect sensor measurement

Stream data

Wristband

Flexible circuit

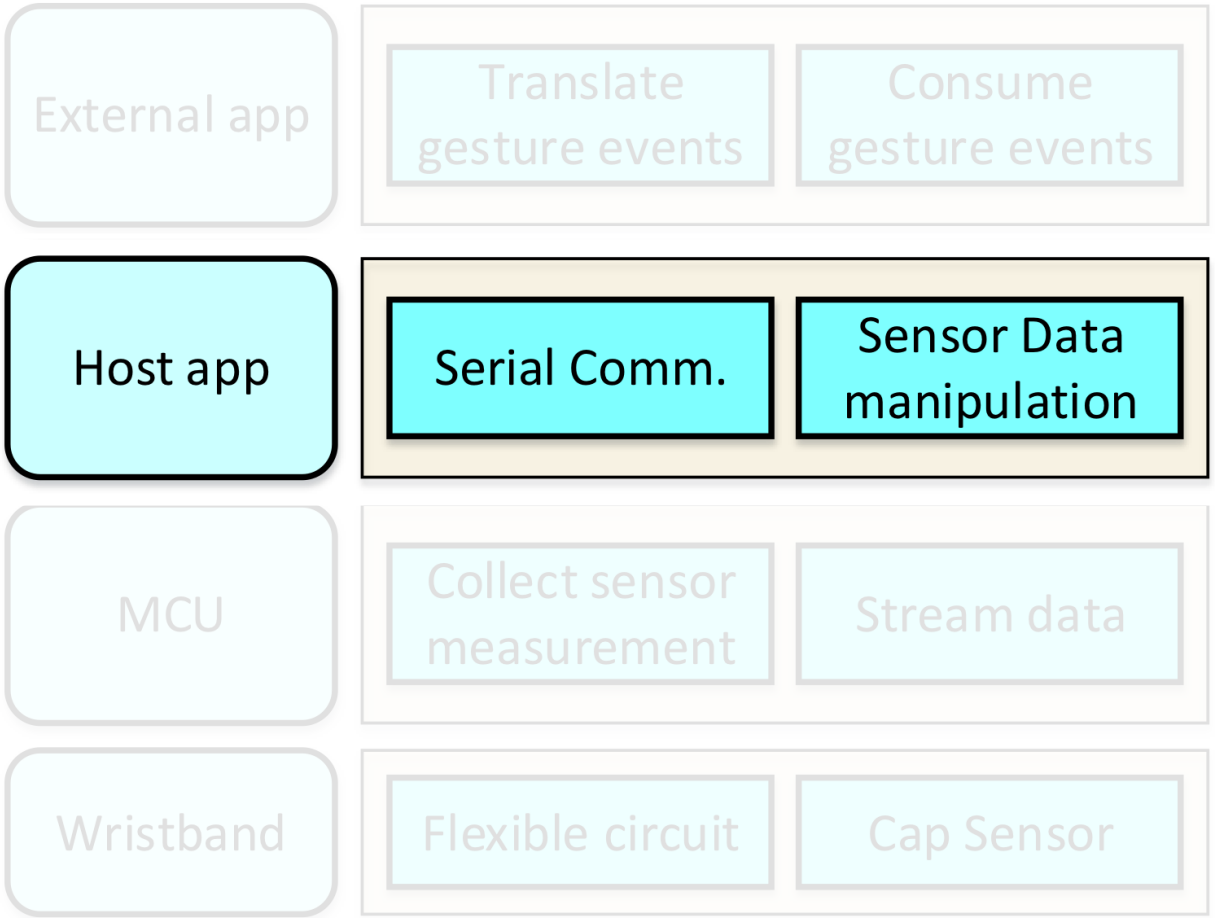
Cap Sensor

CLI

SVM Classification

Web UI, Spring framework

Design concern & decision



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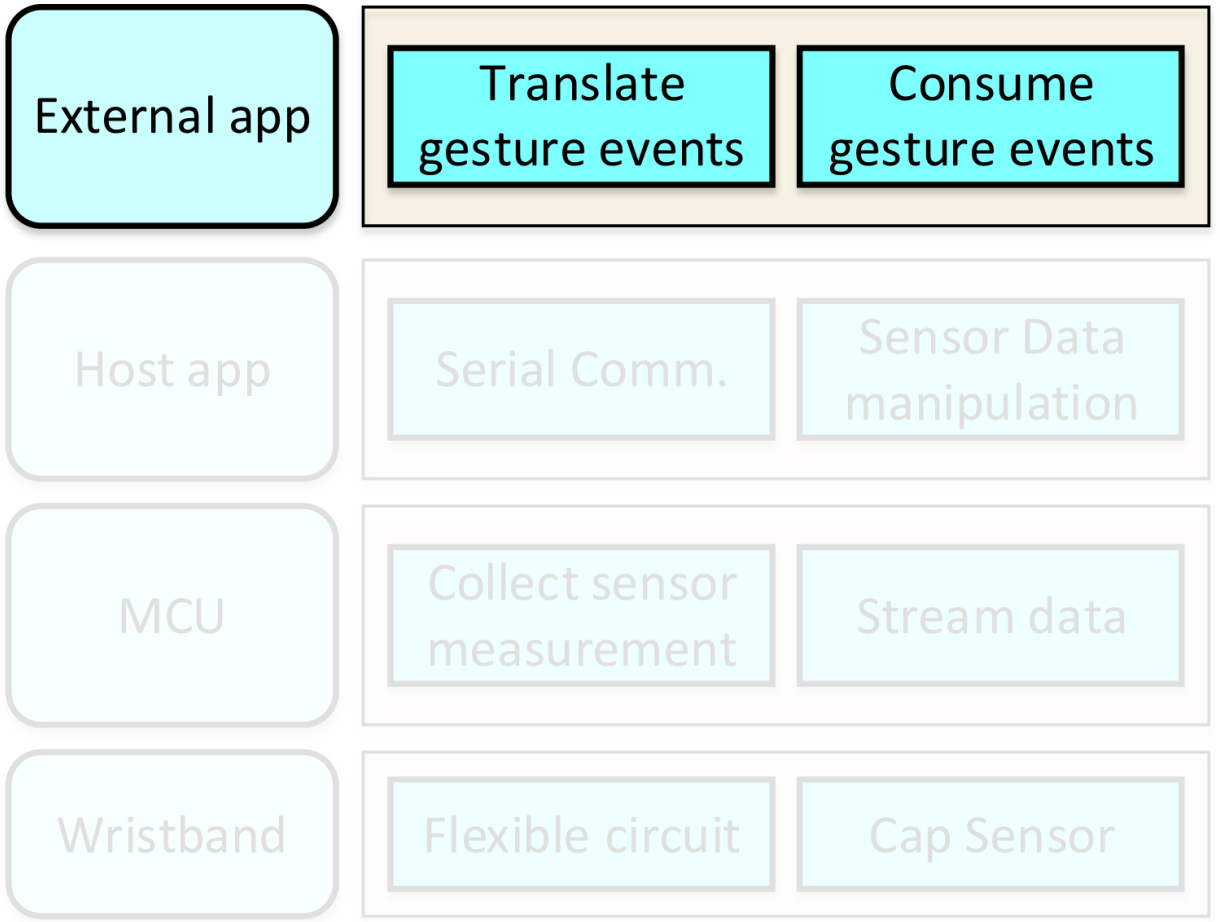
Design concern & decision



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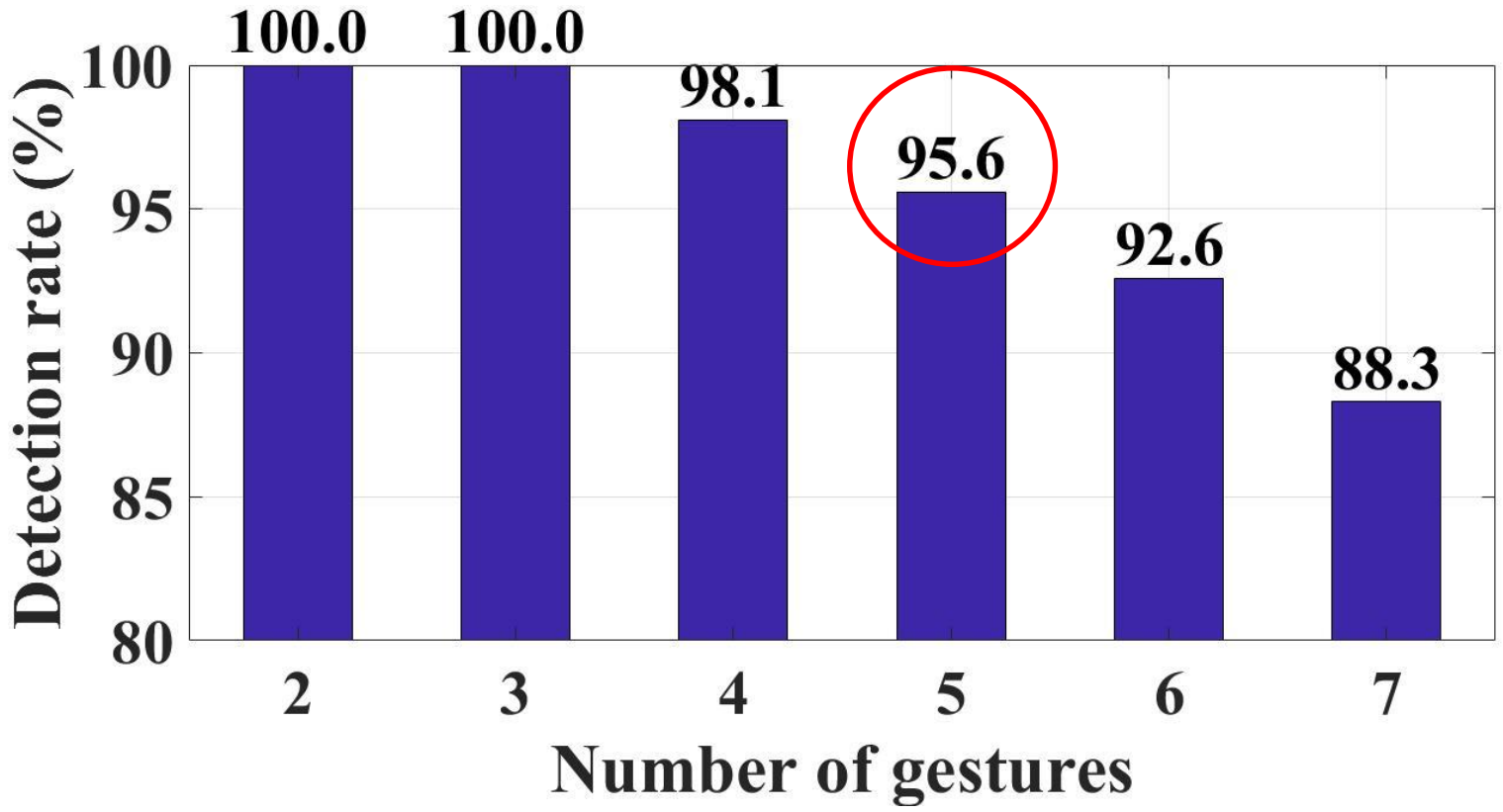
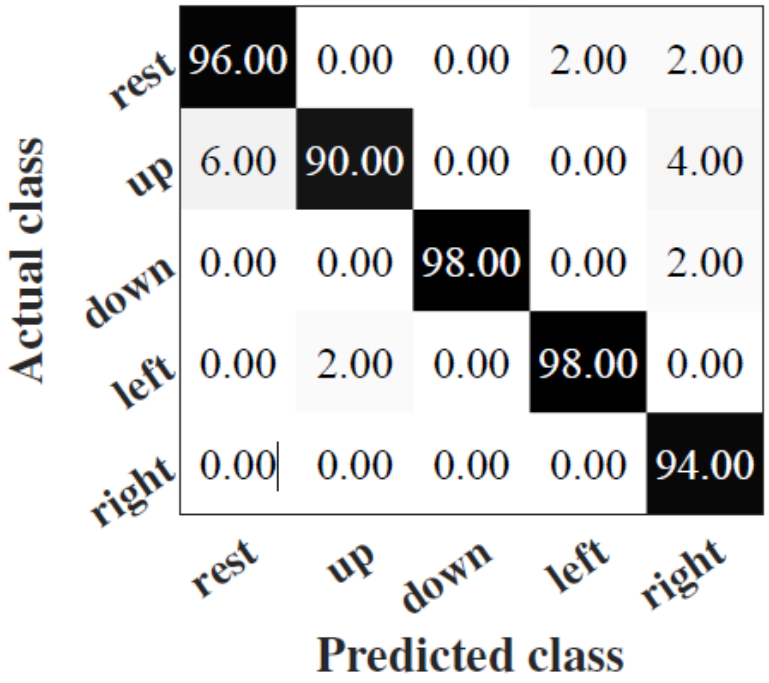
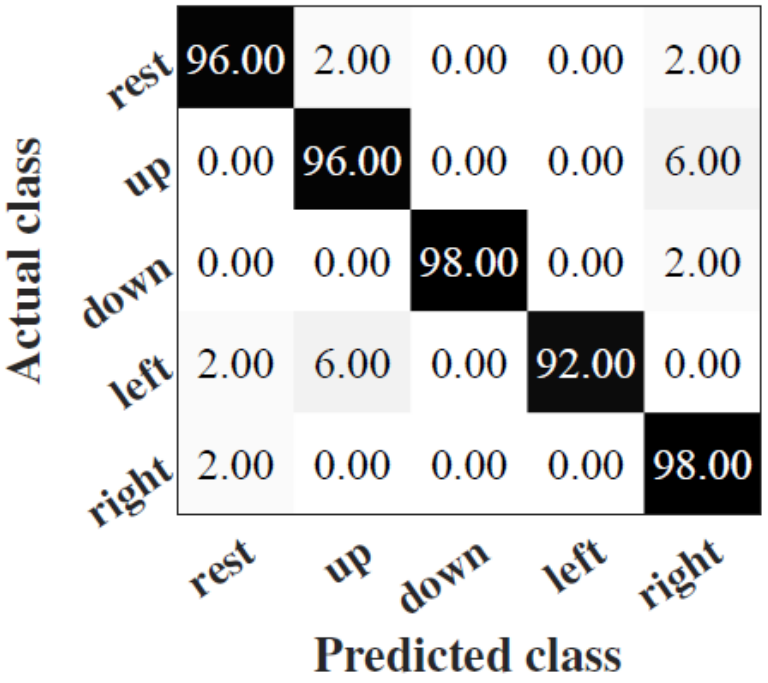
Overall detection rate



Confusion matrix

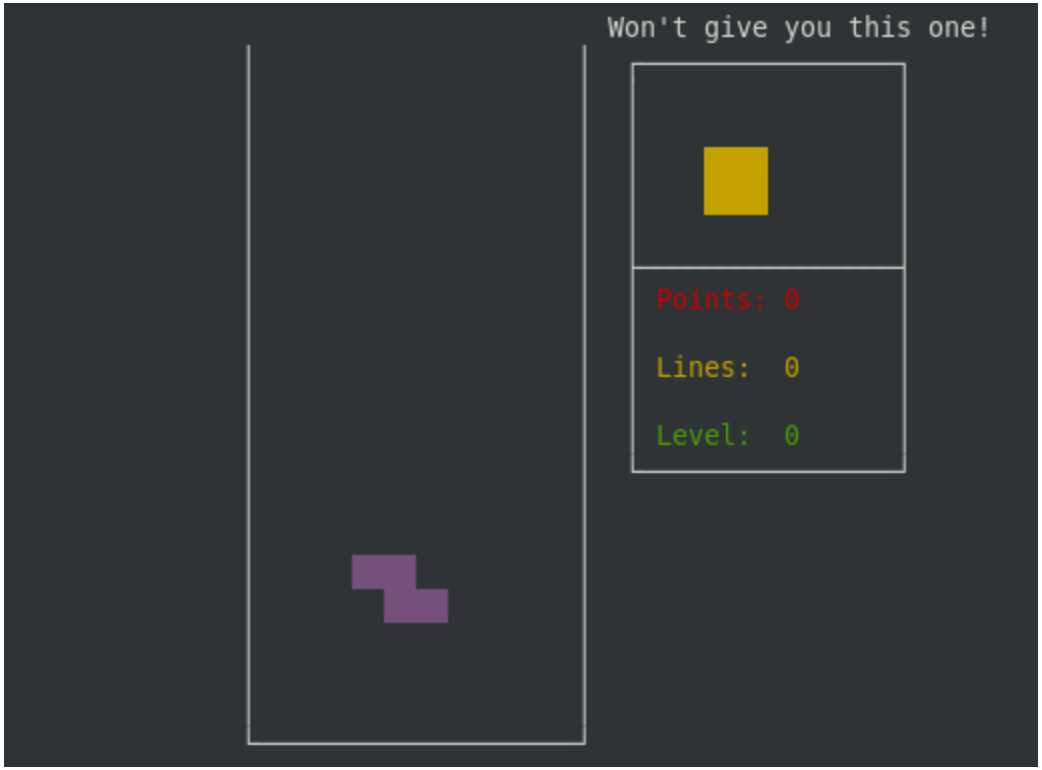


(a) **Left hand**



(b) **Right hand**

Demo app



Tetris time

Conclusion

- We proposed a hand gesture recognition system utilizing capacitive sensing technique.
- We presented a wristband-form device augmented sensor arrays under the flexible circuit board.
- We also provided a detail hardware and software interface of the proposed system.
- We envision that this technology can be easily integrated into a smart wristband or a smartwatch through an implemented application (Tetris game).

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