DEMO: Low-power Capacitive Sensing Wristband for Hand Gesture Recognition

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MOTIVATION

- Capacitive sensing technique enables high sensitivity measurement, low-power requirement and low-cost prototype components.
- Capacitive sensing technique promises a feasibility for a battery-free hand gesture recognition device.
- The system is provided to research and developer community as open source HW-SW design. Prototype is easy to replicate.
- Developers can adopt easily to integrate into their applications.

OBJECTIVES & APPROACHS

Support large number of gesture	Extendable HW-SW design and user defined gestures
Continuous and real-time tracking	Light-weight HW-SW stack
Unobtrusive	Wristband wearable design
User friendly	WEB UI Interface
Enable various application	Open source HW-SW design
Low power	• Dedicated ADC design • Efficient energy harvesting

CAPACITIVE SENSING

- An open capacitor design allows the skin of the user to act as the second plate of each capacitor.
- Compression of the silicone wristband causes a change in distance from the user's skin to the sensors and a change in capacitance
- Capacitance is measured via a comparator-based relaxation oscillator.

CHALLENGES

- The highly sensitivity of capacitive sensors makes the sensor reading fluctuate over time and be susceptible to noise.
- The design sensors (i.e. number and arrangement of sensors, distance to users' skin) must be aligned precisely.
- There is tradeoff between accuracy and power consumption (i.e. higher number of sensors will require more power consumption for ADC input).
- Continuous and real-time operation is necessary to determine users' current gesture.

CONTACT US

Source Code – https://tinyurl.com/MNSWristband

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SYSTEM OVERVIEW

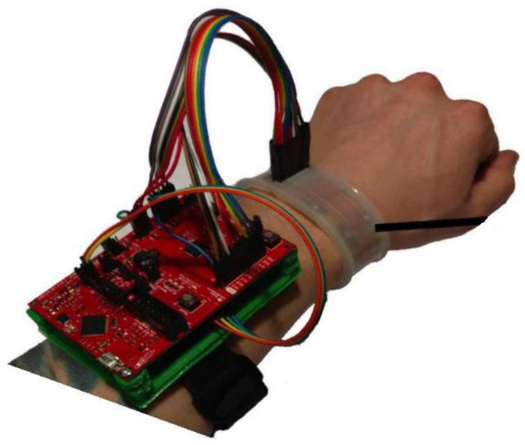

Fig. 1. **Final Prototype**

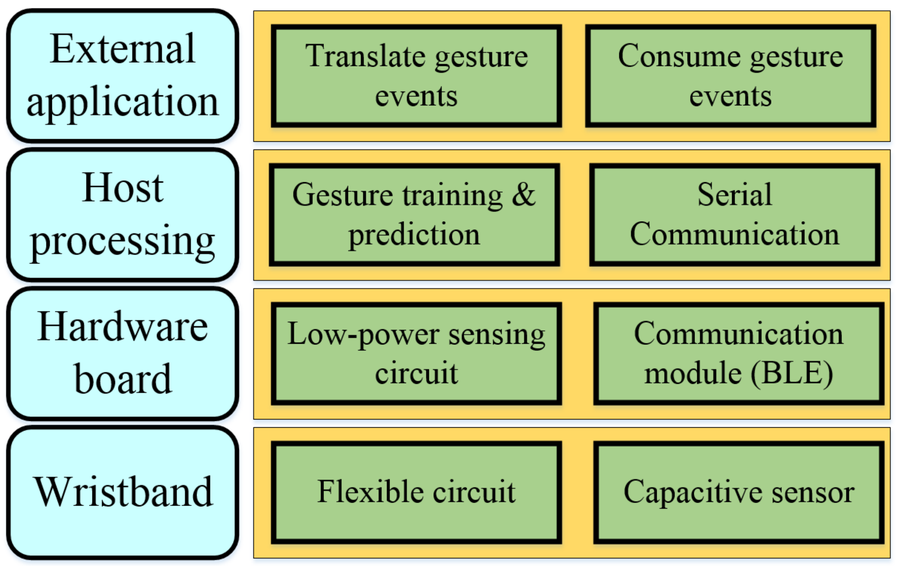

Fig. 2. **System architecture**

CAPACITIVE SENSING (CONT.)

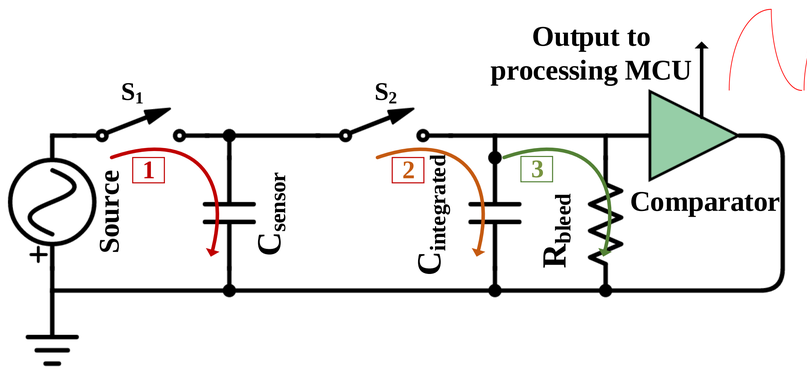

Fig. 3. **General capacitive sensing circuit with 3-stage operation and output for relaxation oscillator method**

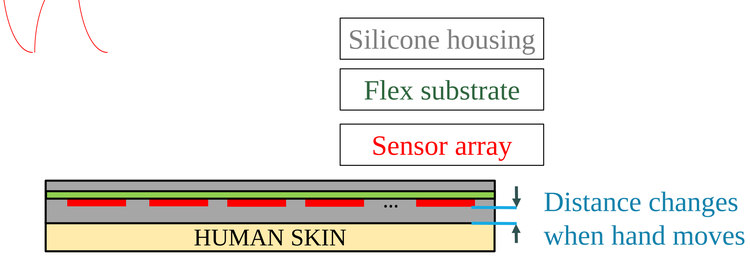

Fig. 4. **Open capacitor - sensor and skin of the user act as dielectric plates**

SENSOR DESIGN

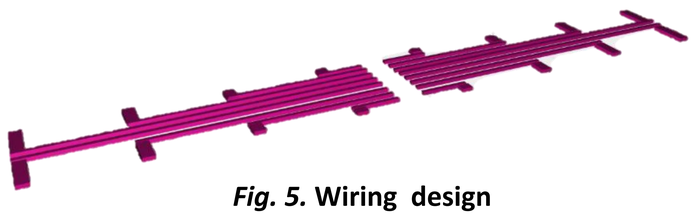

Fig. 5. **Wiring design**

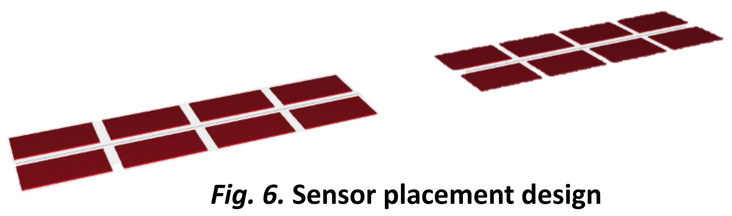

Fig. 6. **Sensor placement design**

SOFTWARE DESIGN

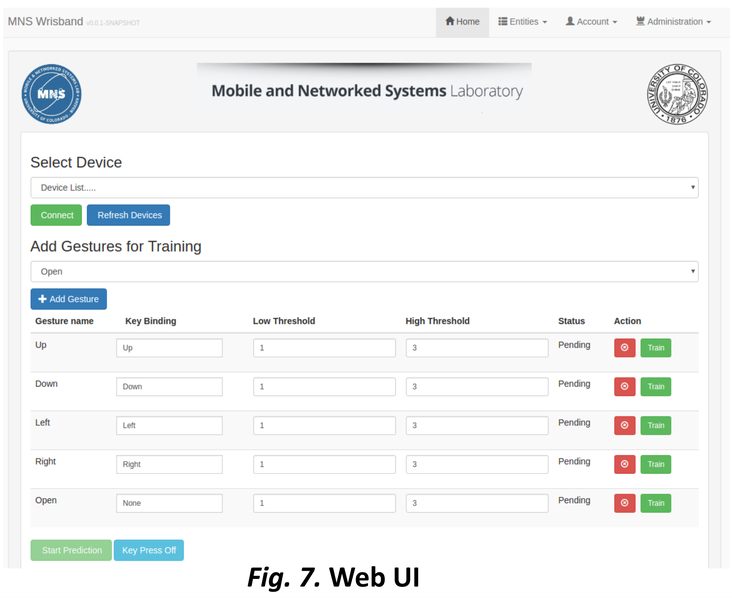

Fig. 7. **Web UI**

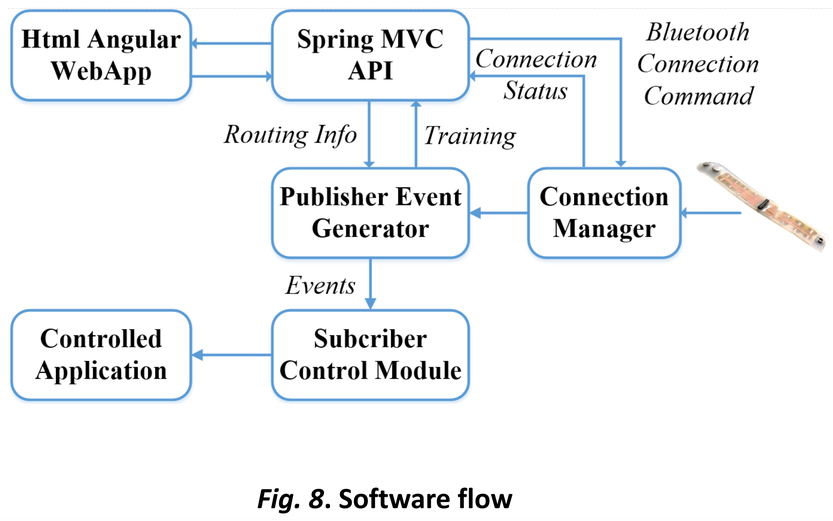

Fig. 8. **Software flow**

SYSTEM PERFORMANCE

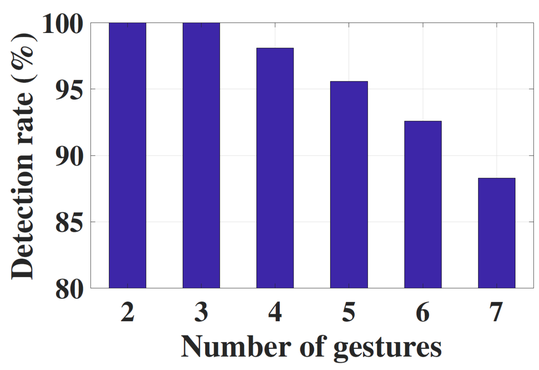

Fig. 9. **System performance w.r.t. the number of gestures in the prediction set**

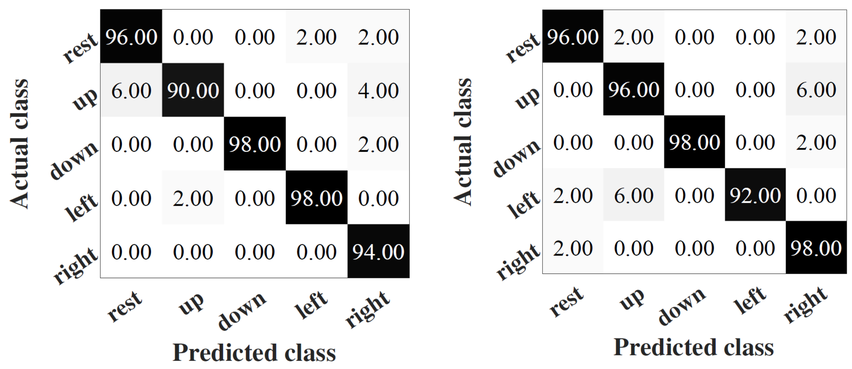

Fig. 10. **Confusion matrix for system performance using training data (left hand and right hand respectively)**