BITNG LAB UPDATE

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Date 1/19/2021

Outline

- Progress to date
- Path forward

PROGRESS TO DATE

Progress from last week

- Shriner’s project
  - Literature review

SHRINER’S PROJECT

Literature review

- Tables:
  - Existing Technology Overview
    - Pressure sensors (wearable sensor glove)
    - Temperature sensors (wearable sensor glove)
    - Strain sensors (wearable sensor glove)
  - Glove Applications
- Figures:
  - Pie chart showing all three sensor nodes
  - Examples of wearable sensor gloves
    - Academic
    - Commercial
    - DIY

Sensor	Sensor properties			Glove application	Reference
	Material	Mechanical	Electrical		
Temperature	Si, Au Nanoribbon in Polyimide	GF = 200; Fracture toughness = 1 MPa $m^{1/2}$; t = 110 nm	10 mV/C	Artificial skin containing staggered arrangement of sensors	Kim et al. [7] (2014)
	OTS Texas Instruments Contact Temperature Sensor	2.80 mm x 2.95 mm	0.0625 C/Bit using TC77 IC	Prosthetic and robotic hand sensory enhancement	Polishchuk et al. [16] (2016)
	Carbon nanotubes and ionic liquid embedded in silkworm fiber yarn surrounded by EcoFlex	0.76 mL of multiwalled CNT; 0.5 mL of ionic liquid	1.23% C^{-1}	Electronic Textile Sensor for High Space Precision	Wu et al. [57] (2019)
	OTS Texas Instruments Contact Temperature Sensor	5.00 m x 4.8 mm	±0.5°C Accuracy; 10 mV/ C	Temperature detection for wearable sensor glove	Hughes et al. [5] (2020)
Pressure	OTS Interlink Electronics FSR	Piezoelectric sensor; 0.2" Diameter	22 N/MΩ	Prosthetic and robotic hand sensory enhancement	Polishchuk et al. [16] (2016)
	Silicone tubing filled with water	2 mm diameter soft tubing	Pressure Delta = 3 – 100 Pa; transducer sensitivity = 38.26 mV/kPa	fluidic pressure sensors glove	Hughes et al. [5] (2020)
	Si, Au Nanoribbon in Polyimide	GF = 200; Fracture toughness = 1 MPa $m^{1/2}$; t = 110 nm	Delta R/R0 %/Pressure kPa ~ 0.40	Artificial skin containing staggered arrangement of sensors	Kim et al. [7] (2014)
	Silicone based sensor with conductive liquid	5.3% Hysteresis @ 1 Hz	100% Resistance increase at 5 N;	Soft fluidic sensors for wearable sensor glove	Xu et al. [6] (2019)
	Galinstan liquid metal in EcoFlex silicone rubber	H = 500 um, W = 300 um, L = 157.4 mm	Pressure sensitivity = 125 kPa / V	Elastomer film to integrate sensors onto hand	Hammond et al. [17] (2014)
	Silver nanowires embedded in silkworm fiber yarn surrounded by EcoFlex	Ag NW L=25 um; D=50 nm	0.136 kPa^{-1}	Electronic Textile Sensor for High Space Precision	Wu et al. [57] (2019)
Strain	EPR, Scotch Electrical Semi-Conducting Tape 13	Elongation =<800%; 5 mm x 20 mm	Resistance change = 30.6%	Fabric sensor glove using silver plated nylon thread	Shen et al. [3] (2016)
	Si, Au Nanoribbon in Polyimide	GF = 200; Fracture toughness = 1 MPa $m^{1/2}$; t = 110 nm	Delta R/R0 %/Strain % = 0.833	Artificial skin containing staggered arrangement of sensors	Kim et al. [7] (2014)
	Knitted piezoresistive fabric	75% electroconductive yarn and 25% Lycra	< 5 Degree error	Wearable goniometer technology for motion sensing gloves	Carbonaro et al. [15] (2014)
	Millimeter-long multiwalled Carbon Nanotubes	Elongation < 200%; fracture elongation ~ 500%; Elasticity Modulus = 2-5 MPa	Sensing delay < 15 ms; GF = 10.5; 300 Ω/%	Wearable glove for real time motion detection	Suzuki et al. [54] (2016)
	OTS Flexion sensors	H = 0.43 mm; L = 112 mm; W = 6.35 mm	> 1 million cycles; Flat resistance = 10 kΩ	Mirror therapy and task-oriented therapy	Chen et al. [10] (2019)
	Galinstan liquid metal in EcoFlex silicone rubber	H = 500 um, W = 300 um, L = 97 mm	1.58 N / V	Elastomer film to integrate sensors onto hand	Hammond et al. [17] (2014)
	Conductive woven glove	Conductive knitted glove with insulated wire	120 unique sensor readouts	Resistive knitting for strain detection in glove	Hughes et al. [5] (2020)
	OTS Omega KFH-20-120-C1-11L1M2R Strain Gauge	Temperature Tolerance = 1/K; Elongation < 20,000 um/m	R = 120 Ω; GF = 2;	Hand pose tracking using limited strain sensing	Zhang et al. [55] (2019)
	Silicone based sensor with conductive liquid	Silicone Eco-Flex; E = 70 kPa; Failure Strain = 900%	GF = 2.2 @ 1 Hz	Soft fluidic sensors for wearable sensor gloves	Xu et al. [6] (2019)

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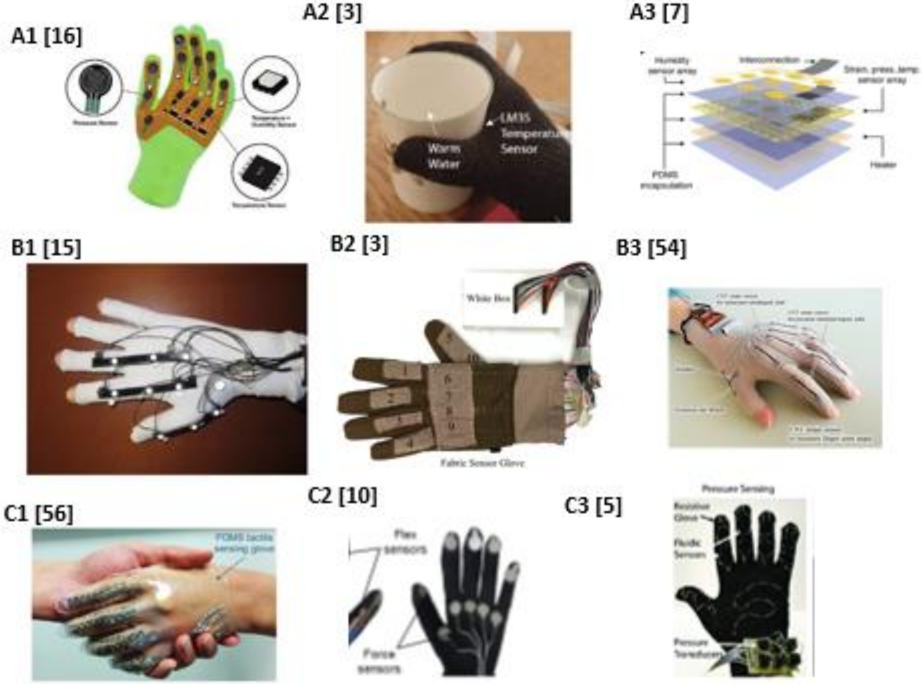

Figure XX. Various type of wearable sensor gloves for recording physical signals. A)


C3 [34]
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C3 [51]

C3 [52]

C3 [53]

Application Type	Application Category	Rational	Alternative	Purpose
Classical				
	Design & Manufacturing	Interact with computer-generated environments in a more natural way	Keyboard; Mouse; 3D Mouse	3D Modeling; Virtual architecture; Virtual prototypes; Virtual training
	Information visualization	Interact with data in a more natural way	Keyboard; Mouse	Scientific visualization; Manipulate scientific data audio-visual presentations; Manipulate data
	Arts & Entertainment	Interact with computer-generated environments in a more natural way	Keyboard; Mouse	Computer-animated characters; Musical performance; Control Acoustic parameters; Video games; Light based artistic shows
	Sign Language Recognition	Automatic translation	Keyboard; Mouse; Specialized video decoding	Communication systems for the deaf
	Computer	Enhance computers' portability	Keyboard; Mouse	Wearable Computers
Recent				
	Virtual Reality	Interact with computer-generated environments in a more natural way	Keyboard; Mouse; Specialized Controller; Headset	Video games; Virtual control of objects; Virtual communication
	Health Care Diagnostics	Easy and direct measurement between the hand and the environment	Motion analysis system; Goniometer; Keyboard; Mouse; Clinical Observation	Motor rehabilitation; Sensory enhancement; Medical diagnostics;
	Prosthetics	Improve control and adoption of prosthetic	Invasive nerve monitoring; Open loop feedback; Visual feedback	Prosthetic use; Prosthetic enhancement
	Robotics	Control and program robots in a more natural way	Keyboard; Mouse	Mobile robots; Automation robots; Teach skills to robots in a natural way
	Artificial Intelligence	Detect hand movements and gesture recognition	Algorithms; Threshold detection;	

Figure XX. This figure was derived from a previous literature review conducted by Dipietro et al. in an IEEE article in 2008 [18] and this figure was updated to reflect the latest advancements in the past decade.

PATH FORWARD

Path forward (1/18/21 – 1/26/21)

- Shriner’s Project:
  - Literature review
    - Introduction
    - Abstract
    - Body paragraphs

APPENDIX

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