DESIGN AND IMPLEMENTATION OF SIGN LANGUAGE TRANSLATOR

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Outline

- Introduction
- Literature Review
- Design Consideration
- Simulation

Introduction

- According to a news article produced by newsghana.com, in the 2010 Population census, there were 110,625 deaf and dumb people in Ghana who are in need for Sign Language Interpreters.
- Sign language has been the primary means of communication for the hearing and speech impaired and remains so.

Aim

- To design a glove-based sign language translator to bridge the communication gap between speaking and hearing/speech-impaired persons.

Objectives

- Review existing works on sign language translator.
- Design of a glove-based sign language translator.
- Implementation of design to detect American Sign Language(ASL) hand gestures.

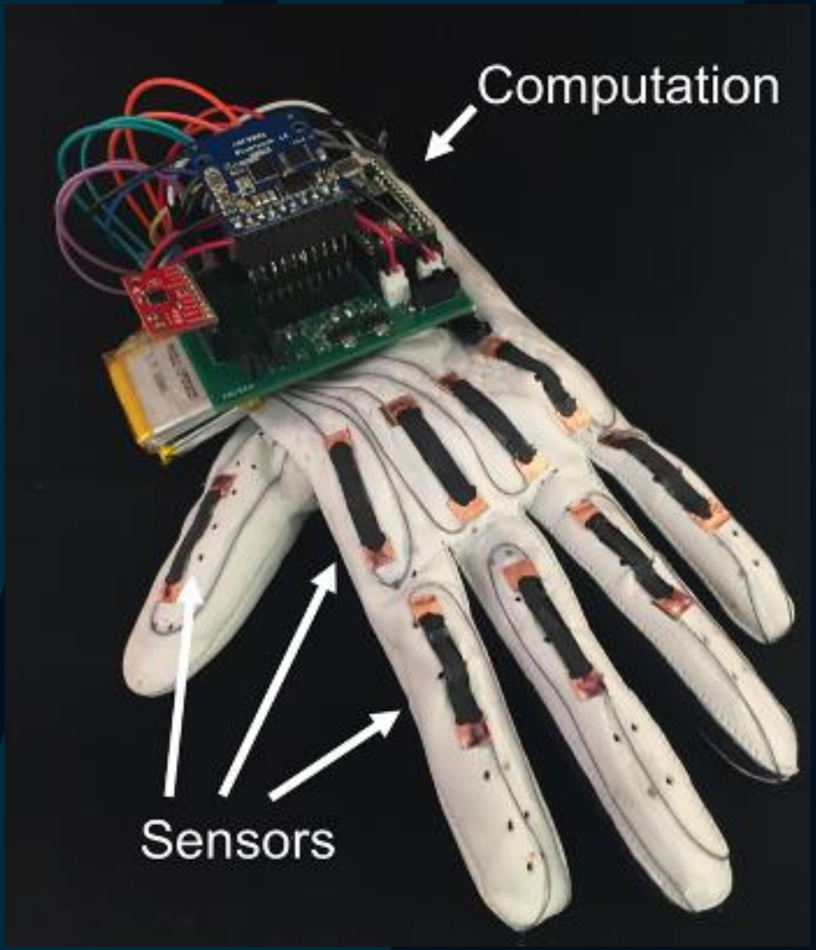
LITERATURE REVIEW

The Language of Glove: Wireless gesture decoder with low-power and stretchable hybrid electronics

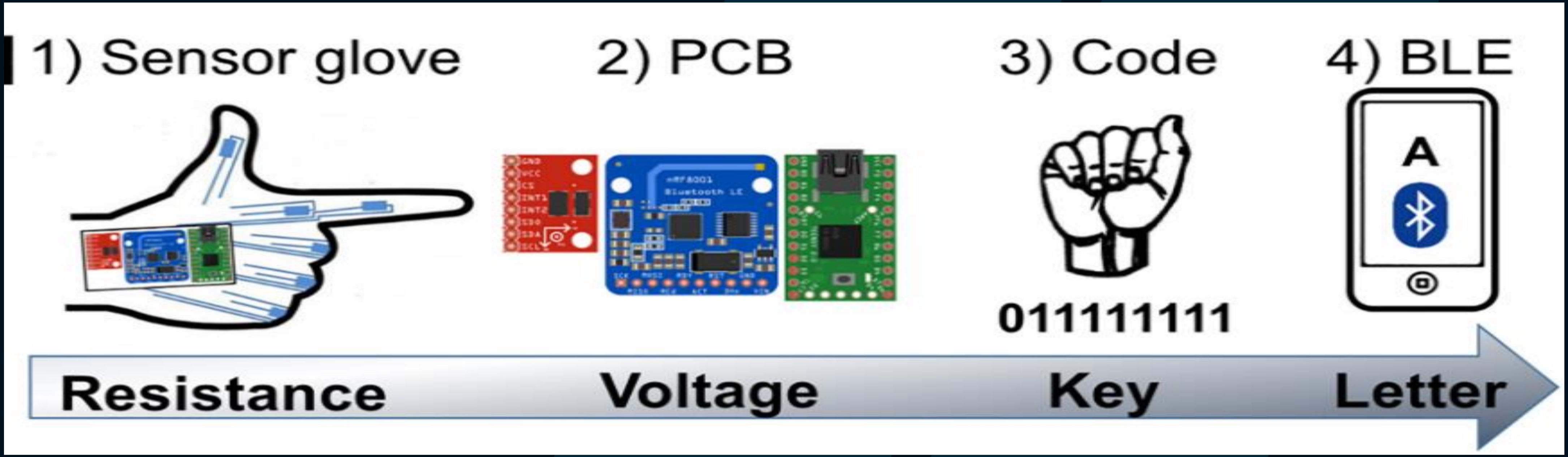
T. F. O'Connor, M. E. Fach, R. Miller, S. E. Root, P. P. Mercier, and D. J. Lipom

The complete process occurred in five steps:

- The strain sensors transduce the positions of the knuckles into variable resistance values;
- The values of resistance were converted into voltages using the voltage dividers;
- The microcontroller measured each voltage to generate a 9-bit binary key describing the state of each knuckle;



- the binary key was used to determine which letter was to be transmitted wirelessly to a smartphone.
- An accelerometer and pressure sensor were added for letters with degenerate codes (E/S, G/L, H/K, R/U/V) or that required motion (I/J and D/Z)



Strengths

- Components used are commercially available.
- Light weight.

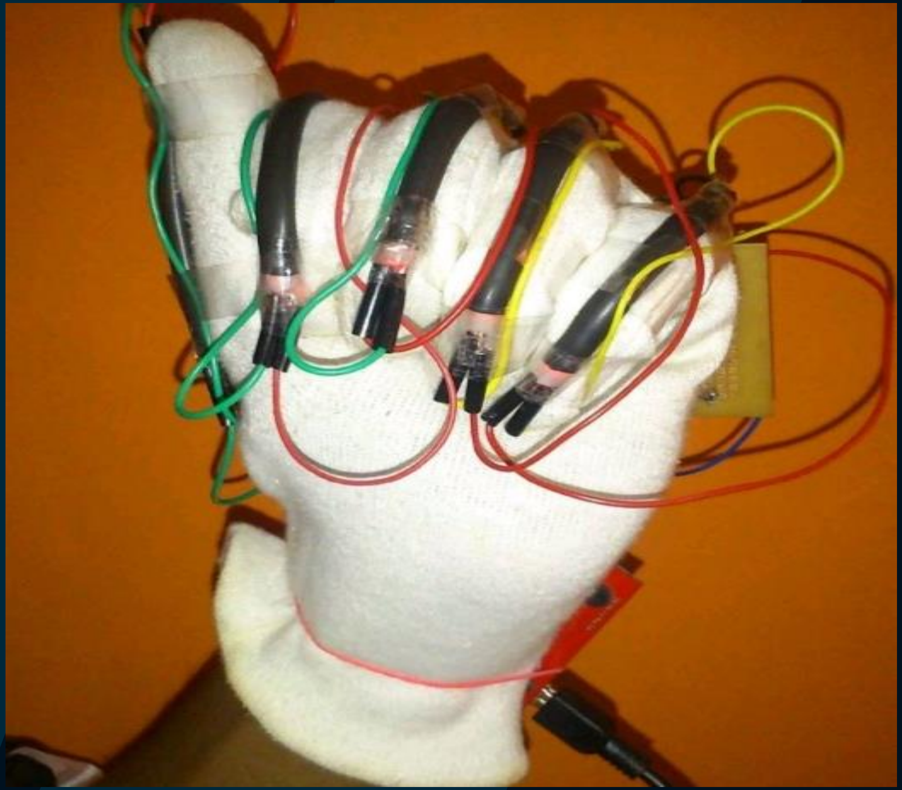
Weaknesses

- Only the 26 letters could be translated. Words and phrases were not translated.
- High cost due to fabrication of strain sensors.

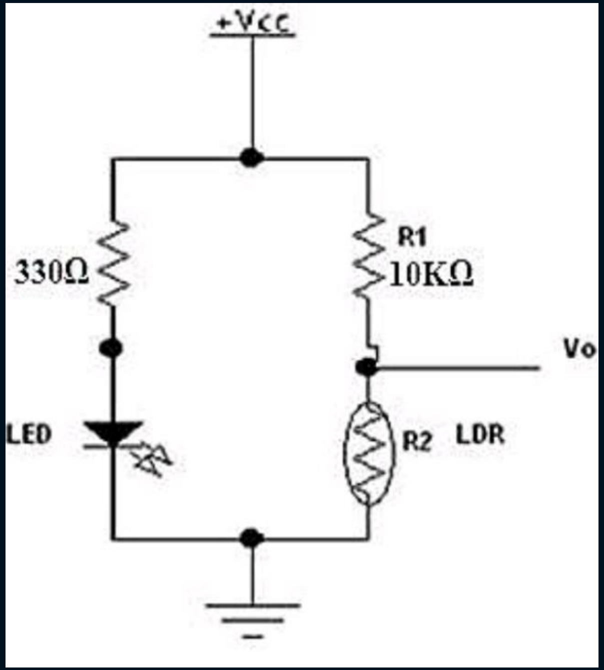
Sign Language Interpreter Using Smart Glove

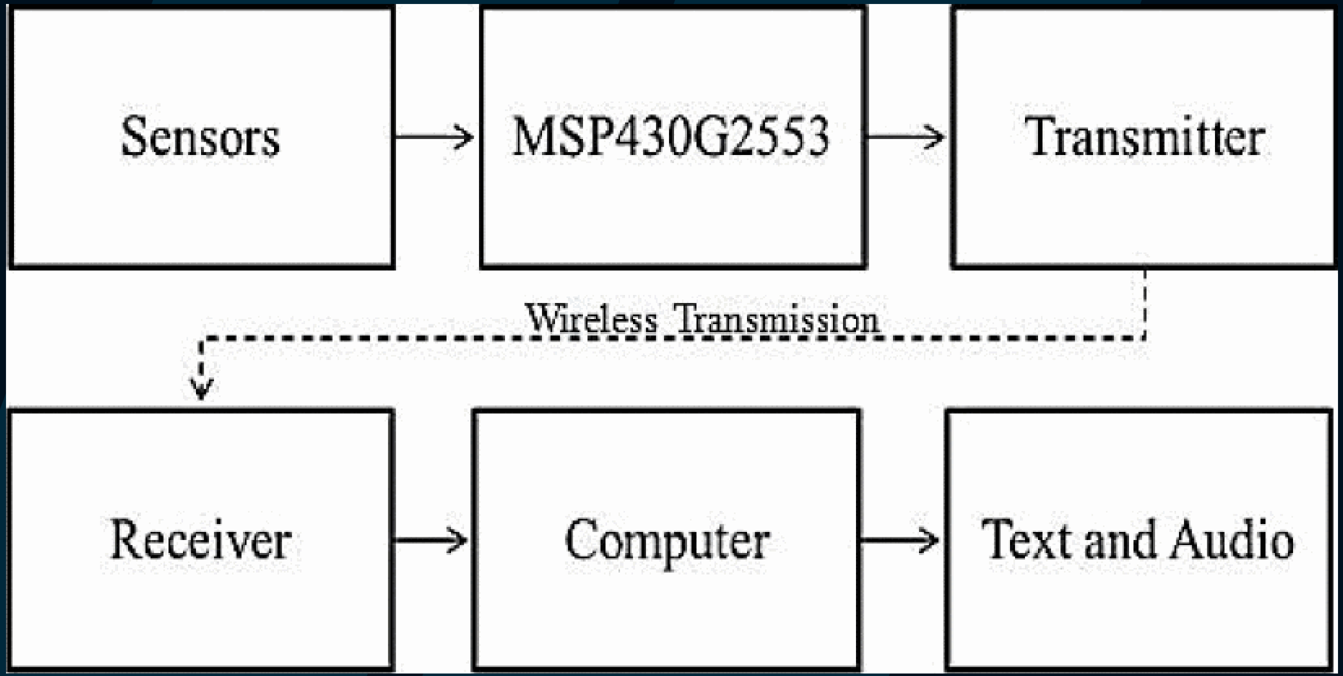
N. Praveen, N. Karanth, and M. S. Megh

- The design utilizes a pair of 5 LED-LDR sensors placed in line of sight in a sheath on each finger of the glove.
- The bending of the finger changes the amount of light intensity that falls on the LDR, changing the LDR’s resistance.



- The (MSP430G2553) microcontroller converts the analog voltages into digital samples.
- The corresponding ASCII character is serially sent via ZigBee technology to the computer to display the character as audio and text.





Strengths

- Low cost of sensors (LDRs and LEDs)

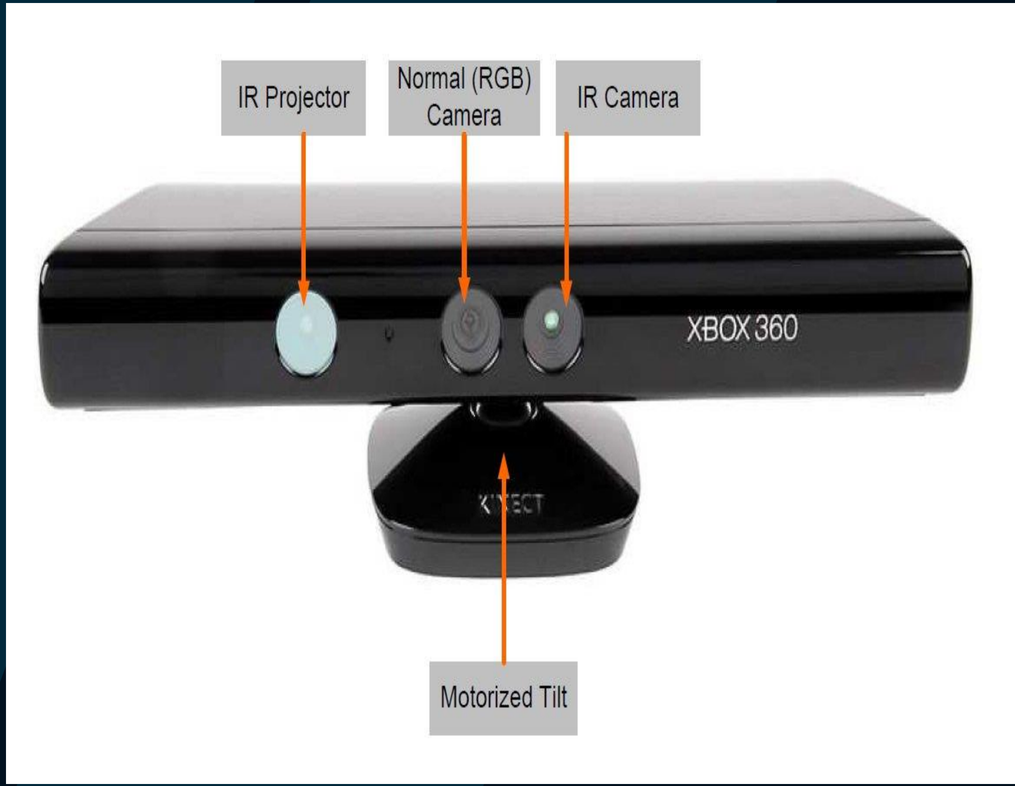
Weaknesses

- Narrow range of scope (designed for only 10 alphabets).
- Not portable (PC is used as the output device)

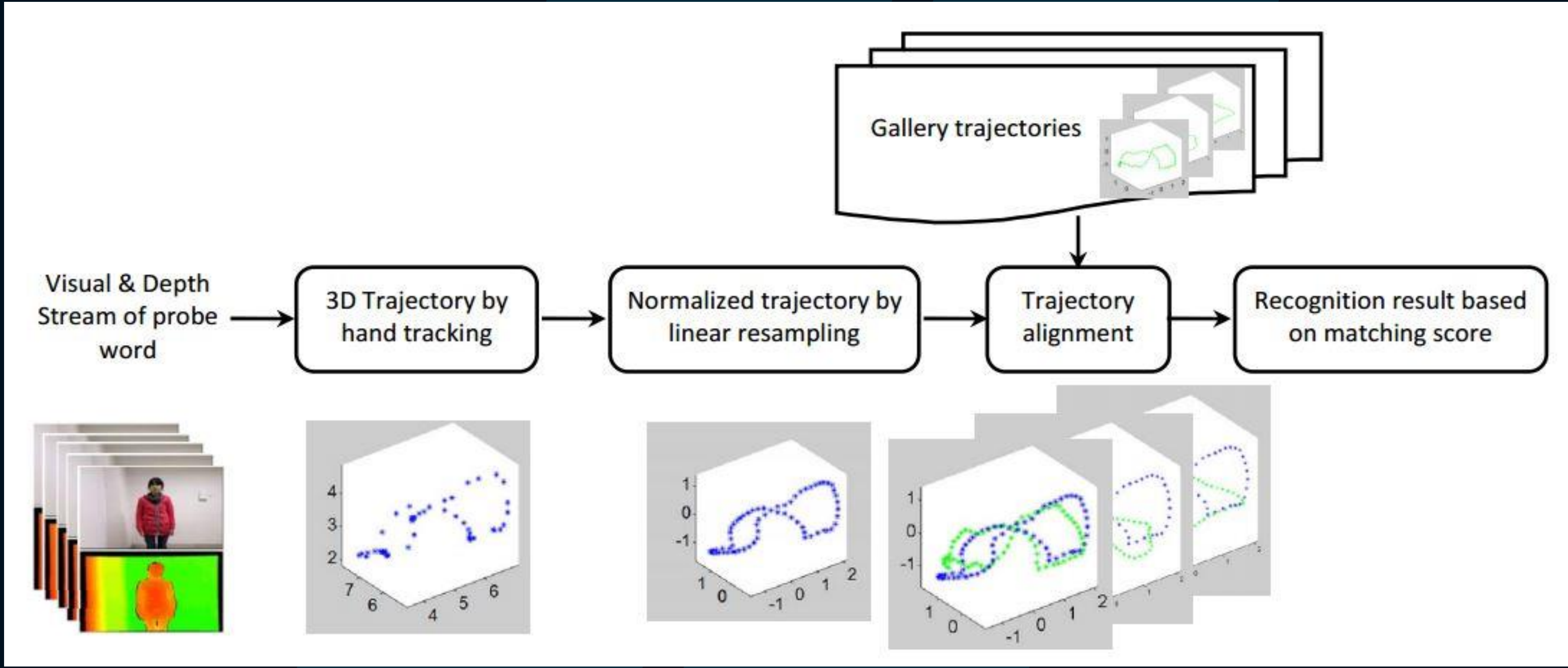
Sign Language Recognition and Translation with Kinect

X. Chai, G. Li, Y. Lin, Z. Xu, Y. Tang, and X. Chen

- The Xbox Kinect is a motion detection device coupled with the Microsoft Xbox gaming console
- Xbox Kinect through the Kinect Windows SDK is used to track sign language by a user



Block diagram of 3D trajectory matching based sign language recognition method



- It possesses two modes, the translation mode and the communication mode
- In the translation mode, sign language is translated to text
- In the communication mode, text is converted to sign language by an onscreen avatar

Strengths

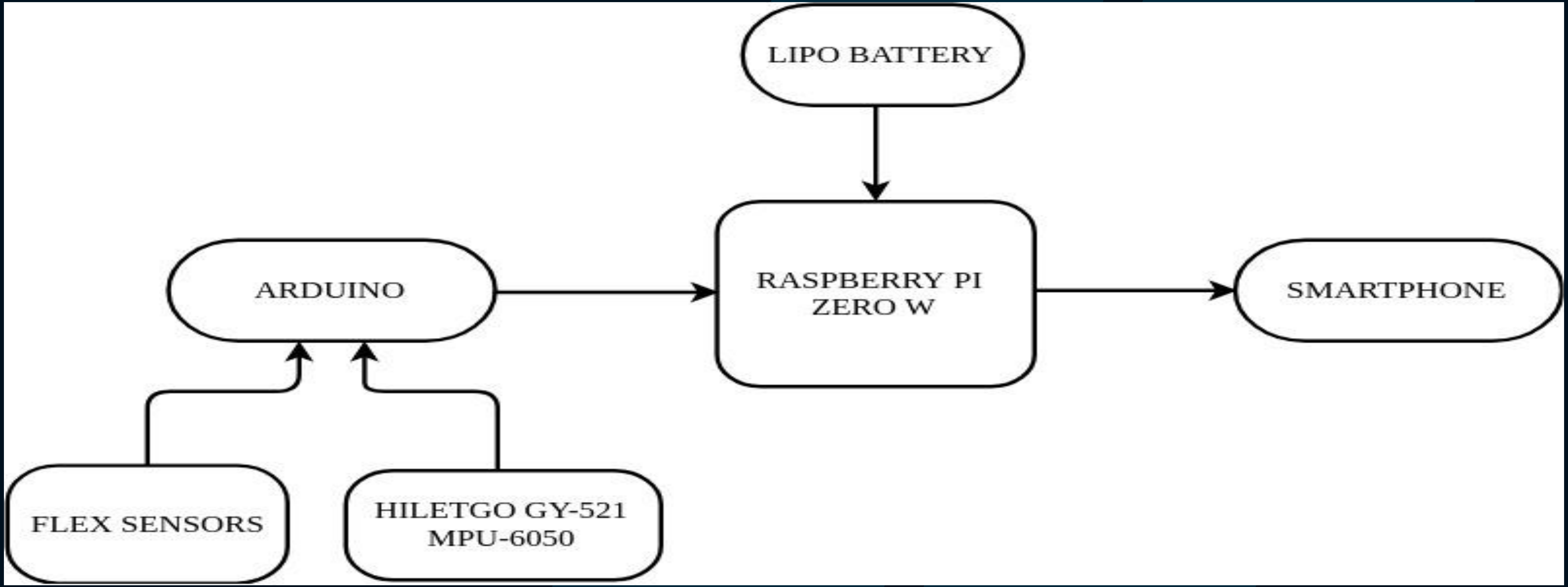
- This design is both very accurate and fast under optimum conditions.

Weakness

- In poor lighting conditions, the camera is unable to detect the user input accurately.
- This design is also power hungry.
- The user has to be within a certain distance from the camera.
- Difficult to detect for the complex backgrounds .

DESIGN CONSIDERATIONS

Block diagram for proposed design



Review of sensors and modules

List of sensors and modules considered for the proposed design

- Flex sensor
- Gyroscope and Accelerometer combo
- Arduino LilyPad microcontroller
- Raspberry Pi Zero W

Flex Sensor

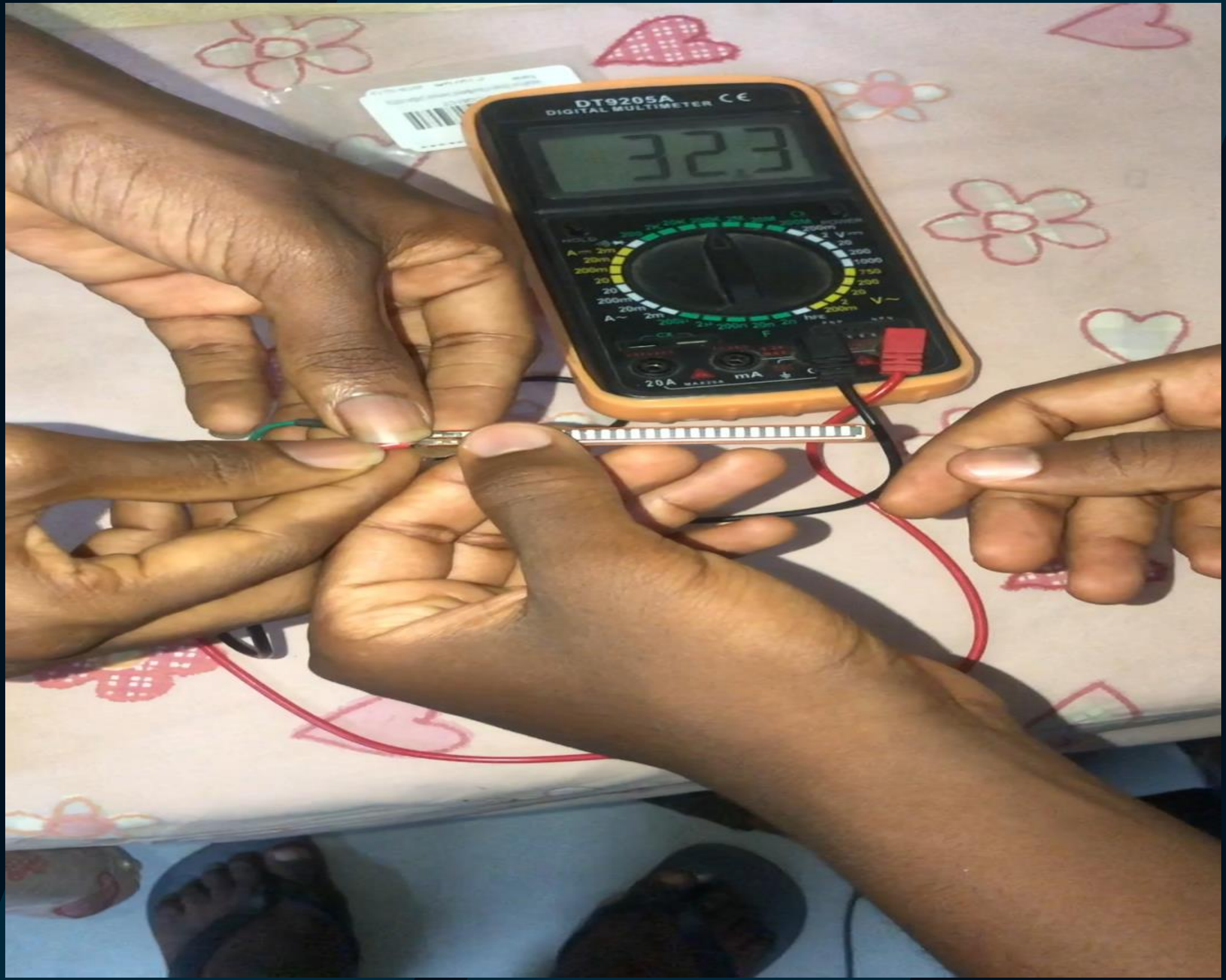
- Main input sensor of the design.
- Resistance of sensor changes in proportion

to the degree of bending in the sensor.

- A voltage divider circuit is employed to get

equivalent voltages of various resistances.

- $Vout = \frac{R2*Vin}{(R2+R1)}$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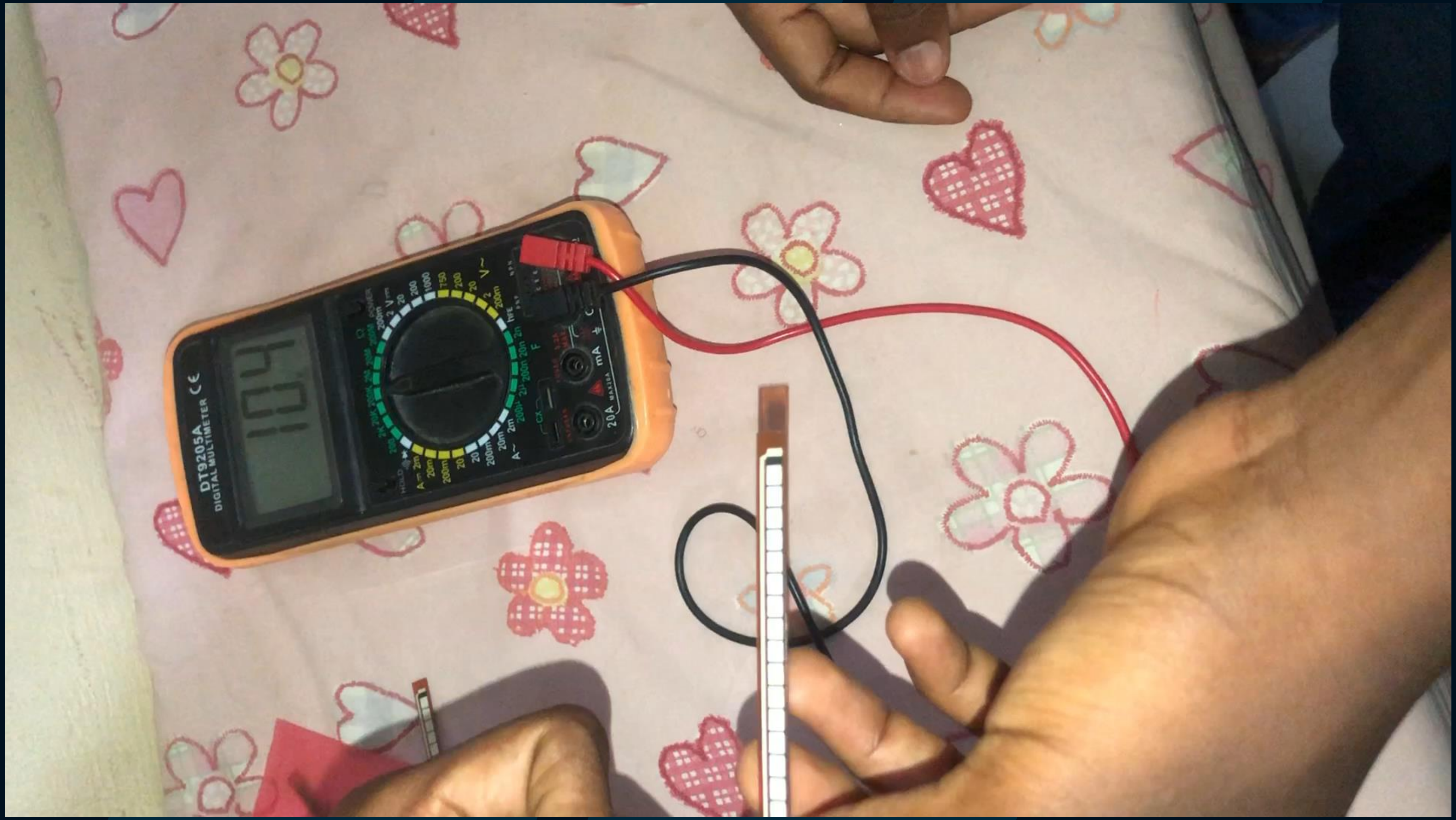
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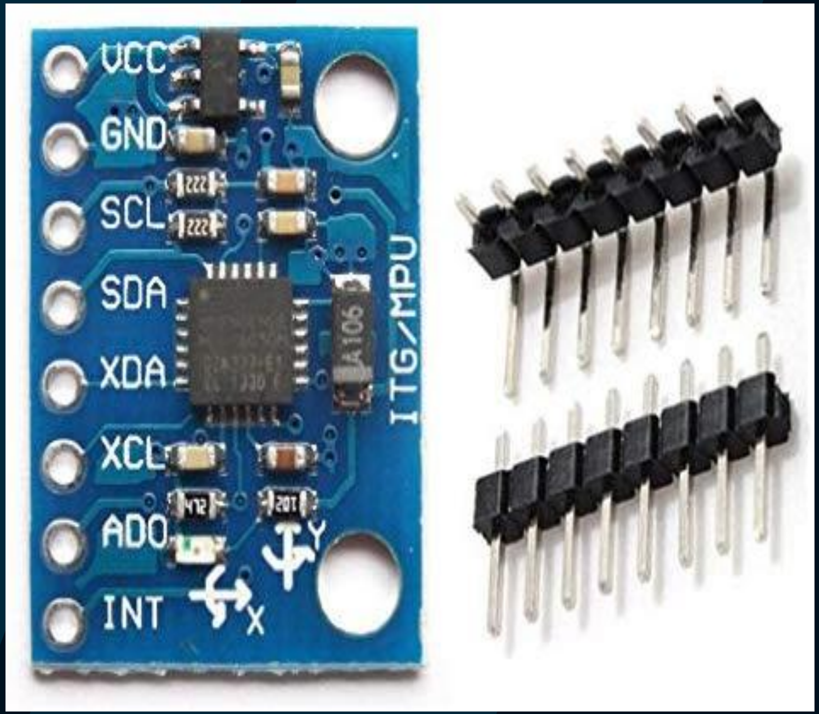
Factors considered in selecting flex sensor as input

FACTORS	FLEX SENSOR	CAMERA	LED/LDR PAIR
Immunity to bad lighting conditions	**HIGH**	LOW	HIGH
Immunity to distance variation	**HIGH**	LOW	HIGH
Accuracy	**HIGH**	AVERAGE	AVERAGE
Robustness	**HIGH**	HIGH	LOW
Cost	**AVERAGE**	HIGH	LOW*
Power consumption	**AVERAGE**	HIGH	LOW
Mobility	**HIGH**	LOW	HIGH

Gyroscope and Accelerometer combo

- A 3-axis gyroscope and accelerometer is used as means of measuring the angular and linear accelerations of movements of the hand in sign detection.
- Hand orientation and speed of motion play important roles in differentiating between similar hand signs.



Factors considered in choosing this model

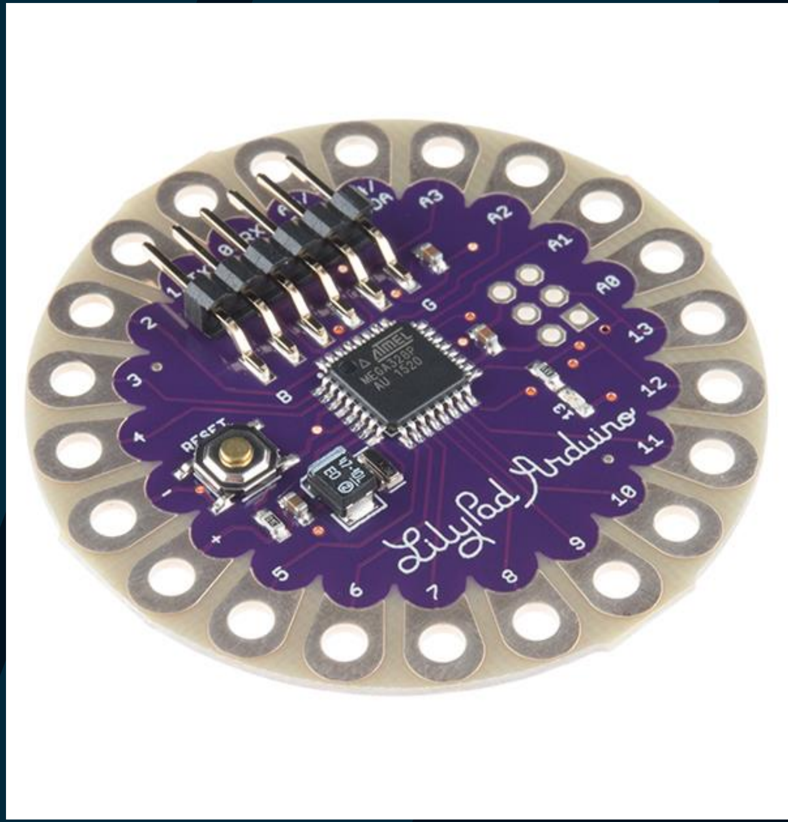
- Light weight at 2.1g
- Integration of both accelerometer and gyroscope in one component

Specifications

- Power Supply: 4.3-9V
- Gyroscope Range: +/-250, +/-500, +/-1000, +/-2000 º/s
- Acceleration Range: +/-2g, +/-4g, +/-8g, +/-16g
- Weight: 2.1g

Arduino LilyPad microcontroller

- The LilyPad Arduino Main Board is based on the ATmega168V (the low-power version of the Atmega168) or the ATmega328V.
- It is designed for e-textiles and wearables projects.
- Its lightweight, round package design and wide tabs make it easy to be sewn down and connected with conductive thread to the various subsystems.



Arduino LilyPad microcontroller

Board	Microcontroller	Digital I/O Pins	Analog Input Pins	Programming Interface	Battery Attachment
LilyPad Arduino Simple	ATMega328	9	4	FTDI	JST Connector
LilyPad Arduino USB	ATmega32U4	9	4	USB	JST Connector
LilyPad Arduino SimpleSnap	ATMega328	9	4	FTDI	Built in LiPo
LilyPad Arduino 328 Main Board	**ATMega328**	**14**	**6**	**FTDI**	**Sew Tabs**

Raspberry Pi Zero W

- The Raspberry Pi will serve as the master microcontroller of the system.
- The Pi runs an operating system which makes it easy to perform multiple tasks and allocate resources such as CPU time and memory efficiently among active processes.
- It does not have an on-board ADC for receiving analog data from the sensors used in this project.
- The main considerations were **processing speed**, **memory capacity**, **programming language to be used for processing** and **ability to interface with output subsystems.**

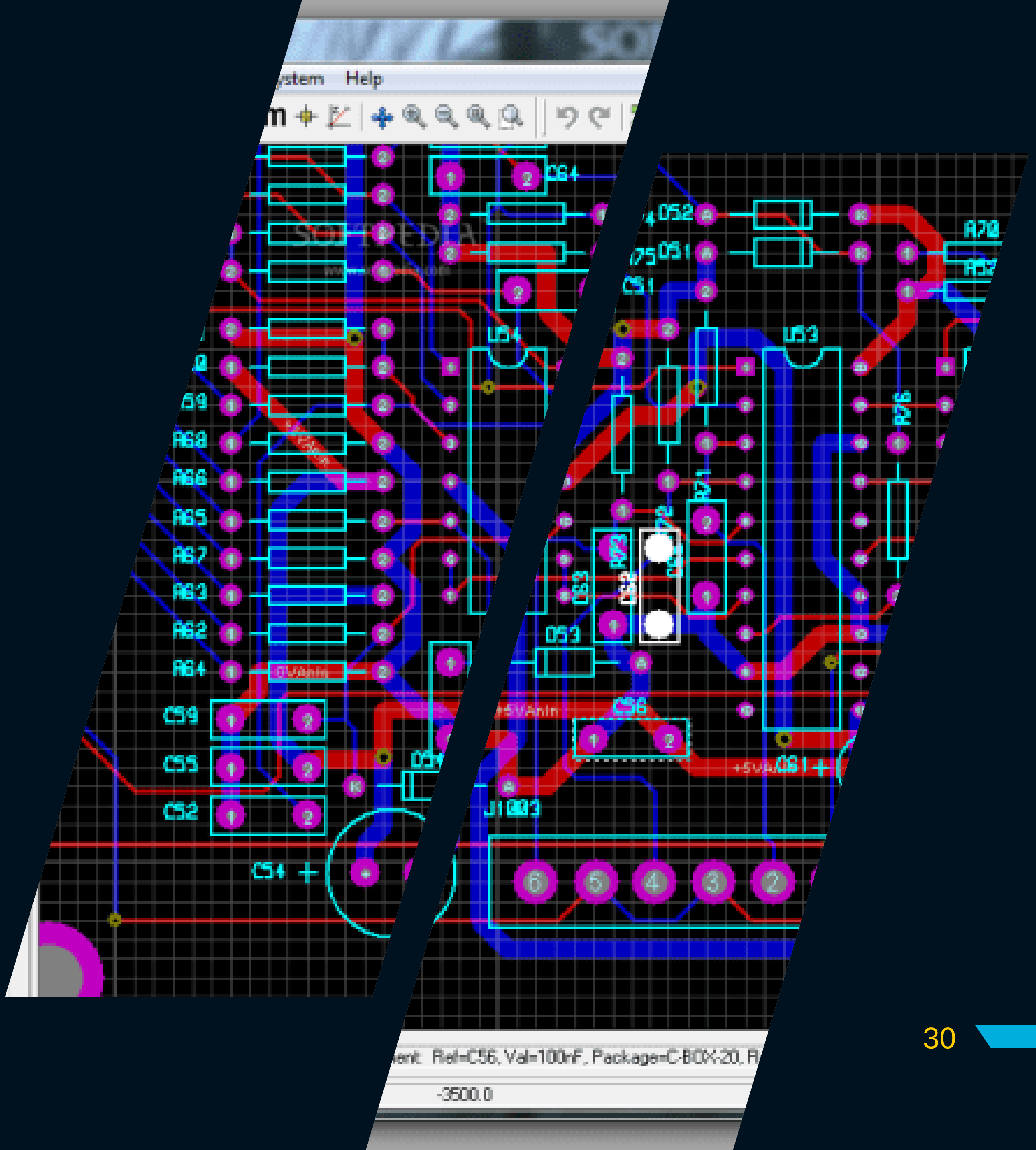
Raspberry Pi Zero W

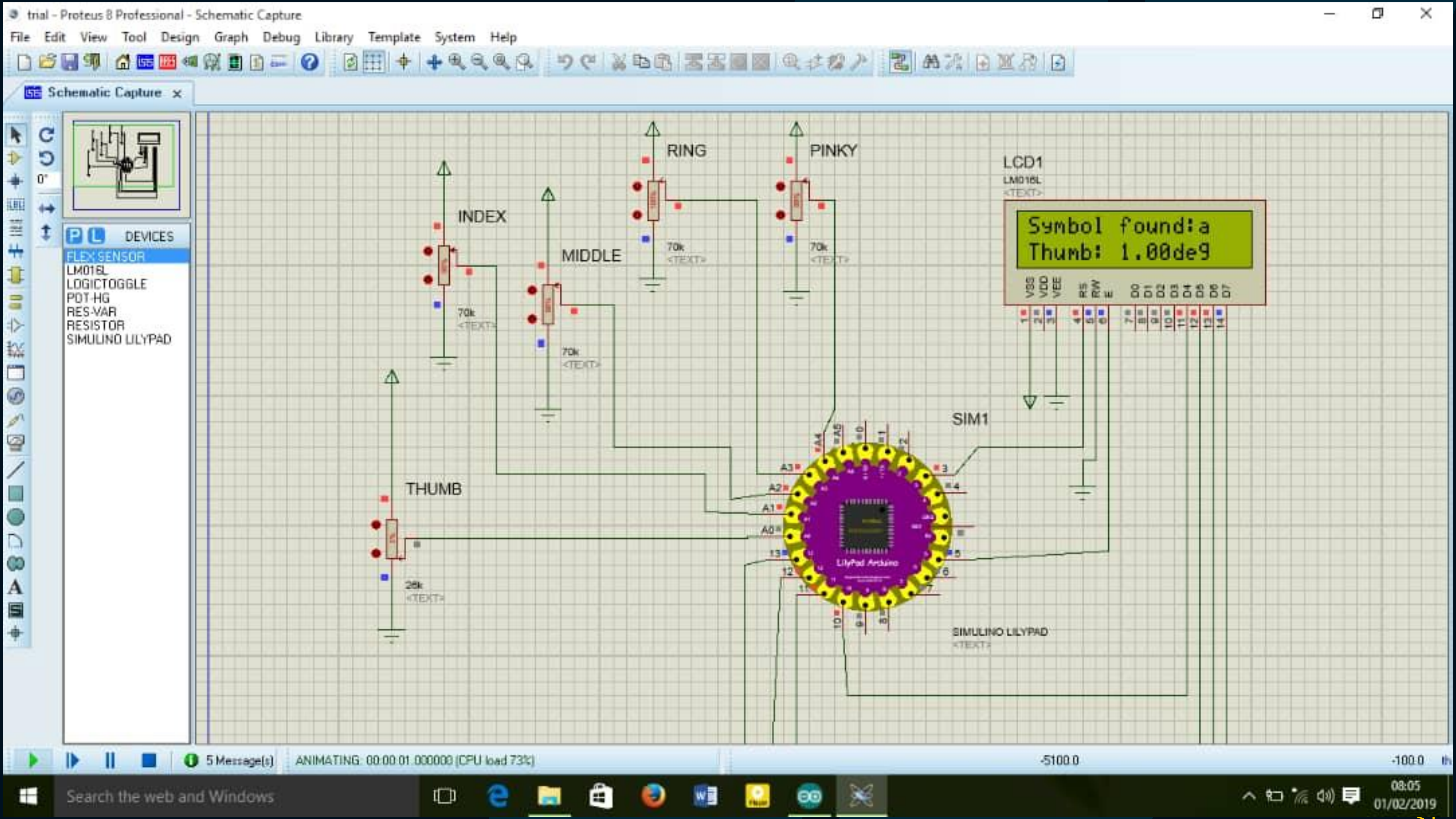
FACTORS	RASPBERRY PI ZERO W	ARDUINO NANO
Memory (RAM)	**512MB**	2KB
Clock Speed	**1GHz**	16MHz
Connectivity	**In-built Bluetooth and Wi-Fi**	External Bluetooth or Wi-Fi module needed
Compatibility with Python and Natural Language Processing(NLP)	**YES**	NO

Lithium Polymer

- A rechargeable Lithium Polymer (LiPo) battery with a nominal voltage 3.7V will be used as the main power supply.
- A 5V/2A boost converter is employed to step up the LiPo battery's output voltage.
- A Constant Voltage/Constant Current (CV/CC) charge IC is used for charging the battery.
- Protection circuit is used to safeguard against over-discharging and short circuit.

SIMULATION

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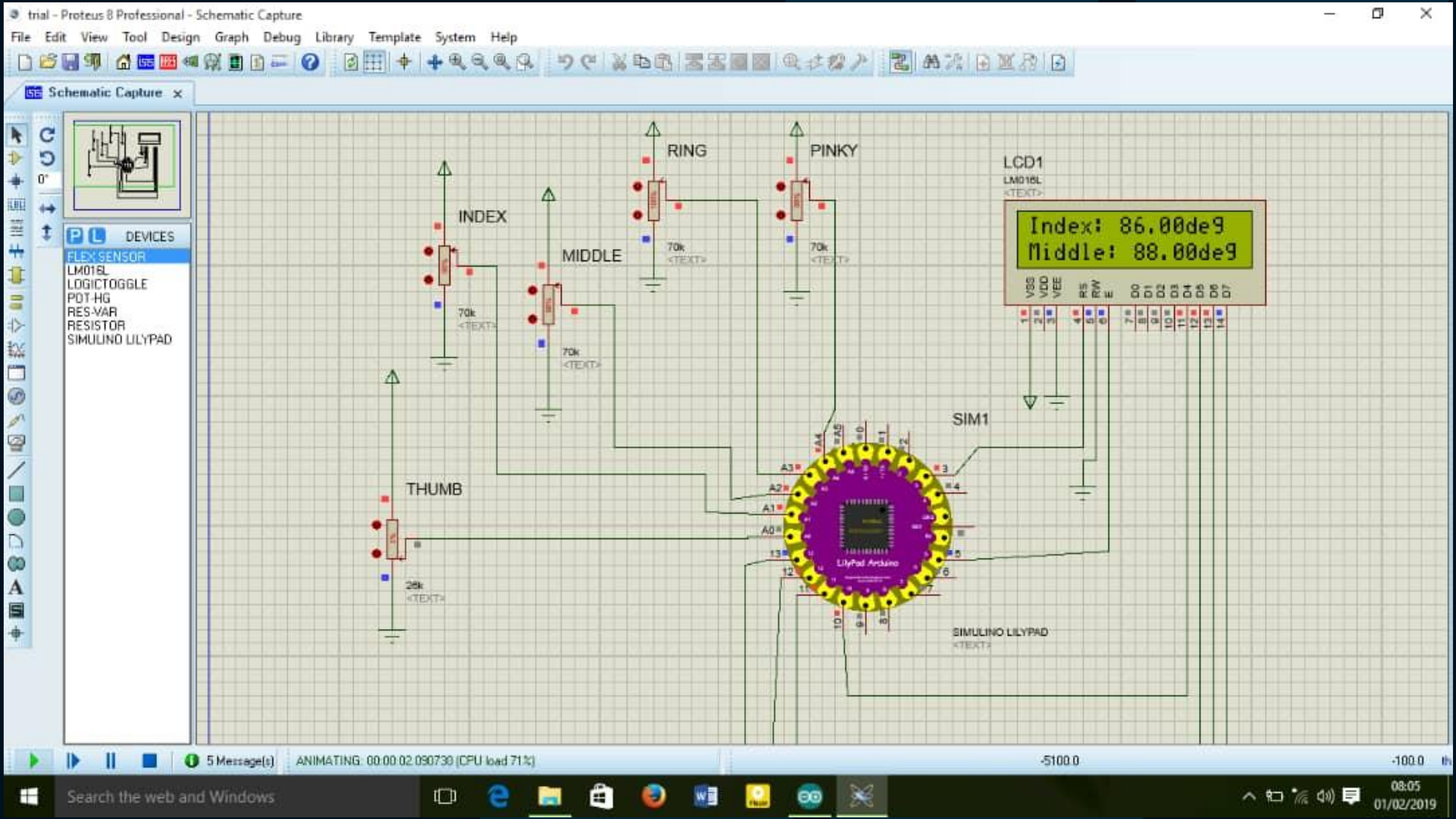
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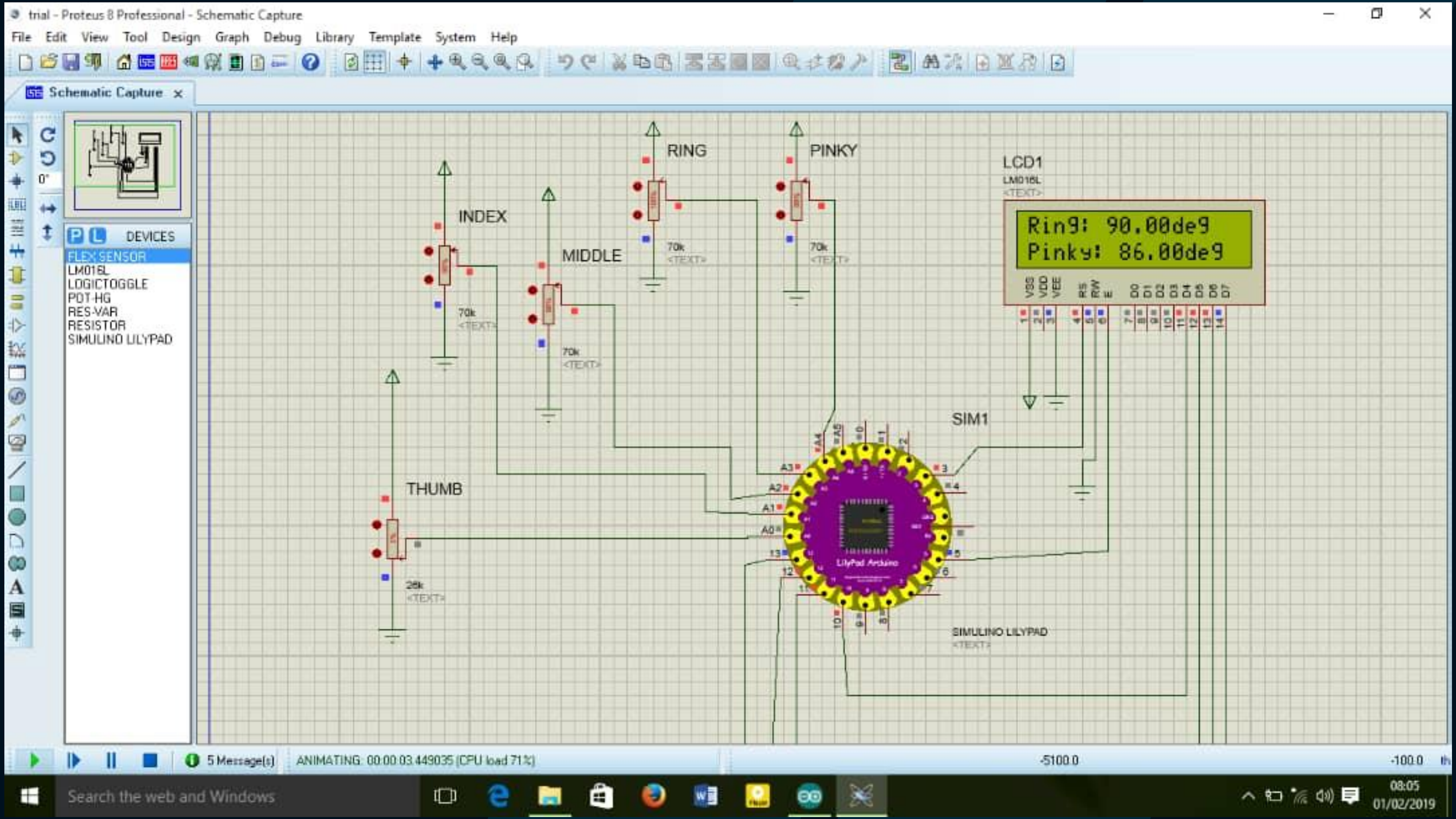
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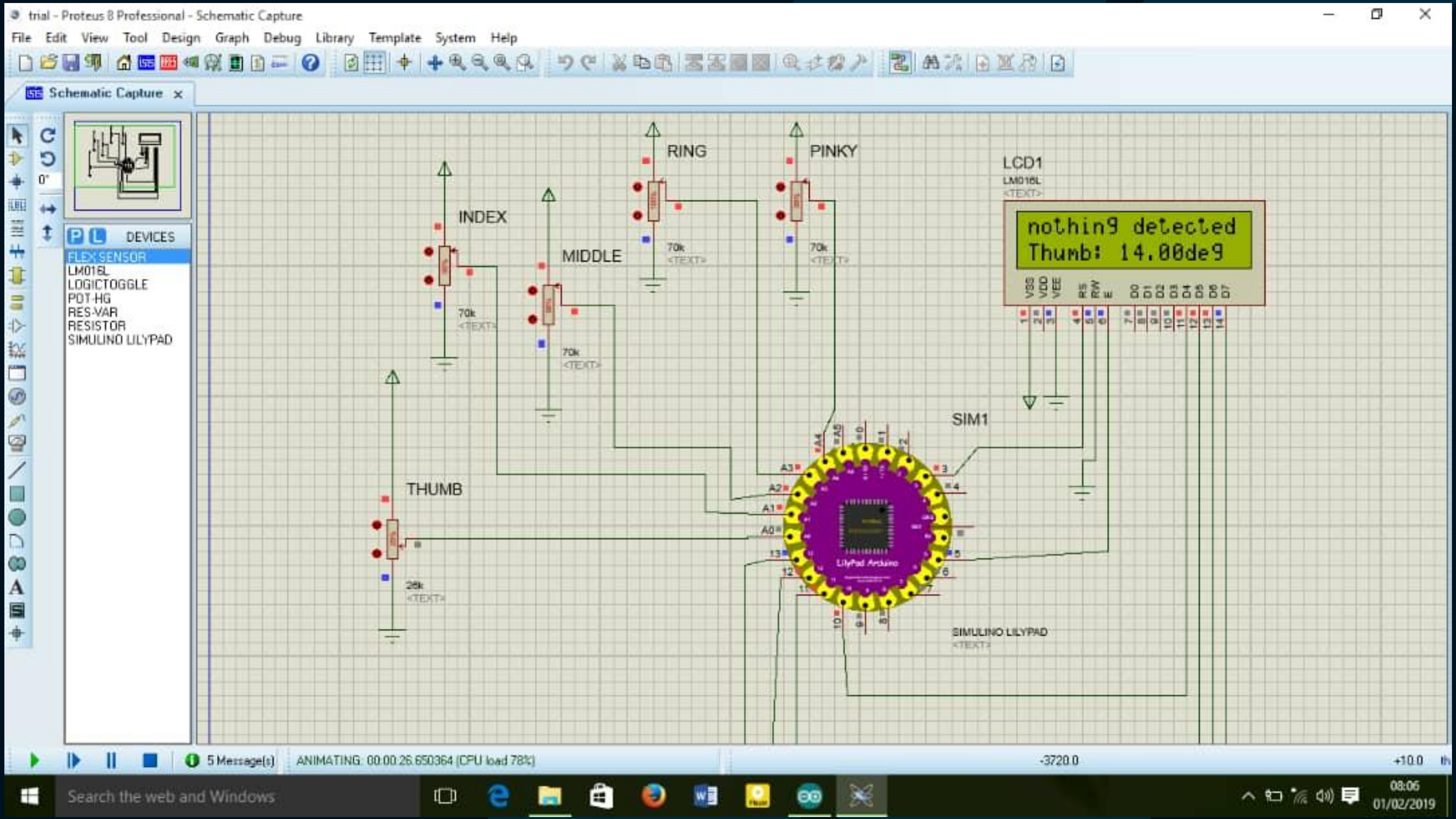
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nothing detected
Thumb: 14.00deg
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SIMULINO LILYPAD
LilyPad Arduino
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THANK YOU!