American Sign Language Alphabet Interpreter

Team 3

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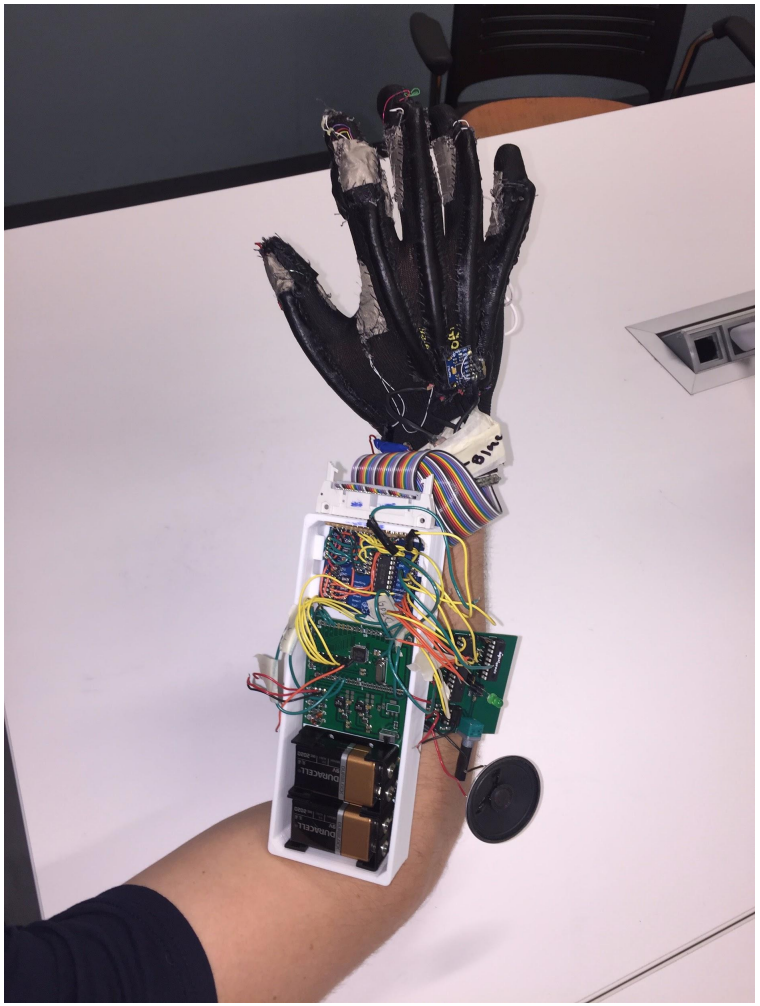
Introduction

[1]

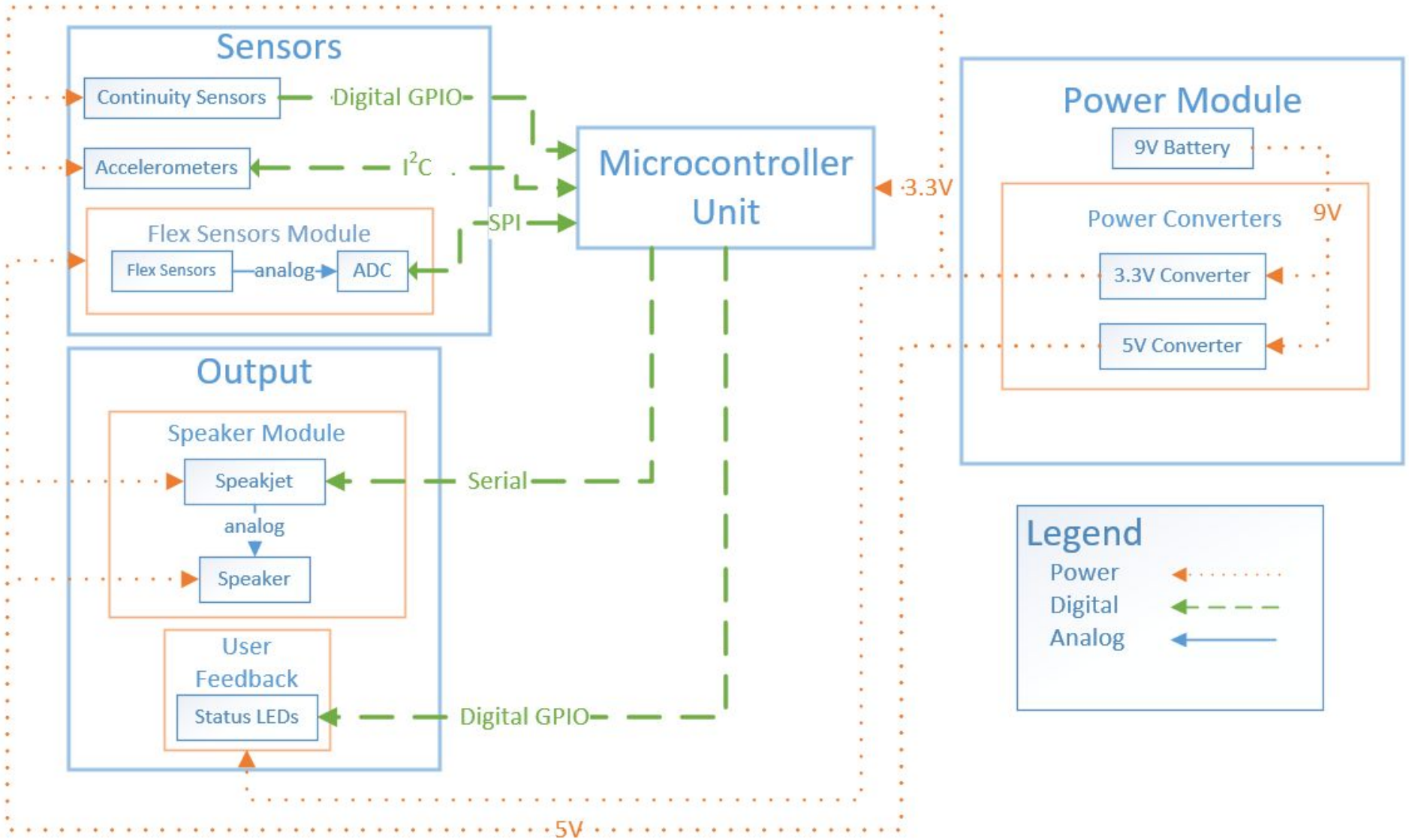
- 500,000 to 2,000,000 North Americans rely on American Sign Language (ASL) to communicate.
- Less than 1% of the larger hearing community can interpret ASL [2].

Objectives

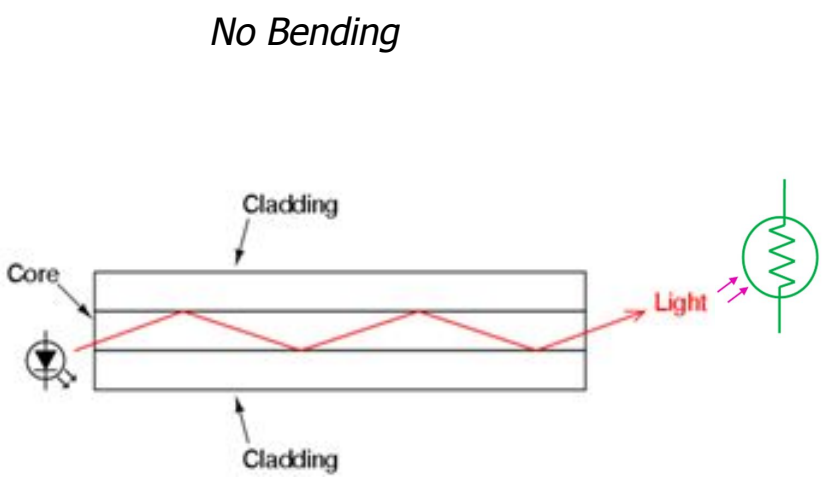
- Develop a device that audibly translates the ASL alphabet into the English alphabet.
- Goals
  - 95% classification correctness
  - 4 hours of battery life
  - Wearability

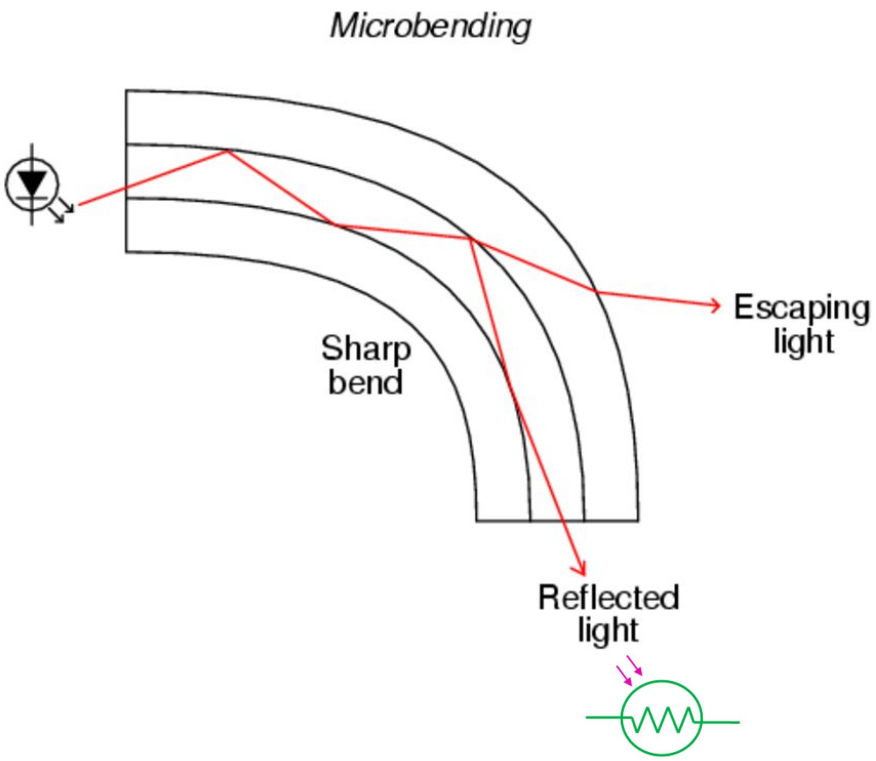


Block Diagram



Flex Sensors Operating Principle





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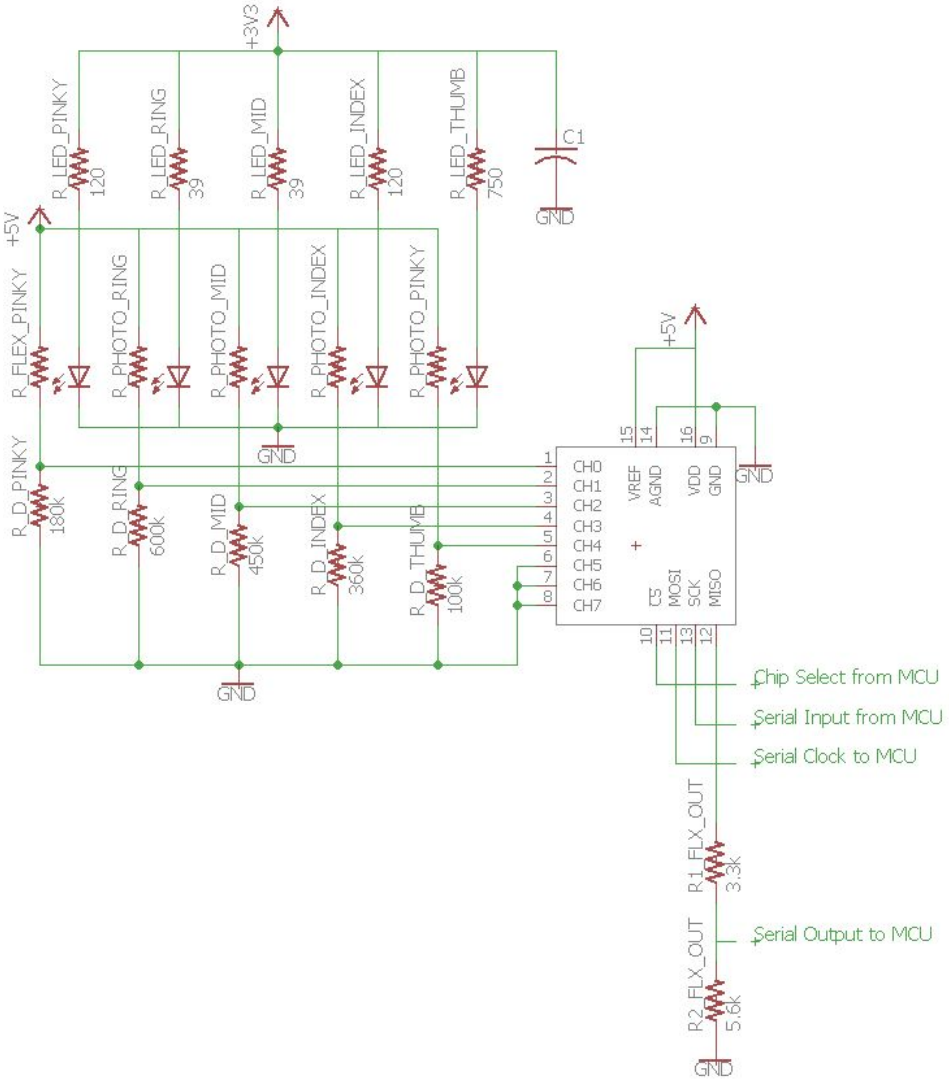
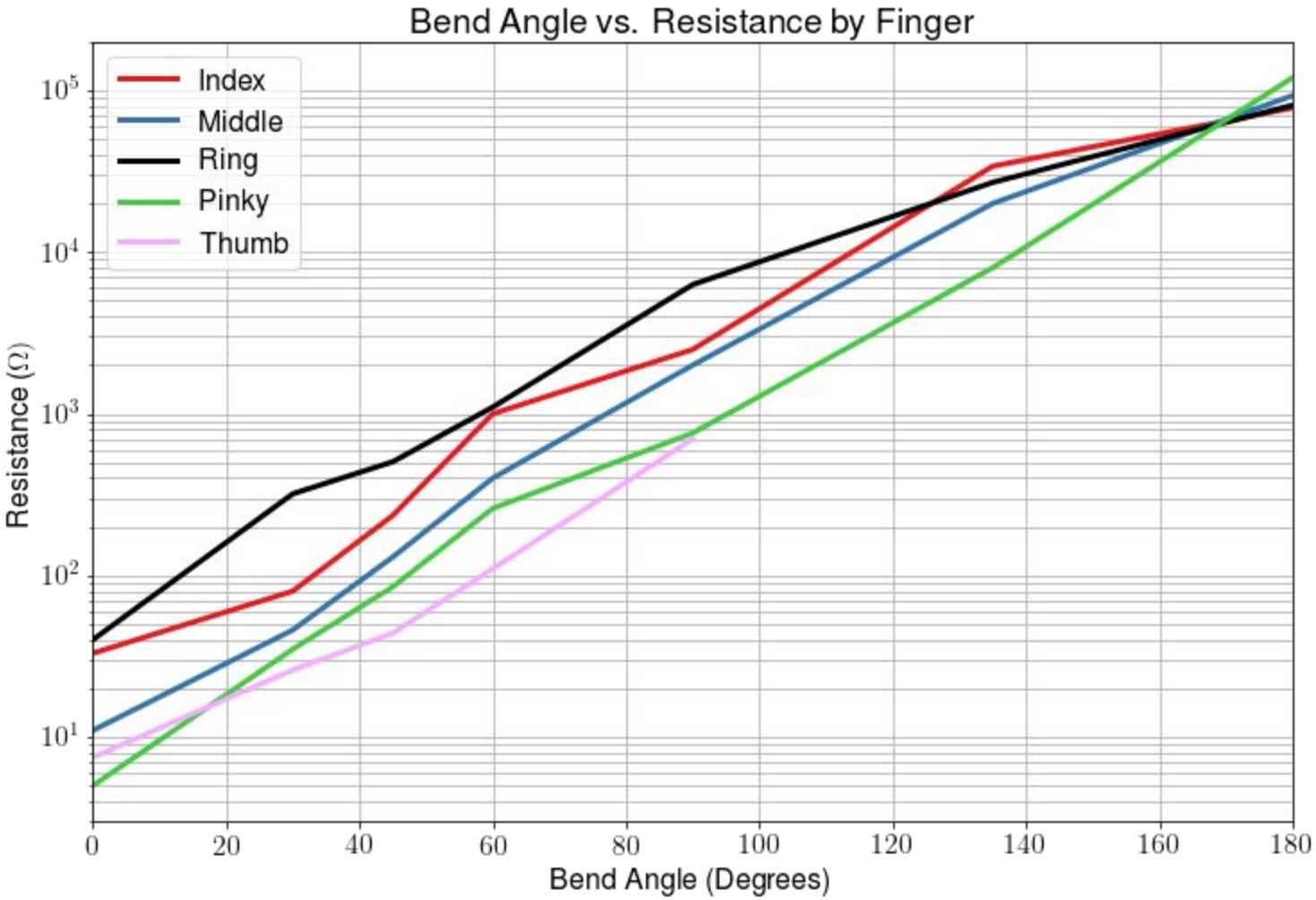
Flex Sensors Circuit



Flex Sensor Construction

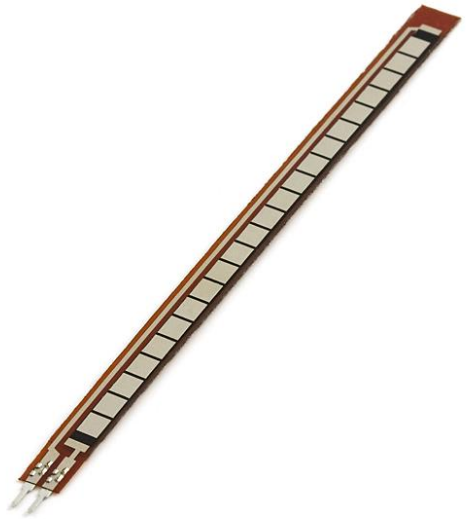
Flex Sensor Performance



Flex Sensors Comparison

Commercial Flex Sensors

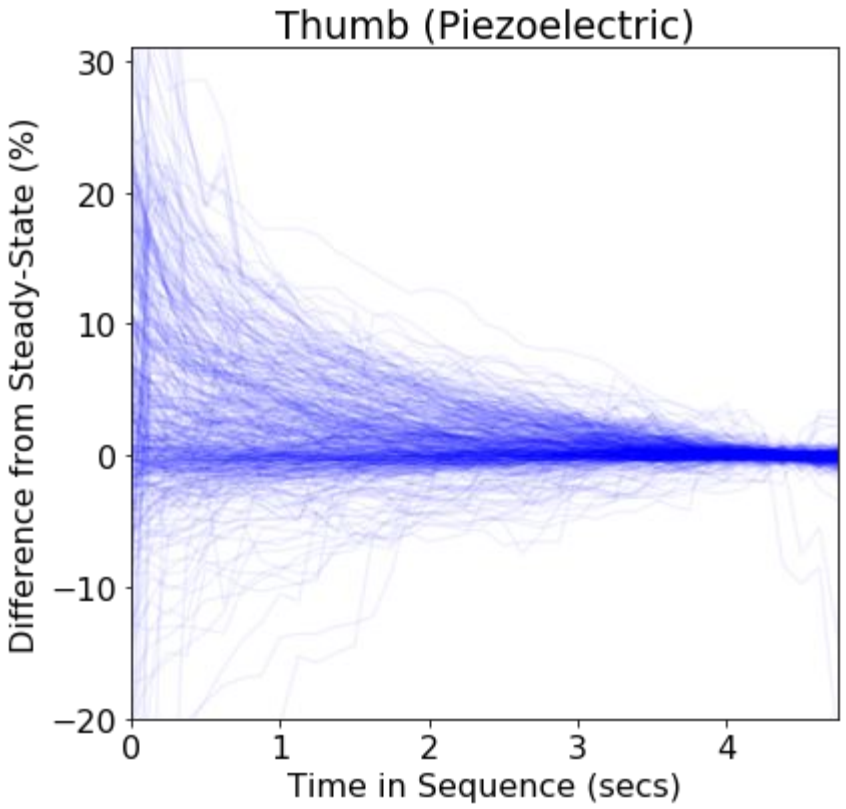
- Slow Response
- Limited Resistance Range
- As Is

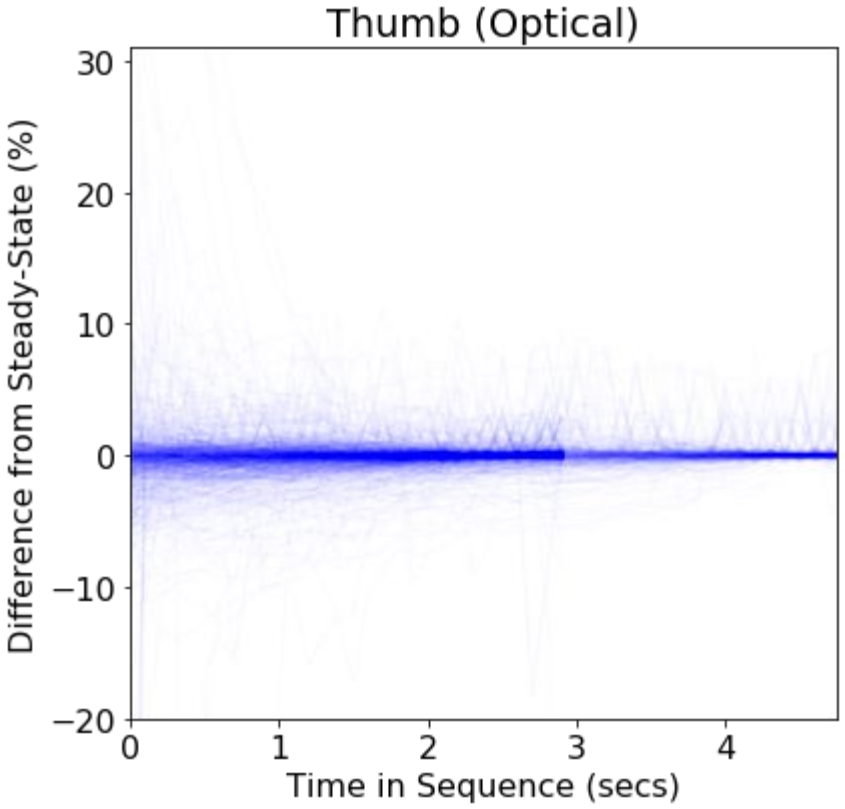


Optical Flex Sensors

- Fast Response
- Large Resistance Range
- Tunability

Settling Time

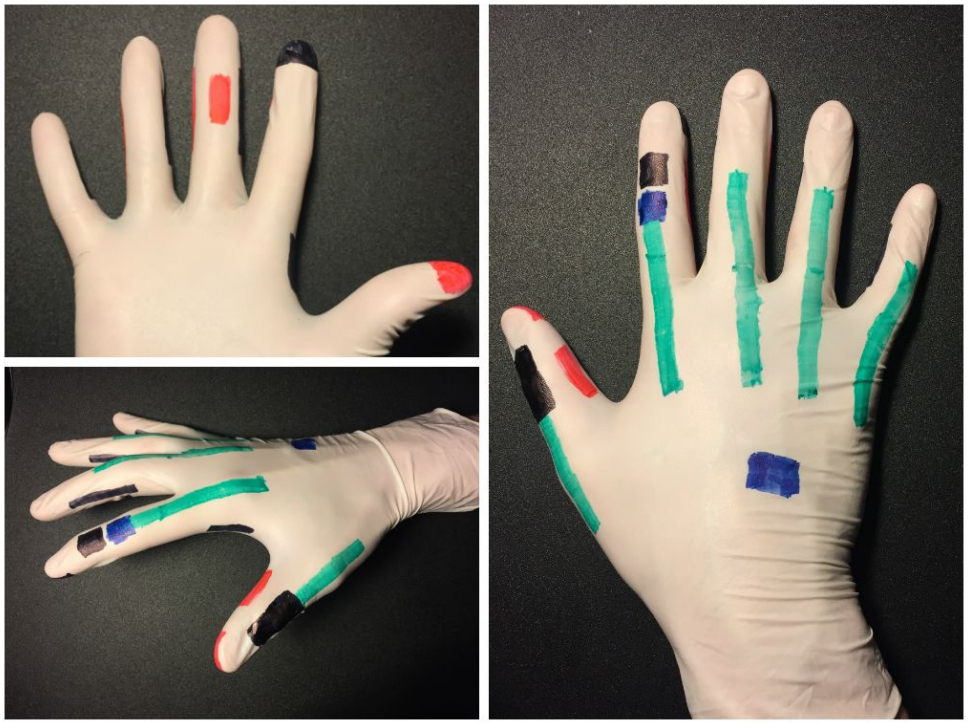




Contact Sensors

High Side
of Contact Sensor

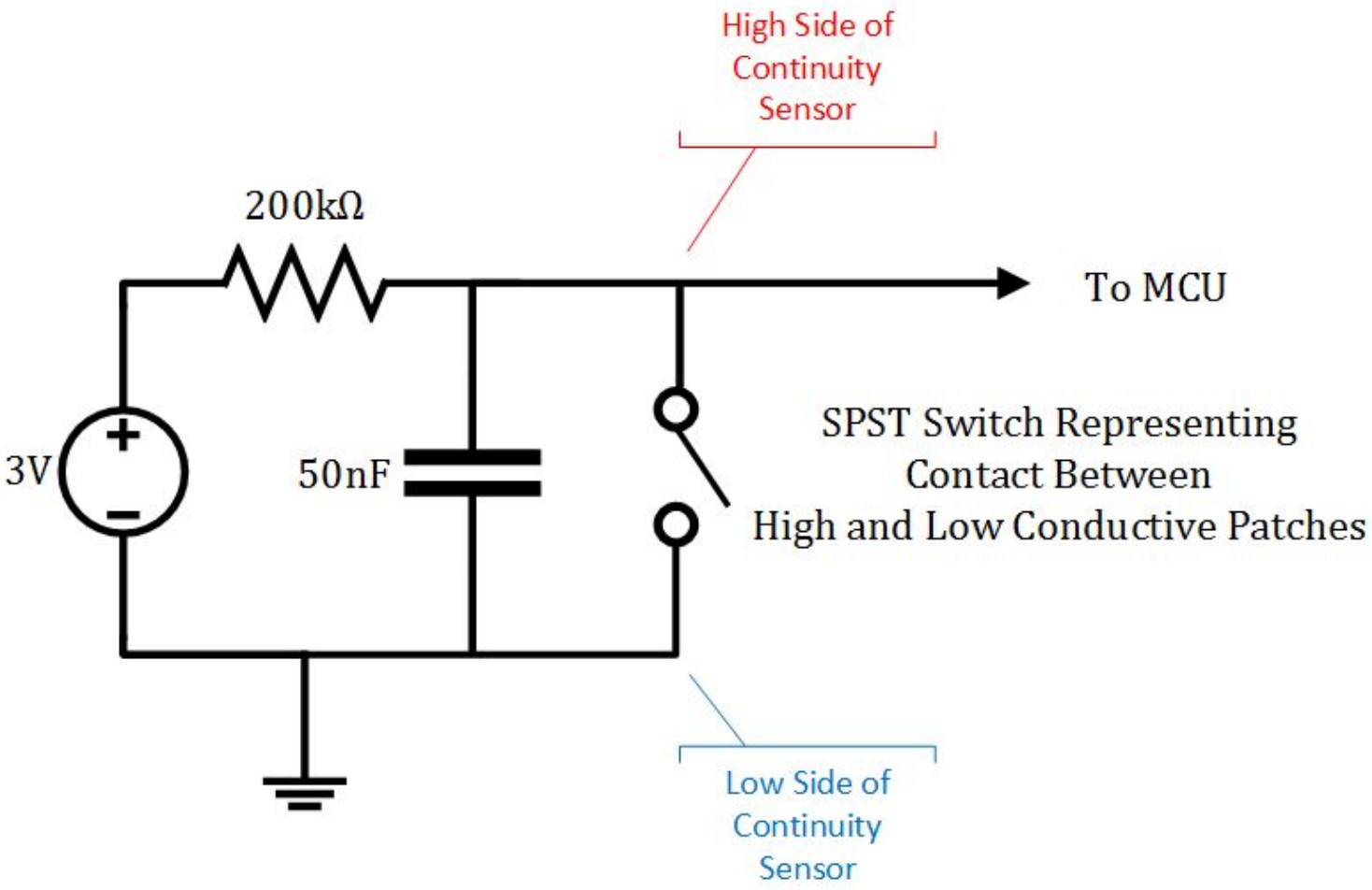
Flex Sensor



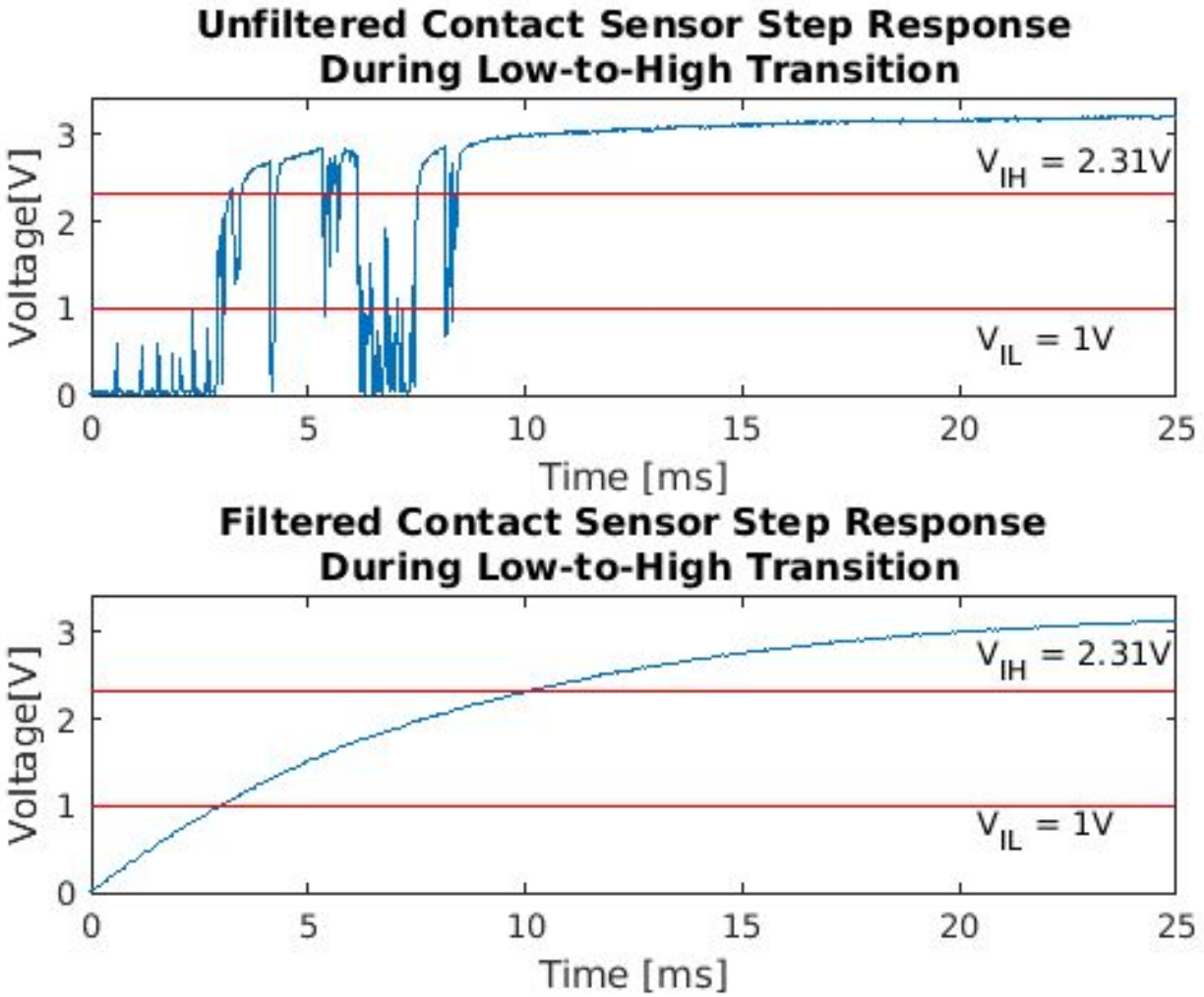
Low Side
of Contact Sensor

Accelerometer

Contact Sensors



Low-to-High Debouncing



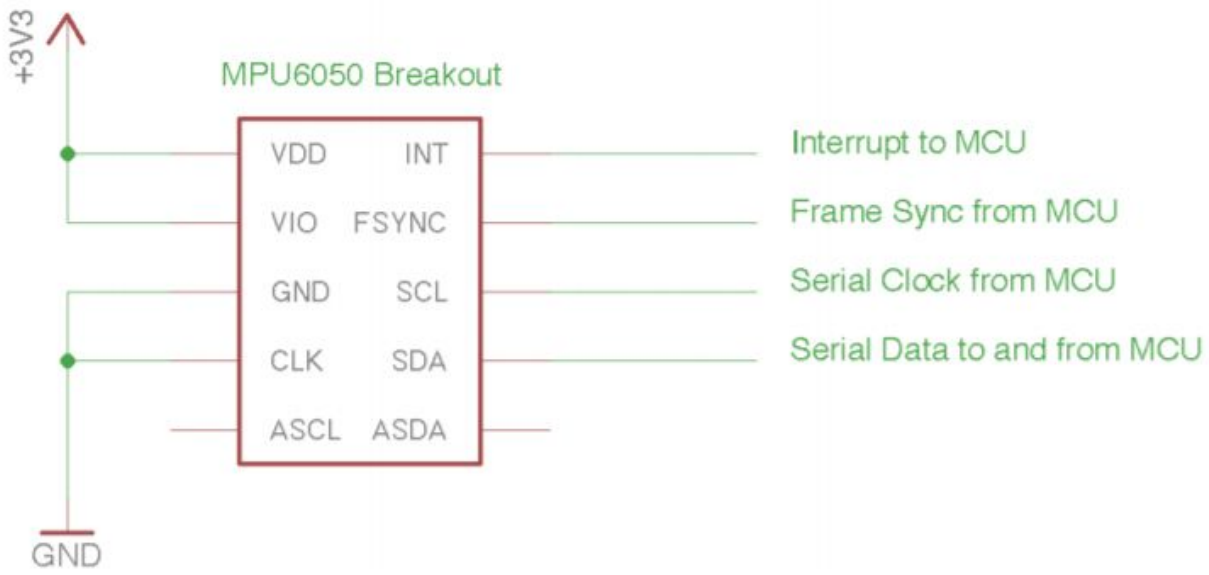
U
3.1% Confusion Rate with V

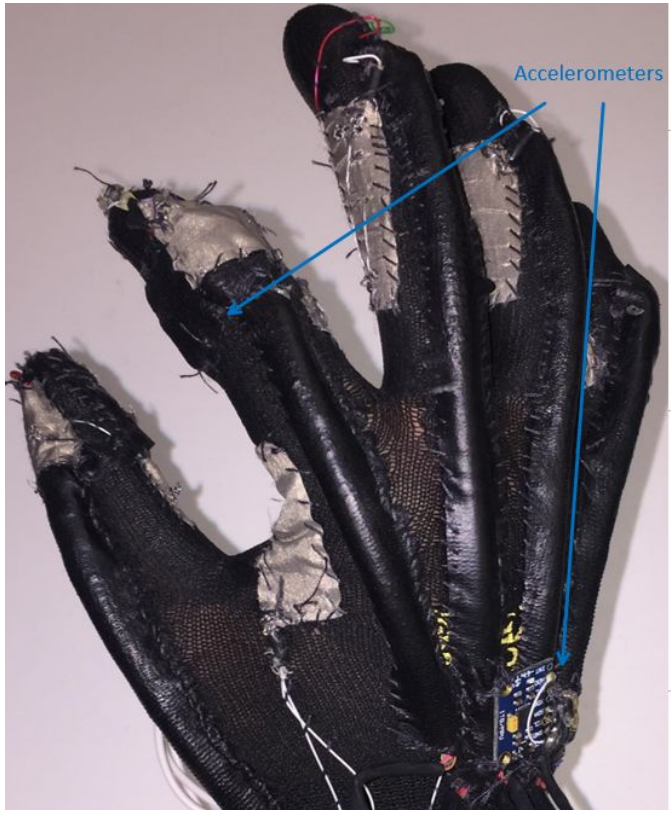
V
No Observed Confusion with U or R

R
No Observed Confusion

[6]

Accelerometers Module

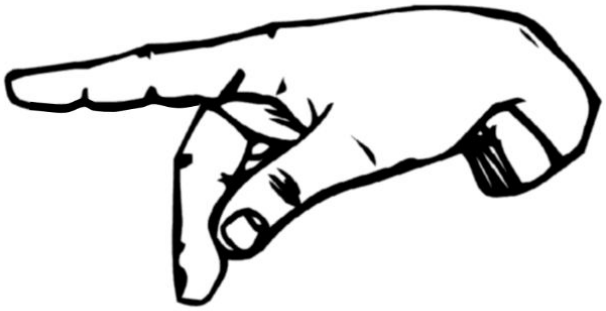




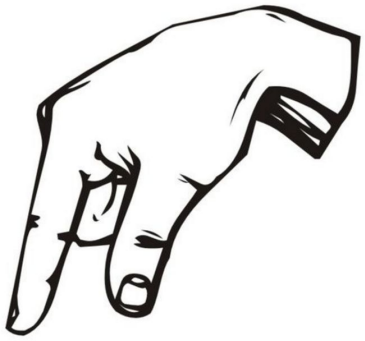
K
1.4% Confusion Rate
with P

G
No Observed Confusion
with Q

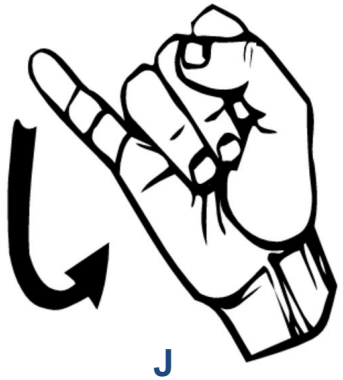
I
No Observed Confusion
with J



P
No Observed Confusion
with K



Q
No Observed Confusion
with G

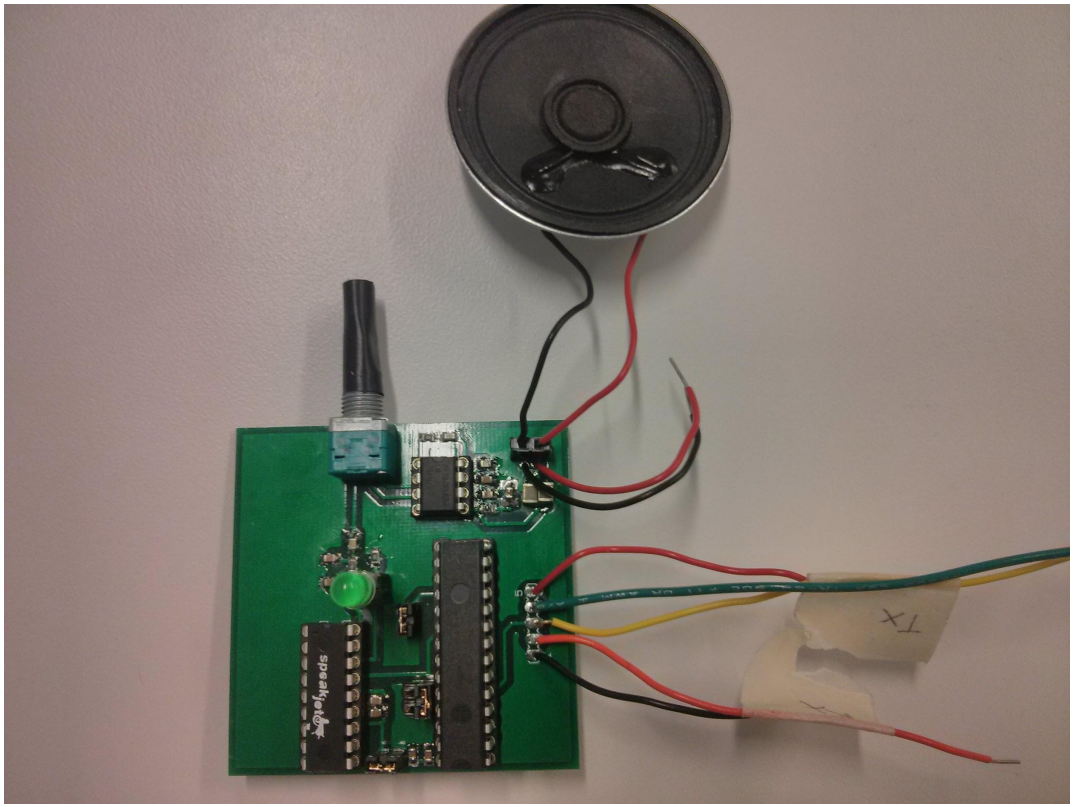


J
No Observed Confusion
with I

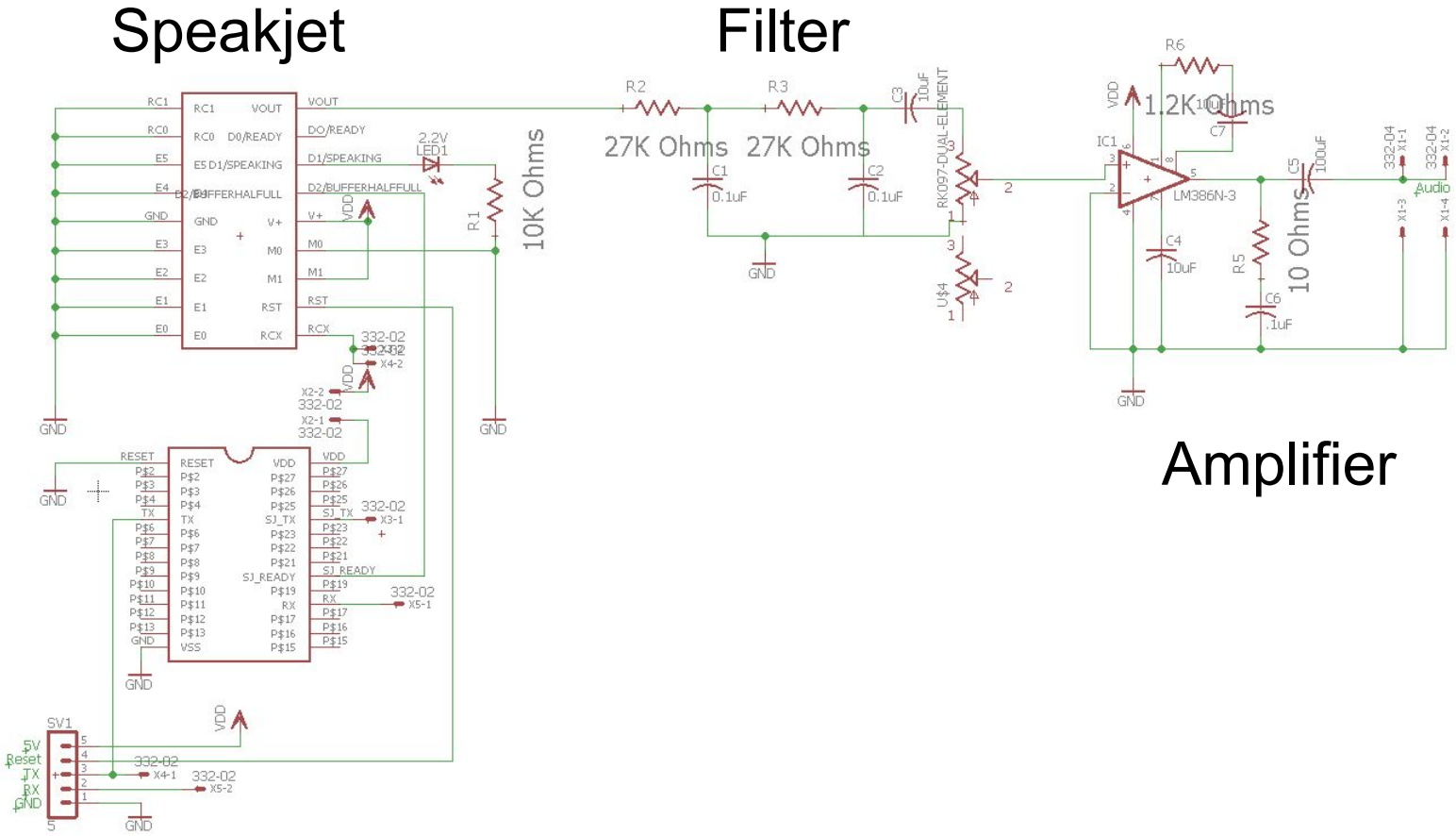
[6]

Speaker Module

The speakjet was used as a low power solution to producing audible speech.



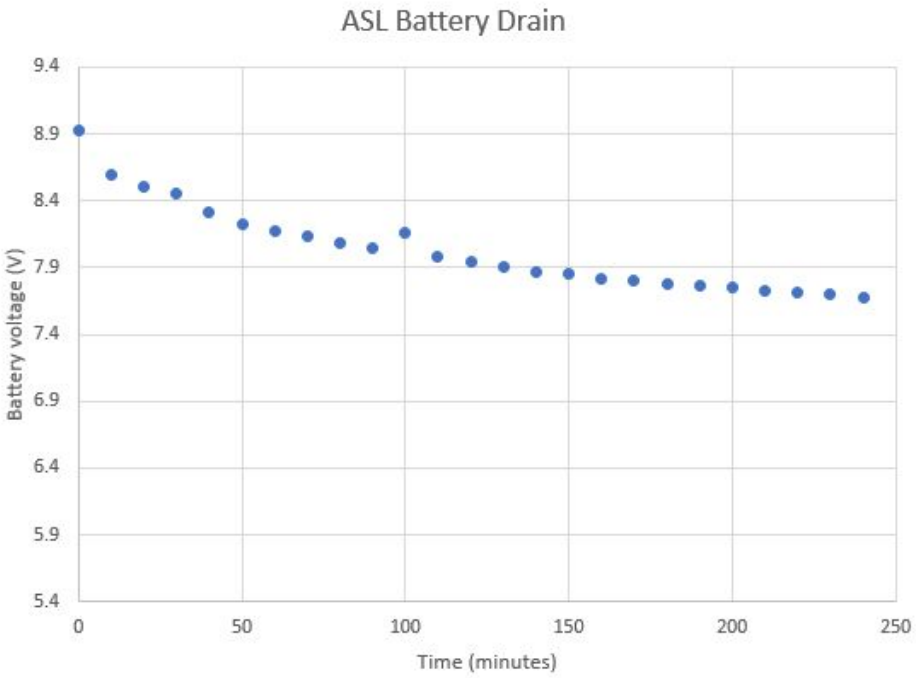
Speaker Module Circuit



Power Module

The power converters needed to be efficient for a full day's use

- 3.3 V and 5 V buck converters were used
- 9V alkaline battery pack for convenience and safety
- 0.385W inactive power draw
- 2.385W active power draw



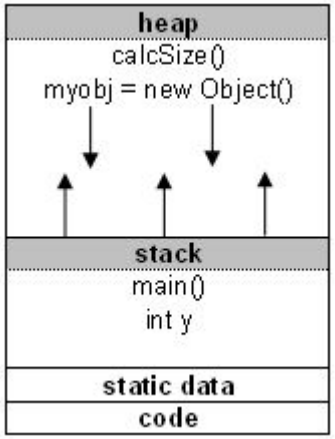
Microcontroller

Used LPC11U37 microcontroller

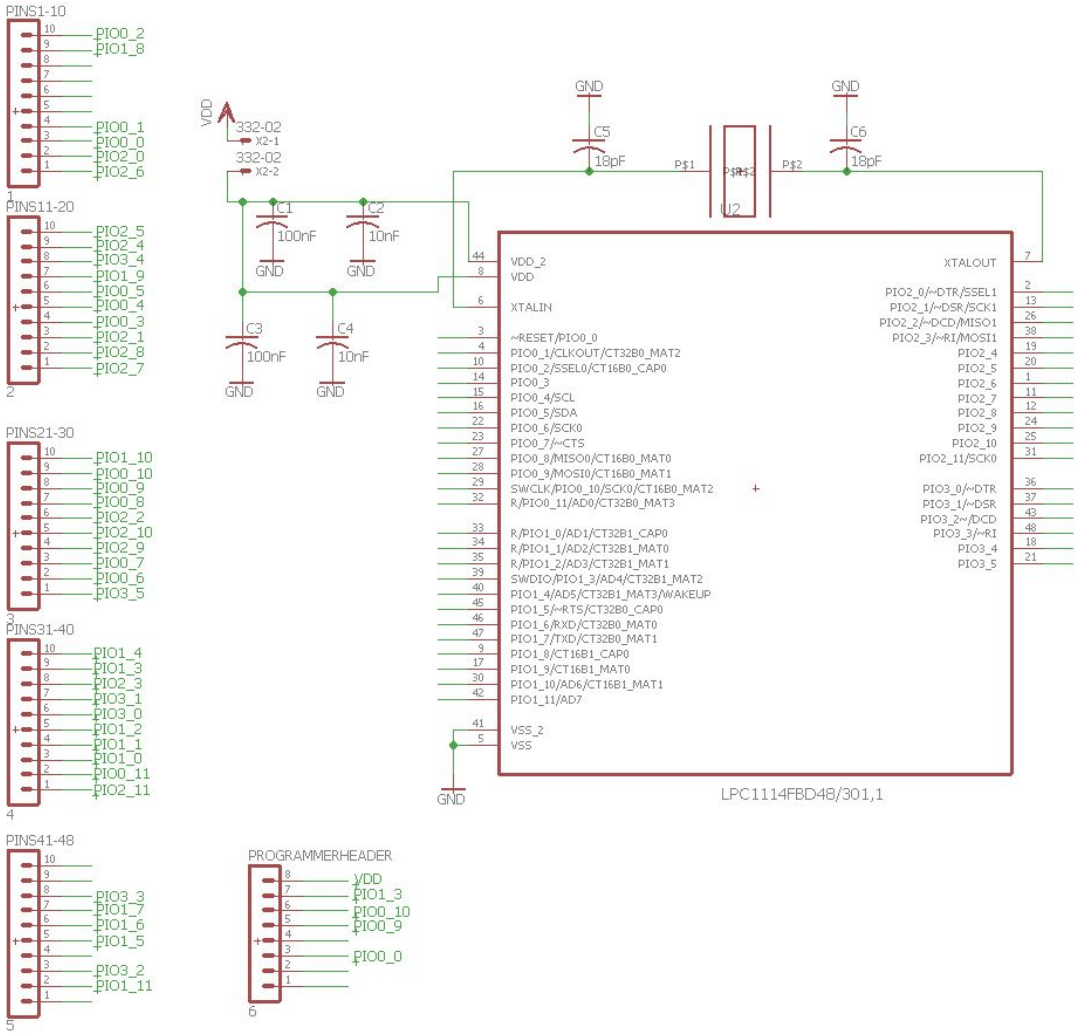
- Low power solution
- 40 GPIO pins
- Supports I^2C, SPI, and UART
- Small

Problems:

- Low memory
- Opted for Raspberry pi for demo



Microcontroller Circuit



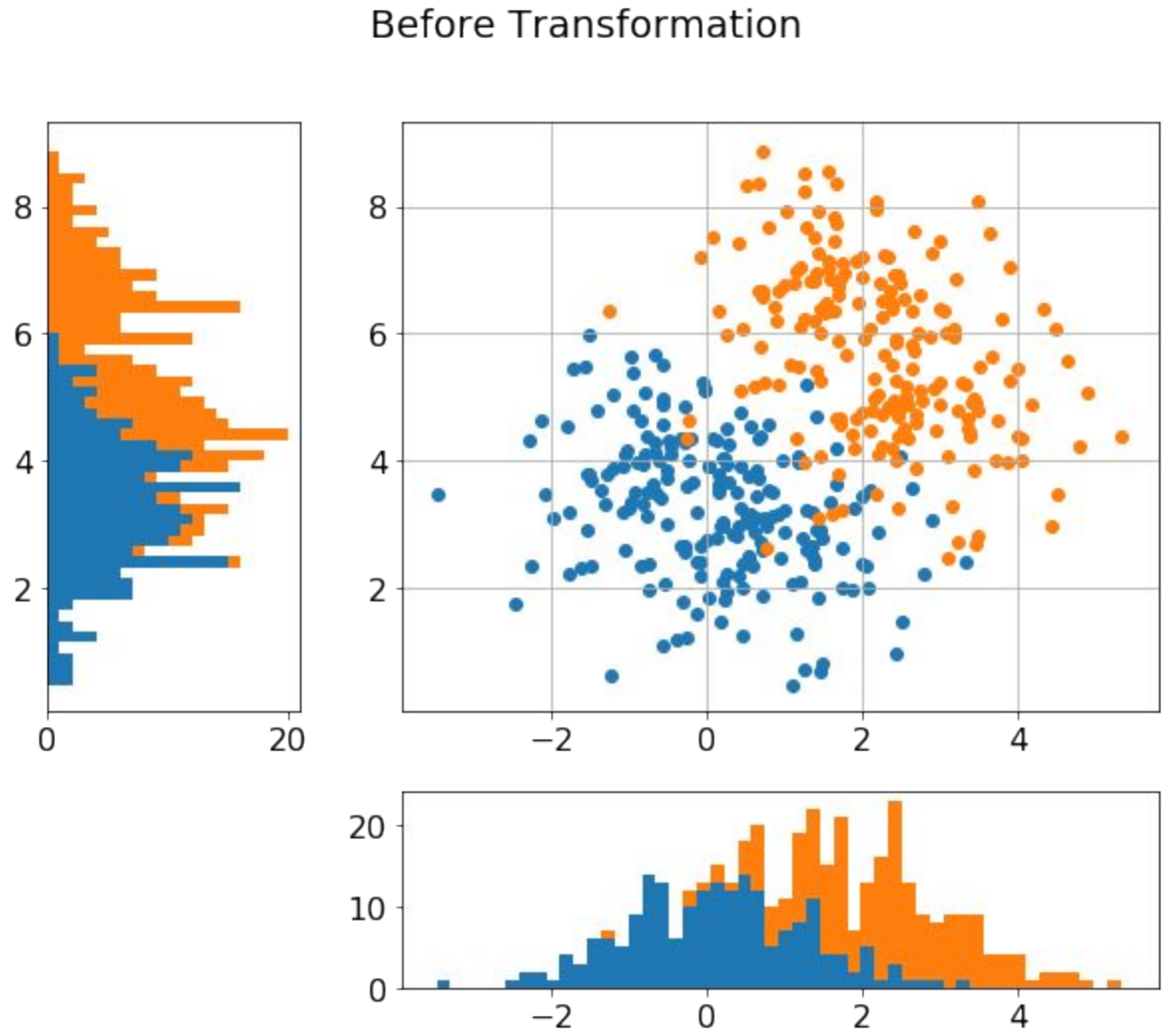
Letter Classification

- Flex sensor, accelerometer and continuity data
- 35,000 labeled examples

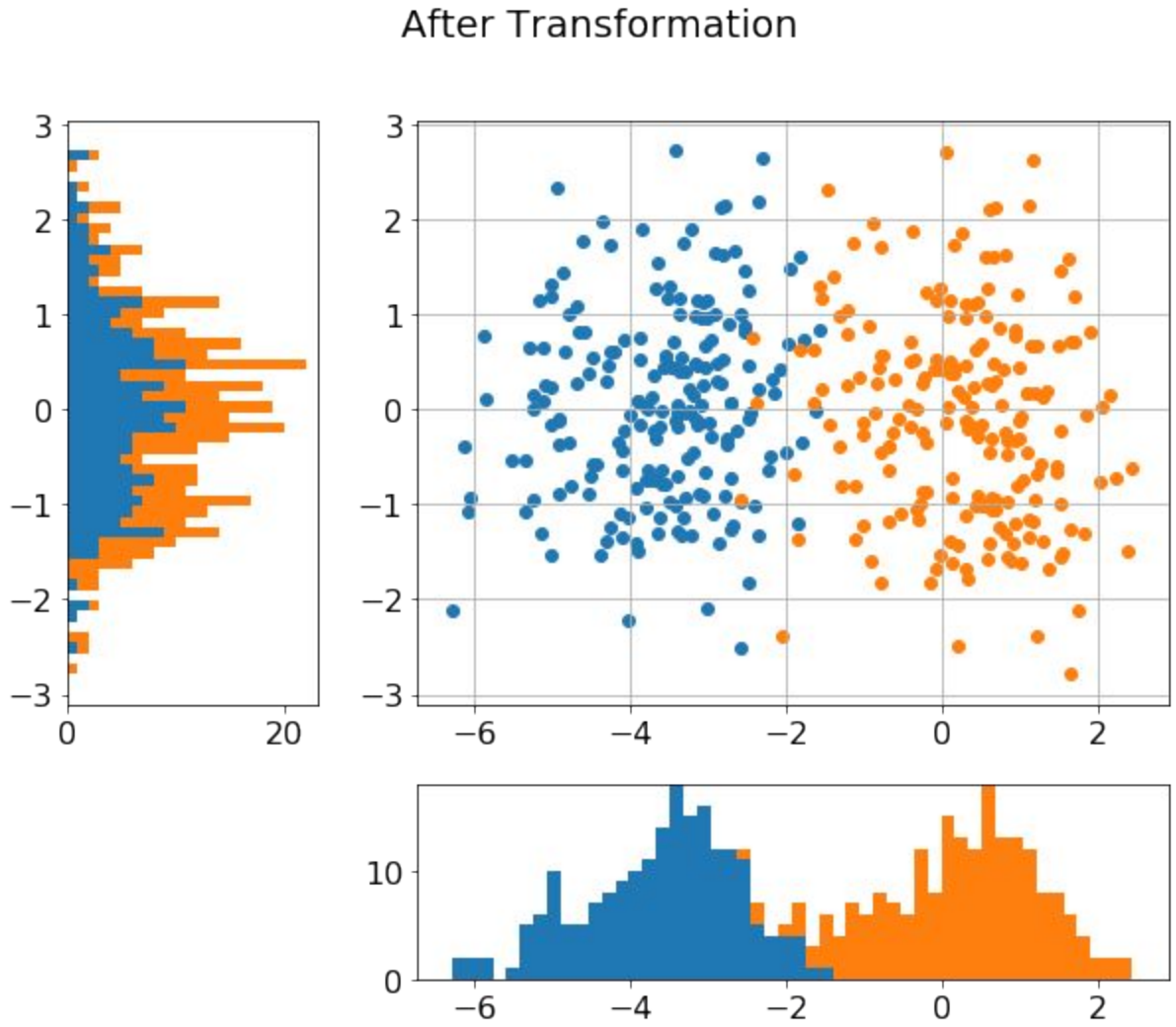
- Standardize all input data
- Linear discriminant analysis (LDA)

- Support vector machine (SVM)
- 26 letters and ‘off’ state

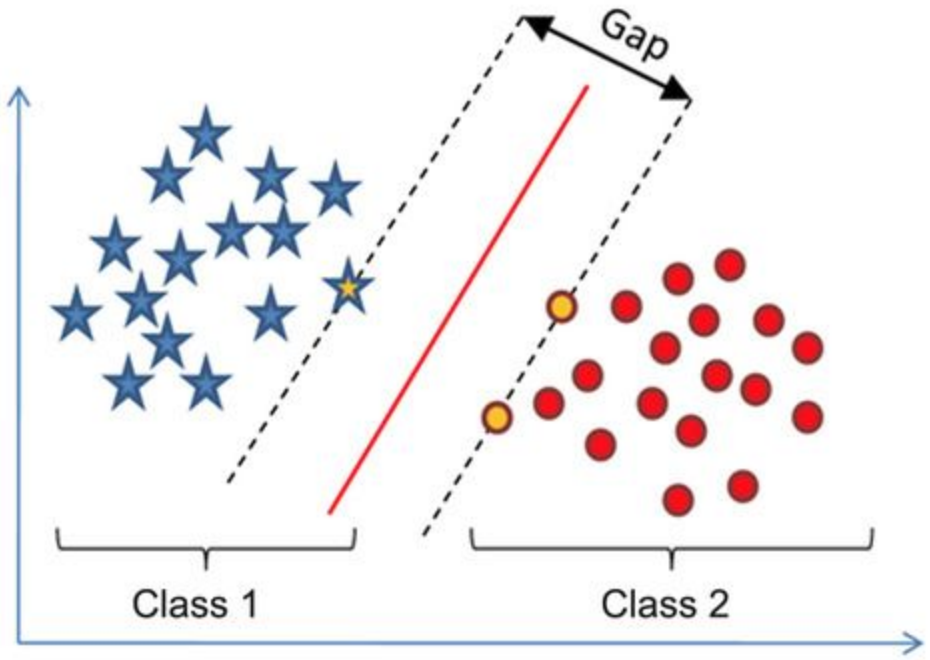
Linear Discriminant Analysis



Linear Discriminant Analysis

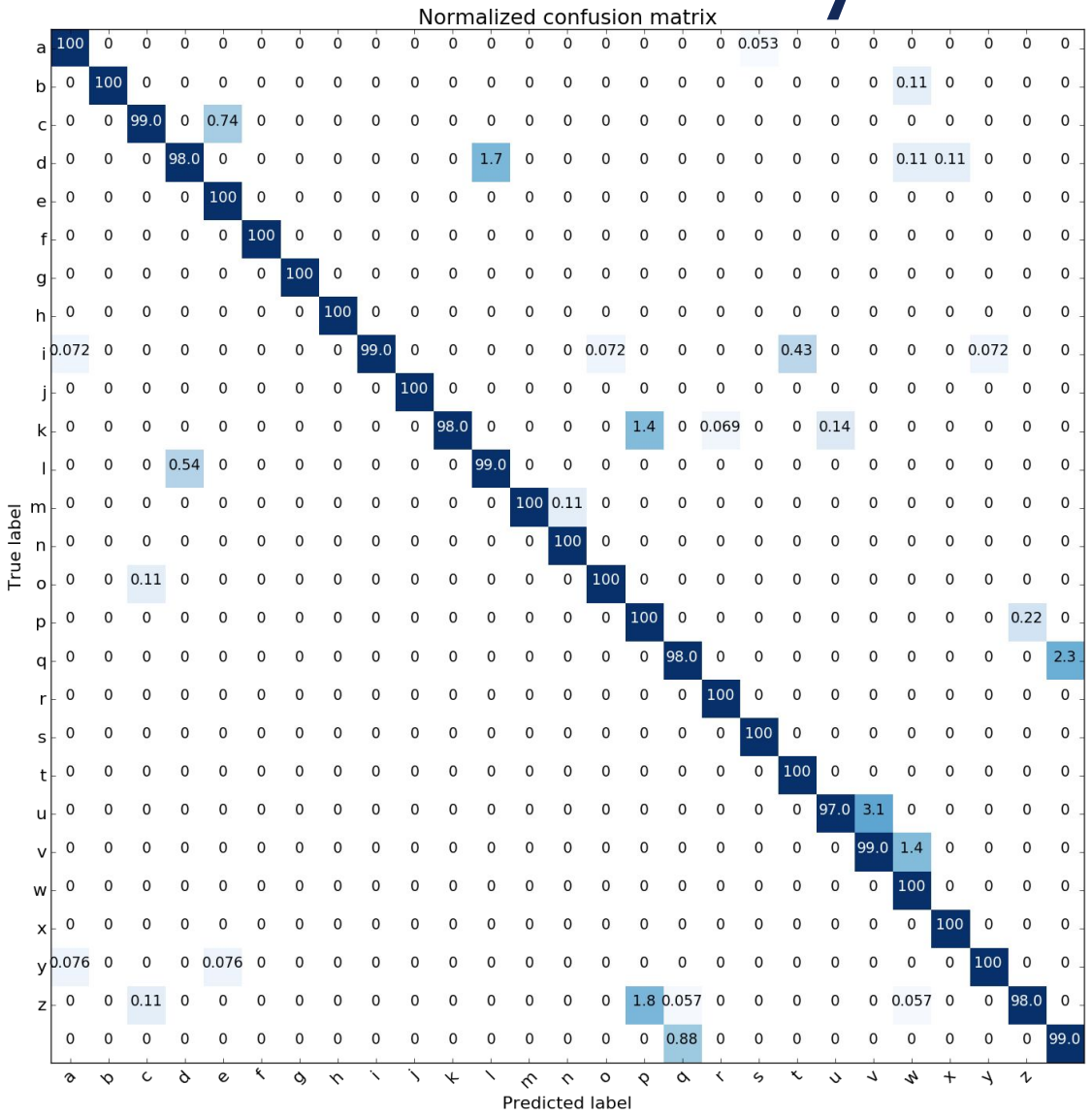


Support Vector Machine

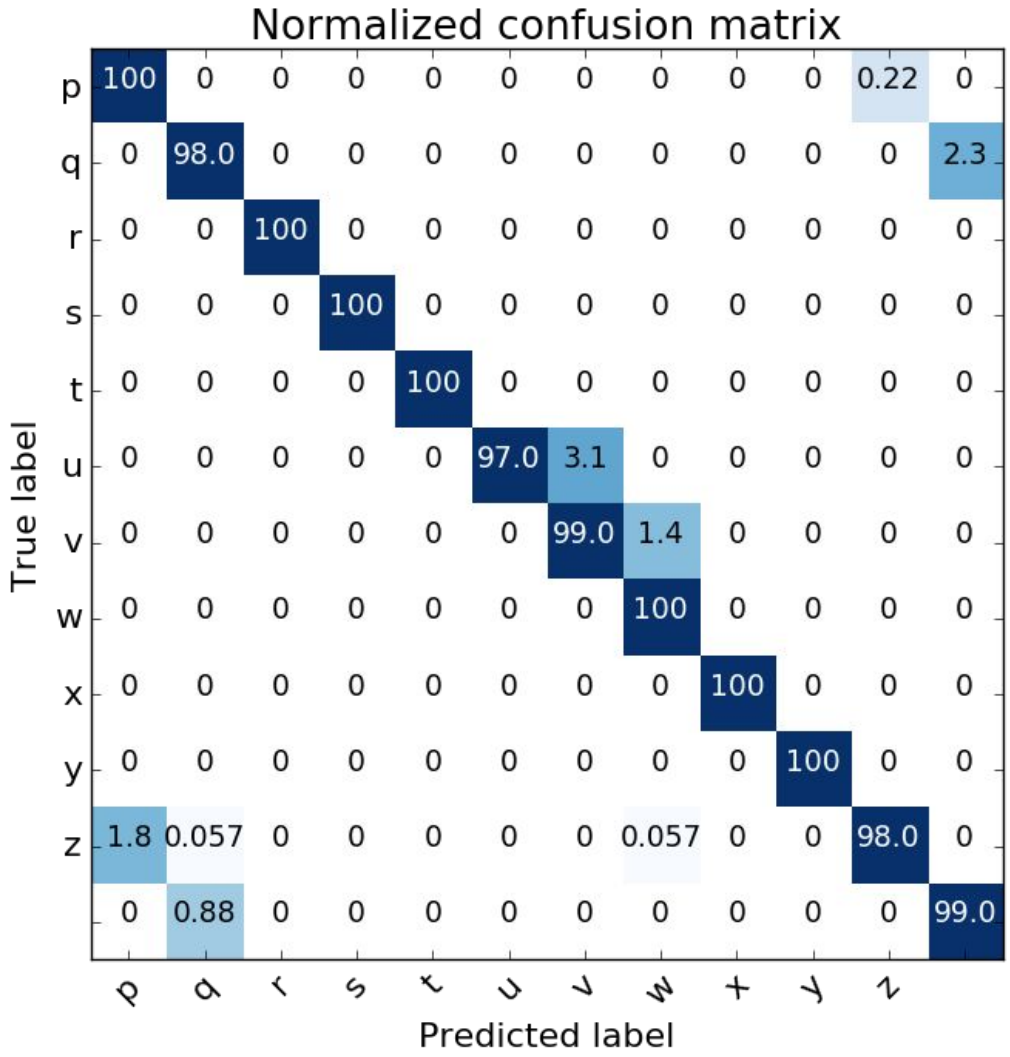


[3]

Classification Accuracy - 98.7%

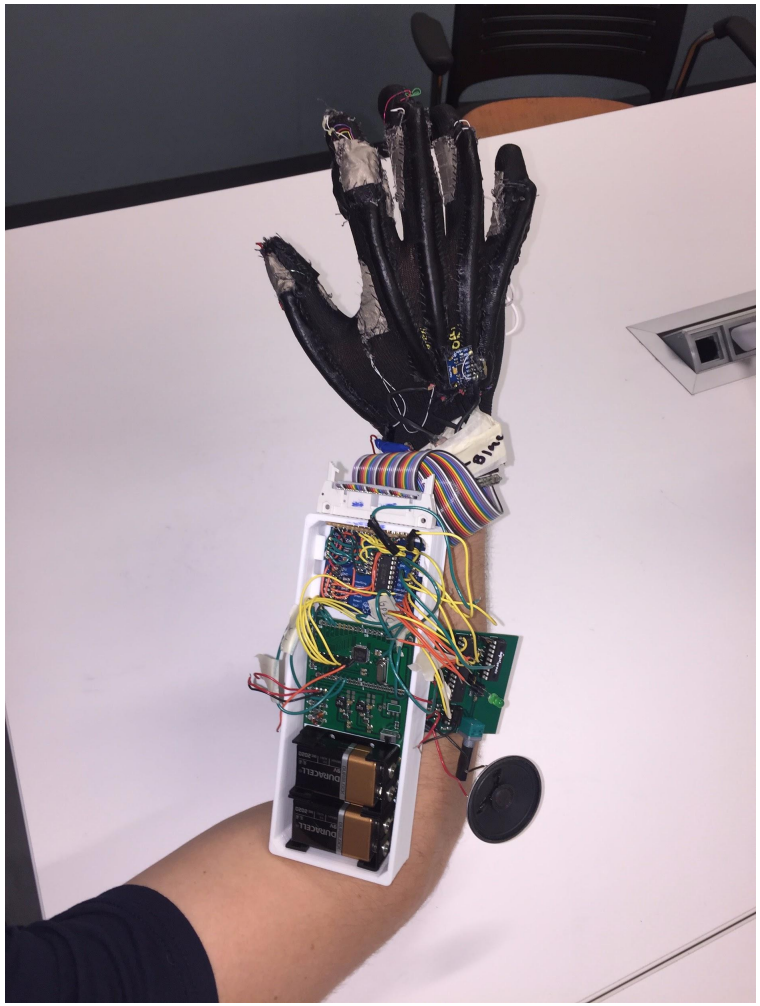


U vs V, Z vs P, Q vs 'off'



Final Remarks

- Outcomes
  - Greater than 95% accuracy
  - Requires MCU with larger memory space
  - Not wearable
- Future Work
  - Gather larger dataset to make glove compatible with more users
  - Shrink form factor



References

- [1] *Signing Into The World of American Sign Language* [Online]. (2017). Available: signlanguagemaster.com. Accessed: April 26, 2017.
- [2] Lane, Hoffmeister, and Bahan. A journey into the deaf-world. San Diego, CA.: DawnSignPress, 1996.
- [3] *Support Vector Machine*. [Online]. (2017). Available: diggdata.in. Accessed: April 26, 2017.
- [4] Flex Sensor 4.5". Sparkfun. [Online] Available: https://www.sparkfun.com/products/8606. Accessed: April 26, 2017.
- [5] Optical Data Communication. All About Circuits. [Online] Avaliable:https://www.allaboutcircuits.com/textbook/digital/chpt-14/optical-data-communication/

References (continued)

- [6] The Fingerspelled Alphabet. lifeprint. [Online] Available: http://www.lifeprint.com/asl101/pages-layout/fingerspelling.html. Accessed: May 1, 2017.

Video

High-to-Low Debouncing