# **American Sign Language Alphabet Interpreter**

### Team 3

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### Introduction



- 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**



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# Flex Sensors Operating Principle



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### Flex Sensors Circuit



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### Flex Sensor Construction





### Flex Sensor Performance



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# Flex Sensors Comparison

### **Commercial Flex Sensors**

- Slow Response
- Limited Resistance Range
- As Is

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### **Optical Flex Sensors**

- Fast Response
- Large Resistance Range
- Tunability





# Settling Time



### **Contact Sensors**









Accelerometer

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### **Contact Sensors**





# Low-to-High Debouncing





#### 13





with V

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with U or R

[6]

R **No Observed Confusion** 





### **Accelerometers Module**



Interrupt to MCU Frame Sync from MCU Serial Clock from MCU Serial Data to and from MCU







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# Speaker Module

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



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### 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<sup>2</sup>C, SPI, and UART
- Small

Problems:

- Low memory
- Opted for Raspberry pi for demo





### Microcontroller Circuit



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### Letter Classification

**Data Collection** 

Preprocessing

### 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

**Before Transformation** 



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# Linear Discriminant Analysis

After Transformation



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### **Support Vector Machine**



# Classification Accuracy - 98.7%

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e label	b	0	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.11	0	0	0	0
	c	0	0	99.0	0	0.74	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	d	0	0	0	98.0	0	0	0	0	0	0	0	1.7	0	0	0	0	0	0	0	0	0	0	0.11	0.11	0	0	0 _
	e	0	0	0	0	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	f	0	0	0	0	0	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	g	0	0	0	0	0	0	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	h	0	0	0	0	0	0	0	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	i	0.072	0	0	0	0	0	0	0	99.0	0	0	0	0	0	0.072	0	0	0	0	0.43	0	0	0	0	0.072	0	0 _
	j	0	0	0	0	0	0	0	0	0	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	k	0	0	0	0	0	0	0	0	0	0	98.0	0	0	0	0	1.4	0	0.069	0	0	0.14	0	0	0	0	0	0
	I	0	0	0	0.54	0	0	0	0	0	0	0	99.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0_
	m	0	0	0	0	0	0	0	0	0	0	0	0	100	0.11	0	0	0	0	0	0	0	0	0	0	0	0	0
	n	0	0	0	0	0	0	0	0	0	0	0	0	0	100	0	0	0	0	0	0	0	0	0	0	0	0	0
True	0	0	0	0.11	0	0	0	0	0	0	0	0	0	0	0	100	0	0	0	0	0	0	0	0	0	0	0	0
	р	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	100	0	0	0	0	0	0	0	0	0	0.22	0
	q	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	98.0	0	0	0	0	0	0	0	0	0	2.3
	r	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	100	0	0	0	0	0	0	0	0	0
	s	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	100	0	0	0	0	0	0	0	0 _
	t	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	100	0	0	0	0	0	0	0
	u	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	97.0	3.1	0	0	0	0	0
	v	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	99.0	1.4	0	0	0	0
	w	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	100	0	0	0	0
	x	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	100	0	0	0 _
	y	0.076	0	0	0	0.076	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	100	0	0
	z	0	0	0.11	0	0	0	0	0	0	0	0	0	0	0	0	1.8 (	0.057	0	0	0	0	0	0.057	0	0	98.0	0 _
		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.88	0	0	0	0	0	0	0	0	0	99.0
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# U vs V, Z vs P, Q vs 'off'



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# **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

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### Video







# High-to-Low Debouncing



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