Sign Talk

A Sign Language Recognition System

Sign Talk

- sEMG vs. RGB-D
- 10 English alphabets with distinct signs were chosen

Background Work for SLR

Gloves

- Users wear a glove which can detect movement and acceleration
- Allows the ability to easily work with a wide variety of hand sizes
- Complex machine learning techniques were not required to handle recognition from gloves

- Able to get accuracy of ~99% for letter by letter recognition
- Unable to do recognize complex gestures requiring significant movement

Camera + Depth Sensor

Camera

- Without depth sensors and only 1 camera letter by letter recognition as done by reasonable success
- Convolutional models were used
- Transfer learning from other big image recognition frameworks was also effective

Camera + Depth

- Most published research used microsoft’s kinect for depth sensor
- Was able to get 99% on letter recognition
- With multiple cameras, word by word recognition was successfully achieved with a dictionary of a few hundred words

Wearables such as EMG sensors

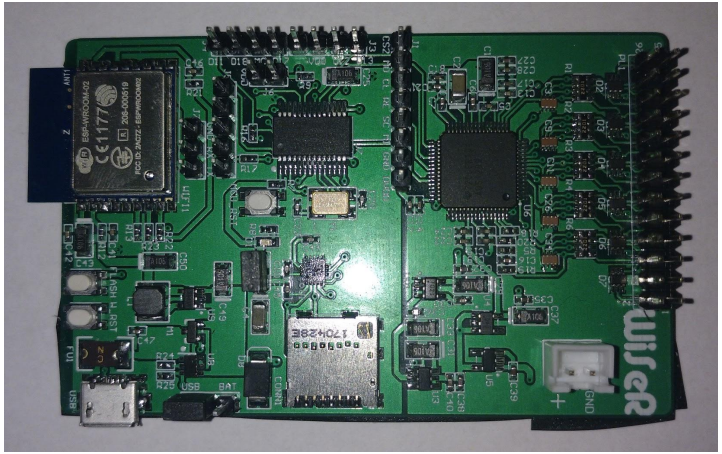
- Devices include myo or custom board with emg sensors
- Published research was able to successfully recognize character by character translation
- Difficult to do word by word translation due to the interactions of other muscles in the arm
- algorithms such as SVM produced reasonably well for this task

Hardware

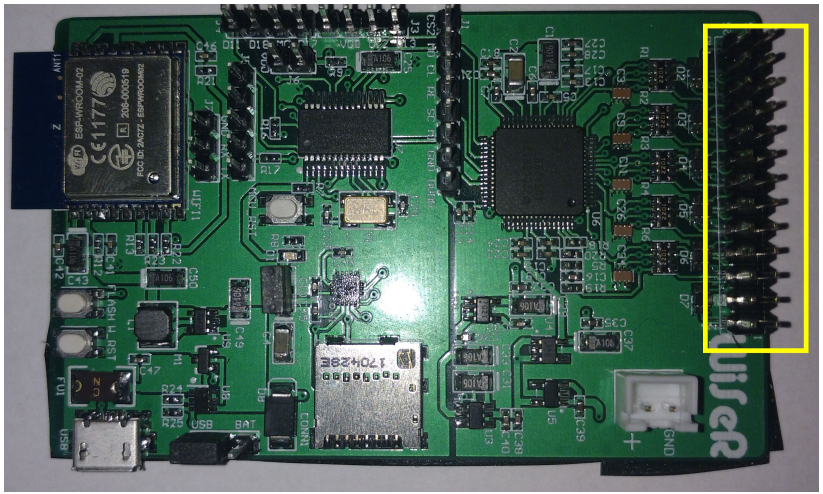
EMG - PCB

Specs:

- ADS1299
- PIC32MX350F128D
- ESP-WROOM-02



EMG - Channels

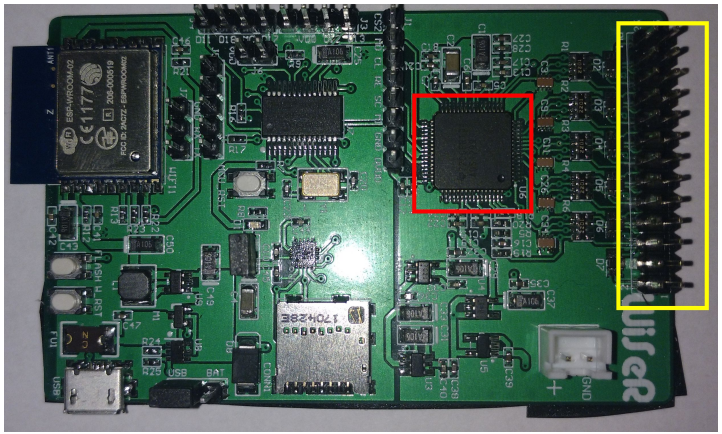


PL1

AVDD	1	1	2	2	AVDD
GND	3	3	4	4	GND
BIAS	5	5	6	6	BIAS
8N	7	7	8	8	8P
7N	9	9	10	10	7P
6N	11	11	12	12	6P
5N	13	13	14	14	5P
4N	15	15	16	16	4P
3N	17	17	18	18	3P
2N	19	19	20	20	2P
1N	21	21	22	22	1P
SRB2	23	23	24	24	SRB1
AVSS	25	25	26	26	AVSS

CON2X13

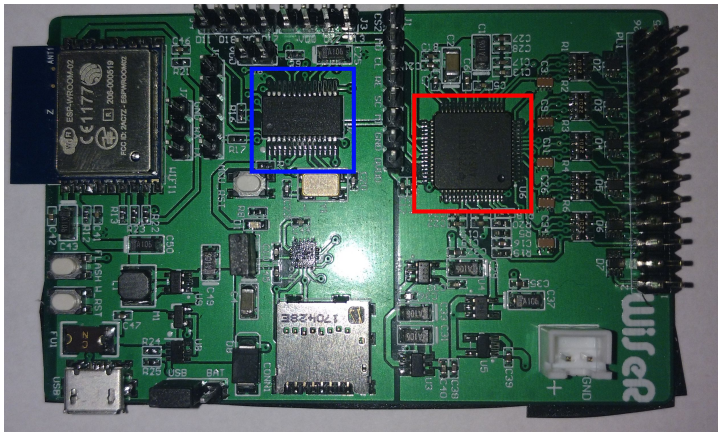
EMG - PCB



Yellow: Channels

Red: 24-bit Analog-to-Digital Converter

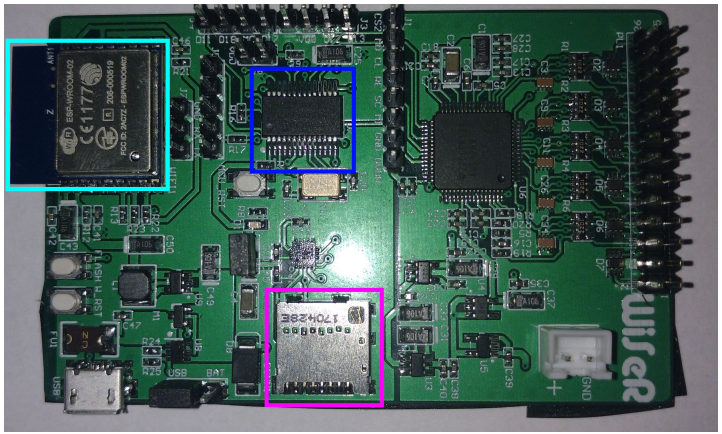
EMG - PCB



Red: 24-bit Analog-to-Digital Converter

Blue: Microchip

EMG - PCB

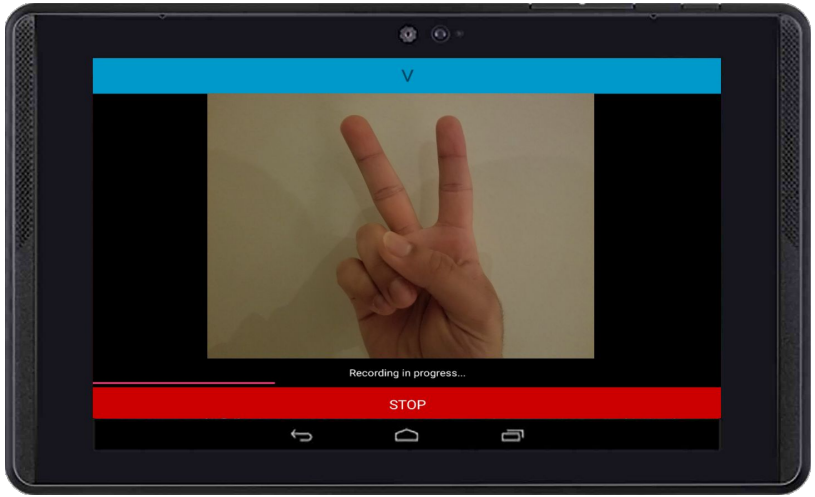


Blue: Microchip

Magenta: Secure Digital Card mount

Cyan: Wireless network card

Tango Tablet

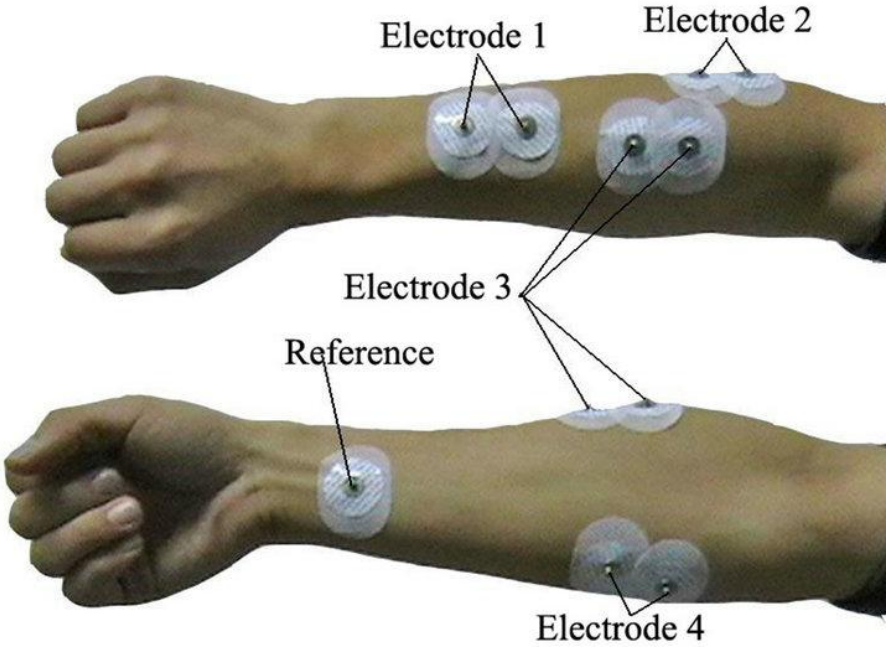


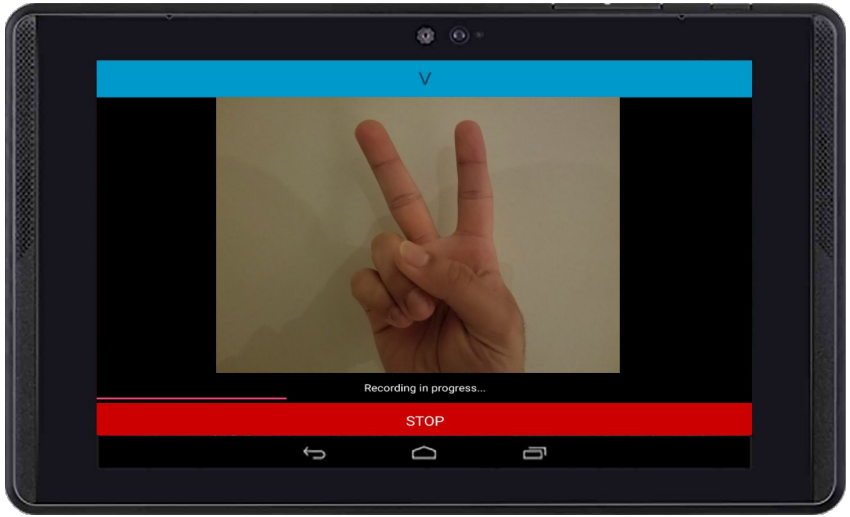
Implementation

Process

1. Data Collection
2. Preprocessing
3. Feature Extraction
4. Classification

Data Collection





Preprocessing

Zero Mean

$X_{zero} = X - mean(X)$

https://upload.wikimedia.org/wikipedia/commons/1/1d/Medianfilterp.png

Feature Extraction (sEMG)

$$MAV = \frac{1}{N}\sum_{i=1}^{N}|Xi|$$

$$SSI = \sum_{i=1}^{N}|Xi|^2$$

$$RMS = \sqrt{\frac{1}{N}\sum_{i=1}^{N}Xi^2}$$

$$STD = std(X)$$

$$MAX = max(X)$$

$$MIN = min(X)$$

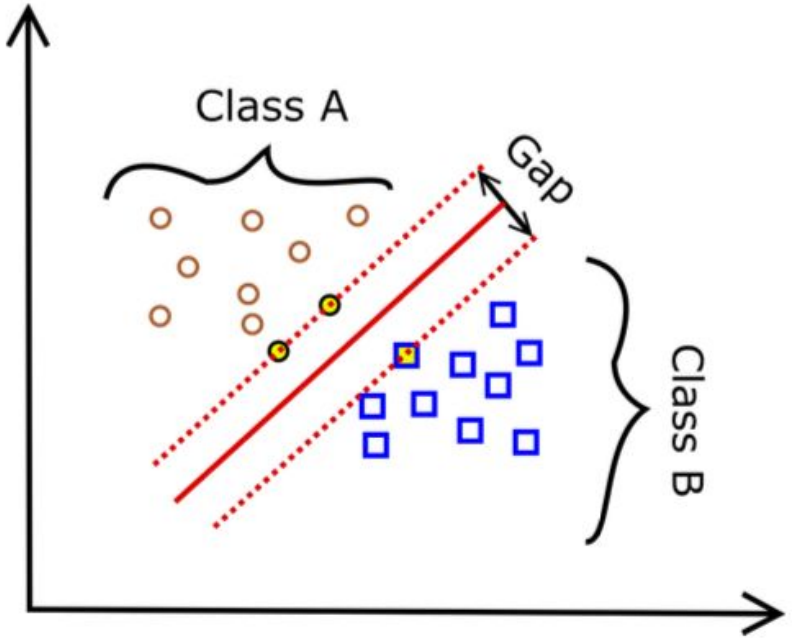
Feature Extraction (RGB-D)

- Histogram of oriented gradients

https://www.learnopencv.com/wp-content/uploads/2016/12/histogram-of-oriented-gradients.jpg

Classification

- Support Vector Machine (SVM)
- Independent Component Analysis (ICA)
- 3D Convolutional Neural Network



Results

Unknown

- Issues with data collection
- Limited documentation on Hardware
- Couldn’t find relevant datasets

References

- [1] Ferat Sahin Celal Savur. “Real-time American Sign Language Recognitionwith Convolutional Neural Networks”. In: (2015).
- [2] Yingli Tian Chenyang Zhang. “Multi-Modality American Sign LanguageRecognition”. In: (2016).
- [3] Bo Li Qiang Li. “Online Finger Gesture Recognition Using Surface Elec-tromyography Signals”. In: (2013), p. 102.
- [4] Celal Savur. “American Sign Language Recognition System by Using Sur-face EMG Signal”. In: (Feb. 2015), pp. 1–10.
- [5] Ala Shaabana.XTREMIS.url:https://github.com/shibshib/XTREMIS_CAPSTONE.
- [6] Stavros M Panas Vasiliki Kosmidou Leontios Hadjileontiadis. “Evaluationof surface EMG features for the recognition of American Sign Languagegestures”. In: (Aug. 2006).