SignTalk (An SLR System)

{ Ahmed Khan, Saim Malik, Sergio Agraz. Supervised by Dr. Rong Zheng }
Department of Computing and Software, McMaster University

Abstract

Many people with a hearing disability rely on sign language to communicate. However, only a fraction of the world population understands this form of communication. Sign Language Recognition (SLR) is a method that allows such people to communicate with the society. The goal of this project is to develop an American Sign Language (ASL) recognition system by using two separate Machine Learning models and comparing their accuracies. One model is trained using surface Electromyography (sEMG) signals from the user's forearm and the other is trained using RGB-D (RGB with depth dimension) data. Due to limited resources, this project is only targeting 10 letters of the English alphabet as the gestures for these letters are very distinct and can be done with only one hand. Following are the letters used.

A, B, D, G, I, L, N, P, V, W

The data collection is done using two separate hardware. The sEMG data is collected using the XTREMIS Board, designed by WiSeR. The RGB-D data is collected using the Tango Tablet via its Infra-Red (IR) sensors and Fish Eye camera. The two input sources are processed separately and the accuracy of each is compared.
Overall, the results of this project are expected to give an insight on advantages and disadvantages for the two input sources mentioned. The accuracy will be based on the number of correct predictions from the test data set.

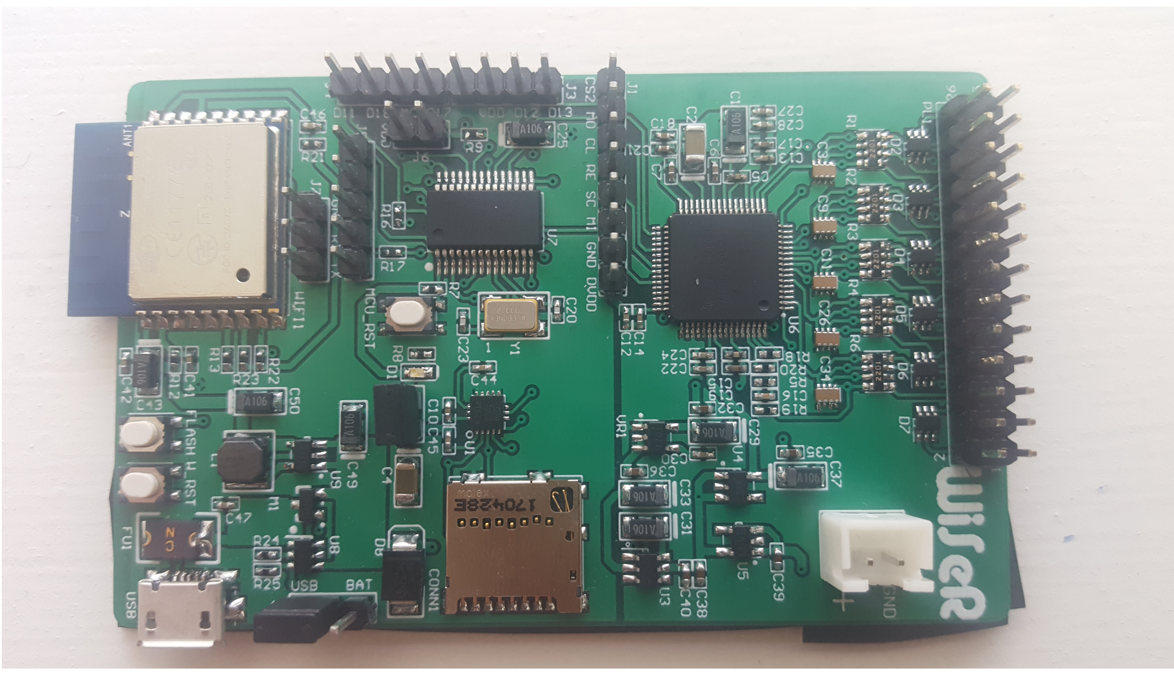
Introduction

According to World Health Organization, as of 2015, there were over 360 million people with a hearing disability [1]. Majority of this population has to rely on sign language to communicate. However, only a small percent of people actually understand sign language.
In this project, a Sign Language Recognition (SLR) system is developed using sEMG signals from the user's forearm and RGB-D data from the Tango Tablet. Both input sources are fed into the appropriate Machine Learning model and are then classified into the corresponding English alphabet.

Hardware

WiSeR (Wireless Systems Research Group) developed a Printed Circuit Board (PCB) that is able to detect millimetre-precise finger movement called XTREMIS. It is an ECG/EMG/EEG board that is capable of collecting data at high sampling rates. It is based on the ADS1299 chip, and is inspired by the OpenBCI open source project [2].

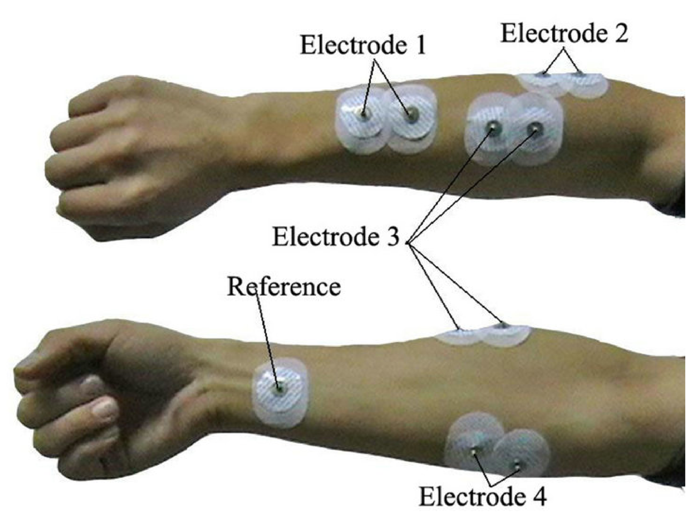
Figure 1: XTREMIS Board



Method

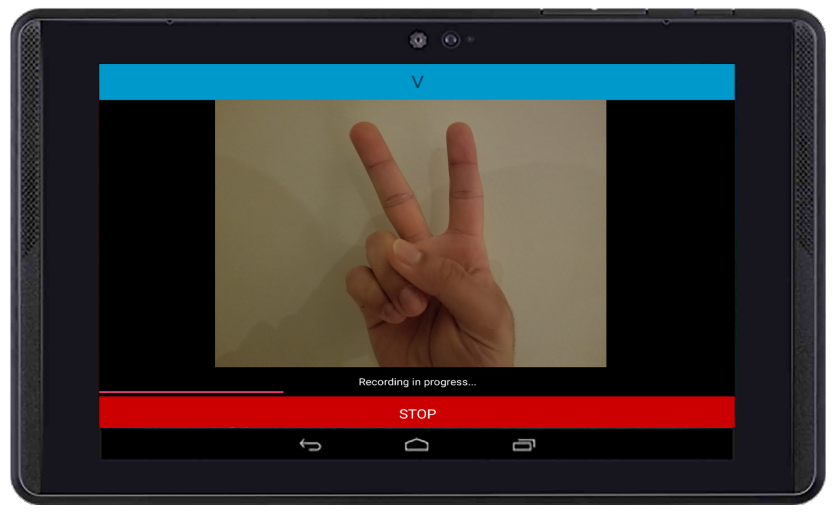
The application works as an offline system in a two step process.
First, the raw sEMG and RGB-D data are collected from the user. For the sEMG signal, five electrodes are attached on the user's forearm and one on the wrist bone for reference. The user is given three seconds to perform the gesture for one of the English alphabets in front of the Tango Tablet camera to simultaneously record both sEMG and RGB-D data. Then, the entire three seconds of data is saved for both input sources. This process can be repeated multiple times.

Figure 2: Electrode placements



Once the data has been collected, it is fed into the main application. The application reads the data for one letter at a time and outputs the predicted English alphabet that corresponds to it. A separate prediction is made for each input source.

Figure 3: Android App



Process

An Android application will been created for training and demoing purposes. The application will be configured to communicate with a Flask server, using HTTP. The same server will communicate with the XTREMIS board for sEMG data collection. Having this architecture in place, the Android application can be used to trigger data recording for both the Tango Tablet and the XTREMIS board simultaneously.
In total, 1000 samples will be collected from 10 individuals (10 samples per letter per person) for training and testing purposes. 75% of this data set will be used for training and the rest will be used as the test set.
For sEMG data, we'll be extracting the following features: Mean Absolute Value, Simple Square Integral, Root Mean Square, Standard Deviation and Frequency Domain. For RGB-D data, we'll be using a convolutional neural network (CNN). The classification method used for both systems is Support Vector Machine (SVM).

Conclusion

To summarize, the results of this project will give insight on the accuracy of sEMG vs. RGB-D based SLR system. However, further research is be required to validate the correctness of these results since only a subset of the English alphabets were used in this project. Furthermore, the results may vary substantially for an SLR system made for recognizing words and sentences instead of letters.

References

[1] Celal Savur. "American Sign Language Recognition System by Using Surface EMG Signal". In: (Feb. 2015), pp. 1–10.
[2] Ala Shaabana. *XTREMIS*. URL: https://github.com/shibshib/XTREMIS_CAPSTONE.
[3] Stavros M Panas Vasiliki Kosmidou Leontios Hadjileontiadis. "Evaluation of surface EMG features for the recognition of American Sign Language gestures". In: (Aug. 2006).

Resources