Project Name : Gesture Recognition
Course Code : CSE 4510
Course: Software Development I

Submitted by:
Mohammad Sabik Irbaz (160041004)
Abir Azad (160041024)
Anika Tasnim Preoty (160041044)

Submitted to:
Dr. Md. Hasanul Kabir
Professor, Department of CSE

Tareque Mohmud Chowdhury
Assistant Professor, Department of CSE

Date of Submission : 10 May 2019

Contents:

1. Introduction:

Biomedical signal means a collective electrical signal acquired from any organ that represents a physical variable of interest. This signal is normally a function of time and is describable in terms of its amplitude, frequency and phase. The EMG signal is a biomedical signal that measures electrical currents generated in muscles during its contraction representing neuromuscular activities. The nervous system always controls the muscle activity (contraction/relaxation). Hence, the EMG signal is a complicated signal, which is controlled by the nervous system and is dependent on the anatomical and physiological properties of muscles.

Electromyography (EMG) signals can be used for clinical/biomedical applications, Evolvable Hardware Chip (EHW) development, and modern human computer interaction. EMG signals acquired from muscles require advanced methods for detection, decomposition, processing, and classification.

1.1 Project Overview:

Our project is aimed at making use of the device called Myo Armband to recognize changes in muscle movement in humans in terms of EMG and IMU signal. The data is in integer form presented graphically by the data retrieving software provided by Myo.
We aimed to translate this signal into meaningful gesture- i.e we recognized gesture with the data provided by Myo armband

1.2 Objectives of the project:

The Myo armband interprets the electrical impulses generated by muscle movements in your forearm. it needs neither light nor a camera to operate. This, coupled with its relatively small size, could make it easier to use in darkened rooms or bright sunlight.
If gesture can be identified individually, these gestures can be used as a trigger to control various devices, i.e: these gestures will work as input to the system we are working with.

What is Myo armband?

Myo band is a wearable device designed by Thalmic Labs Inc. provided with eight electromyographic (EMG) electrodes, a 9-axes inertial measurement unit (IMU) (3-axes gyroscope, 3-axes accelerometer and 3-axes magnetometer) and a transmission module.

The movement in our muscles; i.e. contraction and relaxation causes the clenching or relaxing of our fists. This motion generates signals that are detected by the EMG (Electromyography) sensors in the band which are then translated to virtual actions when the band is connected to a Bluetooth enabled device; i.e. smartphone, laptop, tablet etc.

It is an armband that monitors electrical signals in the wearer's arm muscles and converts them into roll, pitch, and yaw (movement along the x, y, and z axes) to track motion in three dimensions The way the Myo works is quite ingenuous, there are receptors in the armband that are able to detect the electrical impulses that pass through individual muscle groups in the lower arm. Through extensive study, the movements of the arm and hand have been mapped to an extent that when the user makes a designated hand or arm movement, the Myo is able to interpret it and translate it into a digital response. This unique product has the potential to revolutionize the overlap between the digital world and the real world.

2. Motivation and goal of the project:

As people age, they often deal with decreased mobility. Such reduction may ultimately impair people's ability to perform daily activities of life. For those wishing to age in place, a diminished ability to perform daily activities is frequently an indicator to diminished quality of life, decreased independence, increased caregiver burden or institutionalization. With this population in mind the authors envision a comprehensive system of adaptive architectural robotic component to support independent living of people whose capabilities are changing over long periods of time.
The present methods and devices relate generally to human-electronics interfaces, and more specifically to wearable electronic devices that combine muscle activity sensor signals and inertial sensor signals to provide gesture-based control of electronic devices. Gesture control has come a long way since Microsoft released the Kinect in 2010—the first truly mass-market gesture-control system. With Myo (pronounced “my-oh”), we hope will take things even further by building apps enabling the device to do everything from controlling virtual-reality

3. Scope of the Project:

Since Myo streams the raw EMG and IMU data , it can be used to utilize projects and applications on very large scale thus making the scope of our project quite extensive - both professionally and personally.

3.1 Project area and context of work:

The raw data provided by myo armband can be mapped into meaningful data. The device can be trained multiple times to find the range of integer values provided by a single movement. Once the range is identified, it can be mapped into meaningful form. In this way we are giving meaning to a simple movement detected by an electronic device. Thus movements can be used as input to systems , from personal slide switching of PowerPoint presentations to moving as heavy as 1000kg loads in industrial level with a simple gesture.
The armband can also be used in the healthcare sector - often in hospitals and clinics by doctors and medics to enhance images of x-ray, ECG or ultrasound tests to help diagnose medical conditions in a better way.
Thus the use of this device in gesture control can range from very basic applications such as switching on and off of electrical devices to playing video games to even controlling large scale heavy machinery in industries.

4. Contribution and work flow:

The progress of this project was only possible due to the effective collaboration of all members of the team. Each member made their contributions as per their own unique area of expertise. A brief timeline of our work is discussed below:

We had two wait the first two weeks of the semester for the device to be shipped from USA. This time of our waiting phase we spent on learning complex machine learning algorithms and brainstorming on the project.

Once the device arrived, we immediately started working on integrating the device with our machines. The library dependencies, the system requirements of the device did slow us down in our work plan. After facing some initial setbacks, we were finally able to map hand movement into raw integer value in graphical form.

Abir Azad (ID: 160041024) was effortlessly focused in integrating the device with our machine. Sabik Irbaz (ID: 160041004) was mainly focused in finding pattern in the raw data and together with Anika Tasnim Preoty (ID: 160041044) was able to map them into meaningful information.

Initially we had planned on mapping all sign language alphabets. However, the accuracy of the device on detecting small changes; i.e.(i) Two fingers up and (ii)One finger up - was very poor. The raw data was also not much differentiated. This is when we had to change our plans to making more solid movements such as fist, spread hand etc. These solid changes in gesture was quite finely differentiated using EMG signals.

Our next challenge was to make our machine understand that the particular rise in some or all of the sensors data meant a particular gesture and not the other; i.e. sensor 1 having high frequency of EMG signal, sensors 2, 6 ,8 having moderate while 3 ,4,7 having no frequency of EMG at all meant that the motion is a fist. We needed to find the appropriate pattern for each gesture first and then had to map it. Once we could do that, we used it as a trigger and used PyAutoGUI to use it as a mouse function (click-left or right , drag , scroll etc.) or keyboard stroke.
The mouse function can then be used for controlling any system to which it is integrated. Here we are showing our project by controlling the jumper in T-REX game. The jumper jumps only when a ‘wave-in’ gesture triggers a space bar press.

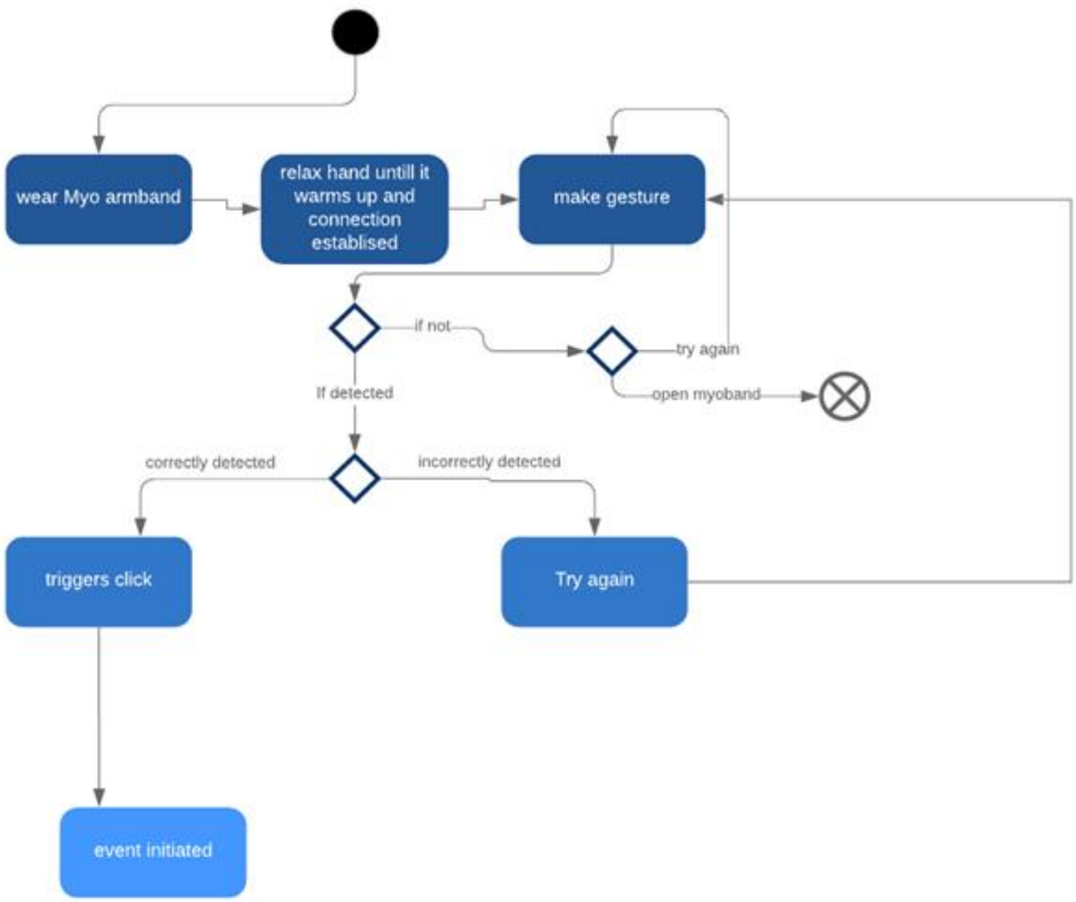
5. Stakeholders:

The major stakeholders of this can be anyone with the is able to make gestures ,i.e. make hand movements and are willing to use them as an input method..
Any industries that requires movement of large loads, to any individual willing to switch off fan with a simple gesture can be the users of this software, depending on how the mapped gesture is integrated and to what system.

6.Project model

6.1 UML activity diagram

This is the activity diagram from the user end perspective only .



6.2 Use case Diagram:

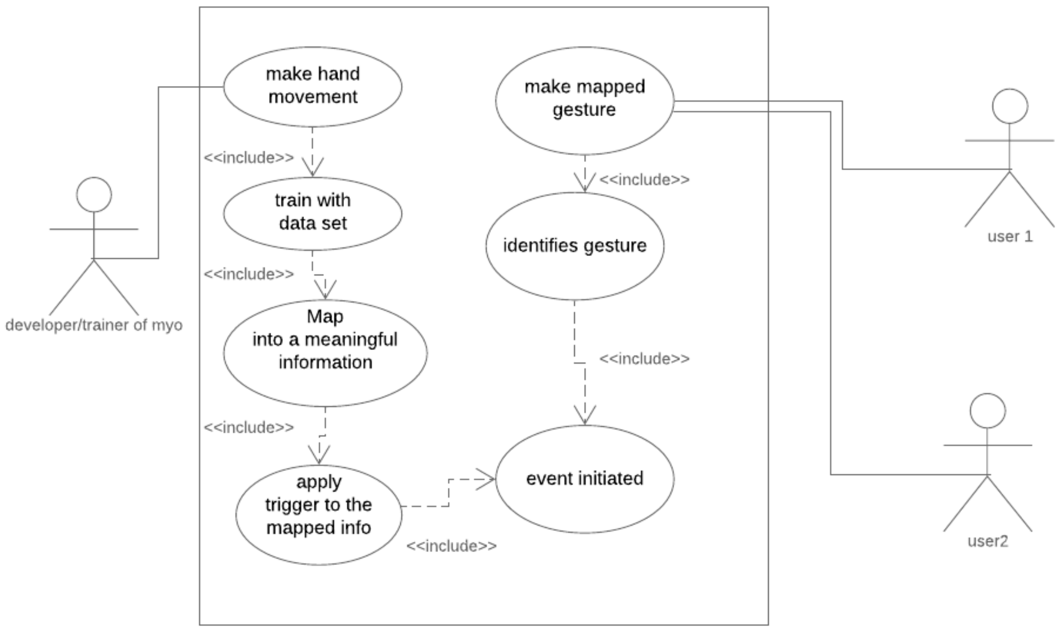


Figure: Use Case diagram

Here we see how users interact with the system to initiate any event in system to which the software is integrated. alongside is also shown how the we can train the software of new gestures.

7. Requirements:

7.1 Functional requirements:

In our system's Functional Requirements include the following:

1. **Bold hand movement**

   The gesture to be recognized must be bold and complete for the device to produce exact data. any incomplete gesture might result in wrong detection.

2. **Bluetooth system must be turned on**

   The machine in which the myo band is integrated must have Bluetooth. Functionality and must have it turned on for myo band to detect the device.

3. **The events interface must be open**

   The game or system to which we want the myo band to be triggering the input must be open in the window. or else the trigger will be lost in background.
4. Forth and most important, a fully charged myo armband with full functionality.

7.2 Data requirements:

Huge number of EMG and IMU signals coming from the total of 8 sensors are the main data set here that are used to train the system . The incoming data right now is very noisy as it is picking up background noise. Due to shortage of time, we could not implement filters on the incoming data set. the less noisy the data, the better the accuracy

7.3 Non-functional requirements

7.3.1 Performance

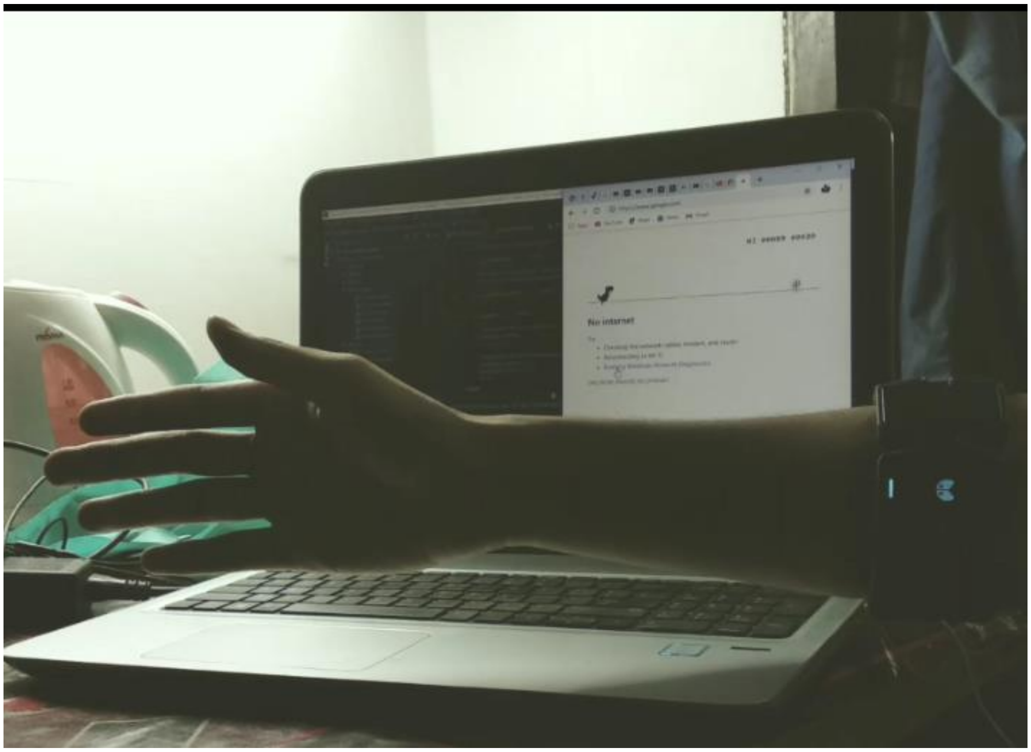
The performance of the software is yet not 100% accurate. to improve the performance, we need to train the software with huge data sets for each gesture as the EMG signal alone cannot always be reliable. Complex machine learning algorithm must further be used on it to make it more reliable.

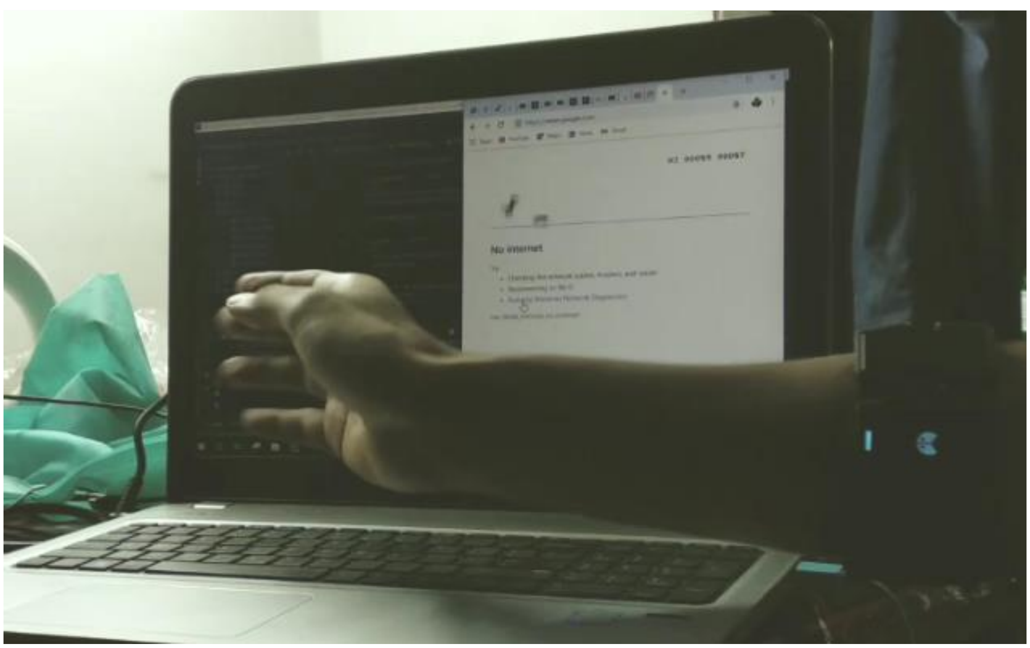
Other than that, the system is very fast at detecting the gesture, it does it almost instantly.

7.3.2 Portability

The device along with the software is portable as it is integratable with laptop. The power backup is huge for the myo band. The android version of the app is still in development phase, but it is possible to integrate the myo band with android device as well, making the software super portable.

8.Prototype and design





9.Conclusion and Future work

As we initially planned to make a method of reading sign language, we plan to implement it in future. After working with use of camera with the band will accurately identify the gesture.
Myo band and seeing its limitations, we realized simply EMG signal will not be enough to implement what we initially planned. Hence we believe
To recognize all the letters of sign language, after camera integration we also need to train the software with huge data set. Repeated training of every single gesture will help the system track less bold gestures too.

Once the performance of the software is upgraded, we also have plans on including a “Train” option in the GUI, so that any user can customize his/her own gestures and map them without having to know the inner algorithm.
Lastly, an app version of the software must be implemented for all deaf and blind people to use it with ease and produce written form of their demonstrated sign language.