A New Dumb's Communication System

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***Abstract*—Communication is one of the major principles to deal with the surrounding environment. The communication between people who are deaf or having an impaired hearing, with everyone around is difficult. This is due to the lack of the common language between both parties. Statistics and studies done by the World Health Organization showcases that 360 million people around the world suffer from hearing loss. Hearing loss is one of the major public health issues; that is considered to be the third most common physical condition after arthritis and heart disease. Dumb people communicate with others using their body language merely; especially their hand gestures. This communication mode is said to be complex, when dumb uses their manual-visual language. Though these languages are used, however, they do not have a typical origin and hence hard to interpret. Gesture recognition is the only way used to interpret and understand sign language. It depends on perceiving and interpreting movements based on Electromyography. For this purpose, we propose a way to transform the sign language of the dumb's into an audio voice to convey their thoughts to others using Electromyography. Electromyography electrodes are utilized as a non-invasive wearable tool to provide clear, sensitive and accurate data for the muscle movement. For every movement there is a message. A database is collected for all the messages templates required. The motion sensor is placed on the dumb hand, while template database is fed into a microcontroller, in real time. Preliminary results showed that the Dumb's system is capable of providing the comparison of every single motion registered with the database to produce the speech signal, based on matching gestures. A Text To Speech conversion block circuits, provided an interpretation to match the gestures. The device is not only interpreting alphabets but also sorting words produced by gestures. Dumb is capable of speaking like a normal person when undergoing the proper training and updating the database of this system.**

***Index Terms*—Dumb's System, Electromyography Signals, Gesture Recognition, Sign Language, Mayo Armband, Signal Processing.**

I. Introduction

Hearing loss is a sudden or progressive decrease in how well a person can hear. The gradual mode may affect people of all ages, varying from mild to profound. The degree of hearing loss that a person experiences is based on the hearing sensitivity [1], [2].

While sound is measured by its intensity and frequency, hearing impairment can be defined as the lack of intensity, frequency or both characteristics of the sound. Hearing Loss can occur in one ear or in both. The loss can be caused by a damage in any part of the auditory pathway [3].

Researchers developed one practical solution for some cases of hearing losses, that is the "hearing aid device". It is a mini electronic device, worn in or behind the ear. It amplifies the sound leading the affected person -deaf- to hear, communicate, and participate in the daily activities. It can support people to hear more in the quiet as well as the noisy situations. The greater the damage to a person's ear hair cells, the more severe the hearing loss, and the greater the hearing aid amplification needs to make up the difference.

There are different styles and models for hearing aid devices; however, they are not enough for communication. Although hearing aids can help people in such a great deal, they do not return an individual's hearing to normal. They cannot hear perfectly even with their hearing aid in. Whilst working correctly, deaf people will need time to adjust to the way things sound. It takes time for a new hearing aid user to become accustomed to the aid. Besides, there are practical limits to the amount of amplification a hearing aid can provide. In addition, if the inner ear is too damaged, even large vibrations will not be converted into neural signals. In this situation, a hearing aid will not be effective. Hearing aids are helpful in improving hearing percentage and quality of life but not in correcting hearing [3].

A. Body Language

Although hearing aid devices are a good assist for deaf of a certain particular cases, sign language is widely used beside for the sake of expressing thoughts. It is said to be complex using the manual-visual language. This language is considered to be a non-verbal form of intercourse that's found among deaf communities. Each country or region uses different sign language. Each one is based on the social, cultural, and historical aspects of the country itself. It becomes hard that deaf people of different backgrounds understand each other's languages. A gap of communication is initiated between deaf communities of different countries as well as the hearing communities around [4].

Scientists have noted that there is more nerve connections between the hands and the brain than the other parts of the body, thus gestures taken by hands are considered to give more powerful insights to emotional state. Using hand gestures grab attentions, increase the impact of communication and helps individuals retain more of the speech information.

II. Problem Statement

People suffering from hearing loss should acknowledge the reality of their case as a first step in accommodation and moving on. It is not an easy step, but one cannot minimize the

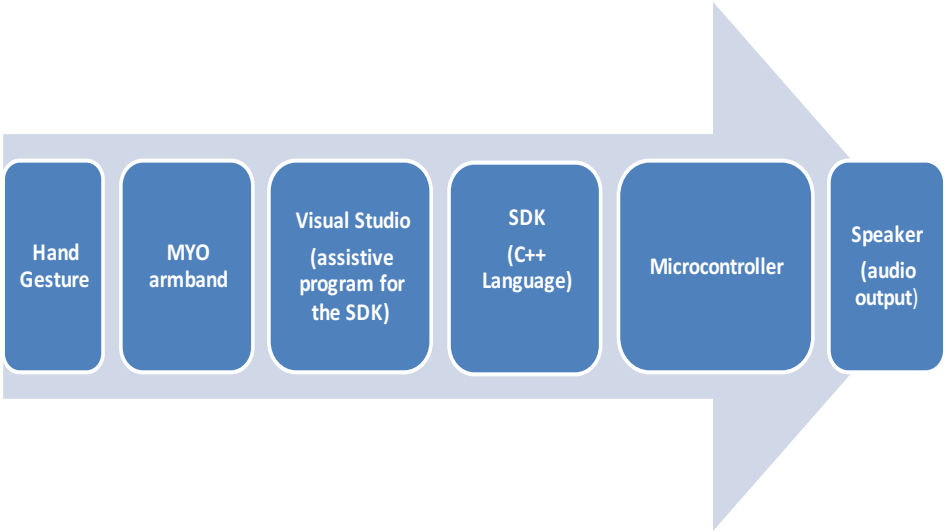


Fig. 1: The Block Diagram of Our Dumb's Communication System.

effects of a hearing loss, and earn an efficient measure when denying his/her case. Having that said, sign language is the most applicable technique used by deaf-mute people to express their needs and communicate with the surrounding; however, it may not be helpful enough to ease the communication between the deaf or mute community and the standard world, that's why a communication gap shows up between the two communities.

III. Our Dumb's Communication System

A. Materials

The Myo armband placed on the arm is responsible for detecting the electrical signals from the muscles for every performed gesture. Then it transmits these signals wirelessly to the software. In the "Dumb's Communication System", the data base requires the implementation and frequent update of the C++ scripts using the visual studio software. Then these data is being translated by the microcontroller, and results in an audible sound respective to the performed gesture (see Fig. 1) [5].

1) Myo Armband: The Myo armband is a complete wireless motion and sensing platform; or in other words, it is the gesture control arm band. It consists of eight medical stainless steel Electromyography (EMG) sensors that measures the electric signals produced by the muscles of the arm, in addition to a 3-Dimensional gyroscope, 3-Dimensional accelerometer, and a magnetometer to track the movements like spinning or moving.

Moreover, it contains a tiny ARM Cortex M4 Processor, battery and a haptic engine; all embedded in an eight plastic shells, held together with a flexible band in addition to some clips in order to fit exactly to the size of your arm. This device has no buttons; it turns on when sensing a motion, and turns off when set away. Once it measures the signals it can directly interpret and translate it into a digital response. In addition to that, it vibrates in order to send information to the user. The Myo device communicates with other electronic device or circuits wirelessly by "Bluetooth". This device can be used in dark or bright light sun places. Furthermore, the Myo arm band can be used with windows 7/8/10, MAC OS X 10.8, i-phones and other androids [5].

2) Visual Studio: It is an application used to develop computer programs using different programming languages. It includes the tools for creating software, design, coding, testing, and testing the code performance. These tools are designed to work together, and are all exposed through the Visual Studio Integrated Development Environment (IDE). In addition to that, in our project C++ language is utilized on this software to produce the database of the Myo armband gestures.

3) Emic Text-to-Speech Module: It is a voice synthesizer that converts the digital text data into a sound speech using the DEC talk text to speech synthesizer and the NLP micro-controller chip embedded in it. It has many specifications, and needs a 3.3 V to function normally. It provides a high quality speech synthesis in both English and Spanish languages [6]. It can also provide a nine predefined voices male, female, and child. In this module the speaking rate, the word emphasis, and the voice characters can be controlled easily by programming. In addition to that, on the chip board there is a power audio amplifier an audio jack, and two pins to connect a speaker instead of the jack [6].

B. Method

The major steps of this study are summarized in the block diagram in Fig.2. Fig.2 showcases the biomedical Dumb's Communication System.

After believing in all the difficulties that face the dumb people in their daily life, and after months of thinking about a way to help them overcome their impairment; we proposed the new technique that transforms the sign language of the dumb into an audio voice. This will be a great assistance in order to convey their thoughts to others. We will be using EMG electrodes as a non-invasive wearable technology that provides us with a clear sensitive and accurate data of the muscle motion. This data will be analyzed using software in a separate circuit. The software in combination with previous database will convert the gesture of the dumb person into a real audio voice. For every motion there will be a meaningful

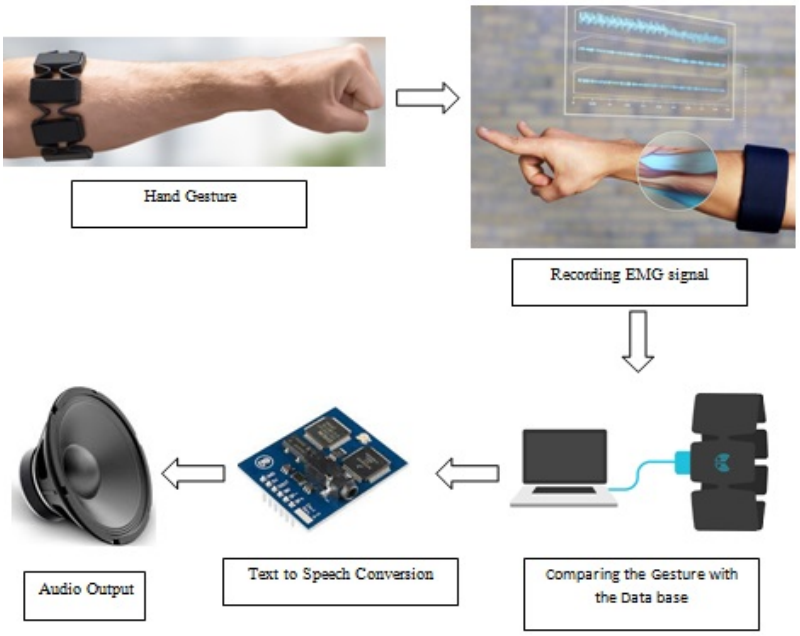
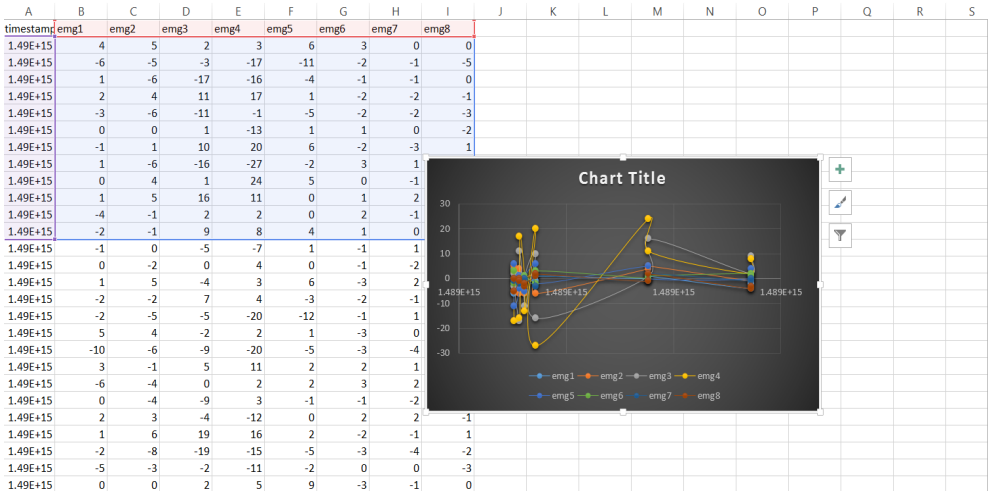


Fig. 2: The Combination of the Used Materials for Our Dumb's Communication System.



timestamp	emg1	emg2	emg3	emg4	emg5	emg6	emg7	emg8
1.49E+15	4	5	2	3	6	3	0	0
1.49E+15	-6	-5	-3	-17	-11	-2	-1	-5
1.49E+15	1	-6	-17	-16	-4	-1	-1	0
1.49E+15	2	4	11	17	1	-2	-2	-1
1.49E+15	-3	-6	-11	-1	-5	-2	-2	-3
1.49E+15	0	0	1	-13	1	1	0	-2
1.49E+15	-1	1	10	20	6	-2	-3	1
1.49E+15	1	-6	-16	-27	-2	3	1	
1.49E+15	0	4	1	24	5	0	-1	
1.49E+15	1	5	16	11	0	1	2	
1.49E+15	-4	-1	2	2	0	2	-1	
1.49E+15	-2	-1	9	8	4	1	0	
1.49E+15	-1	0	-5	-7	1	-1	1	
1.49E+15	0	-2	0	4	0	-1	-2	
1.49E+15	1	5	-4	3	6	-3	2	
1.49E+15	-2	-2	7	4	-3	-2	-1	
1.49E+15	-2	-5	-5	-20	-12	-1	1	
1.49E+15	5	4	-2	2	1	-3	0	
1.49E+15	-10	-6	-9	-20	-5	-3	-4	
1.49E+15	3	-1	5	11	2	2	1	
1.49E+15	-6	-4	0	2	2	3	2	
1.49E+15	0	-4	-9	3	-1	-1	-2	
1.49E+15	2	3	-4	-12	0	2	2	-1
1.49E+15	1	6	19	16	2	-2	-1	1
1.49E+15	-2	-8	-19	-15	-5	-3	-4	-2
1.49E+15	-5	-3	-2	-11	-2	0	0	-3
1.49E+15	0	0	2	5	9	-3	-1	0

Fig. 3: A Graphical Representation for the Eight EMG Tabular Data Recorded at a Specified Time.

idea. A database will be constructed for all the messages templates required. In real time, the motion sensor will be placed on the dumb hand, while template database is fed into a microcontroller. The motion sensor will be accelerated by every single action. This acceleration sends a signal to the microcontroller. The latter compares the registered motion with the database and produces the speech signal based on the matching. The systems output utilizes a speaker. Dumb will speak like a normal person when updating the database of this system properly. A Text To Speech (TTS) conversion block circuits is included within the circuit for interpreting the matched gestures (see Fig.2).

IV. Results

Myo armband is considered the critical component of our hardware project. Replacing the EMG electrodes, this device detects the electrical signals from the muscles, and sends it wirelessly to the analyzer circuit. For the time being, the Myo armband device has been tested and calibrated. It was used to control the mouse and the Keyboard on both mac and windows laptops. In addition to that, it was used for the music player application that controls the playlist wirelessly, on androids. Thus the main gestures installed in this device were correctly performed, and we were practicing each gesture in controlling the TV channels too.

Myo Data Capture is a simple command line executable that log all data produced by the Myo armband's IMU and EMG sensors to separate, times tamped CSV files. When re-connecting to armband, a new set of log files is produced. The files include tabular data regarding the eight EMG pods, the accelerometer, the gyroscope and the orientation (see Fig.3). The data stored are considered our future signals that are going to be further processed for the sake of gesture recognition.

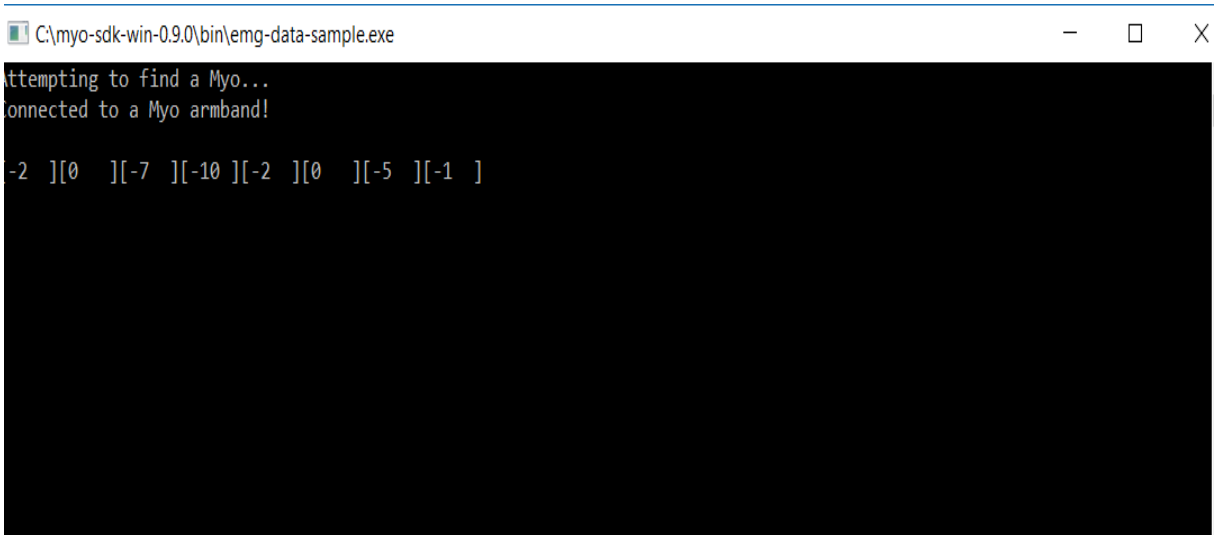


Fig. 4: Raw EMG data recorded by Myo armband.

The procedure can be summarized by connecting the armband to the Personal Computer (PC) and running the application. Microsoft Visual Studio is an indispensable part in the run time, it should be already downloaded.

Using Myo-SDK software, we were able as well to record an EMG sample data (see Fig.4). SDK does not provide a view of the ”raw” EMG data, however, a ”classified outputs”; data that’s already been processed by algorithms inside the Myo armband. Rather than exposing the signal directly in muscles, the classifier output shows what that signal means: a fist, a wave motion, spread fingers, and so on. Similar to how a mouse outputs the relative x and y positions of the cursor, not the raw values of the optical sensor inside. The Myo armband provides the output command.

Note that IMU is the Inertial Measurement Unit, and CSV is a simple file format used to store tabular data, such as a spreadsheet or database. Files in the CSV format can be imported to and exported from programs that store data in tables, such as Microsoft Excel or OpenOffice Calc. CSV stands for ”comma-separated values”.

V. Conclusion

Communication between hearing impaired people and normal ones have always been a challenging issue. Expressing your needs and conveying your ideas are not always understandable using sign language. Although it is always evolving, however it is considered a common misconception and international worldwide language. Thus, the ”Dumb’s Communication System”, is being developed to ease this challenging communication. It represents a fast, wireless, and highly effective technology to be used by the dumb. It only requires the permanent update of the data base, and the charging of the Myo armband when needed.

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