SIGN LANGUAGE RECOGNITION USING sEMG AND IMU

Marlon Sequeira, Dr. G.M.Naik, Dr. J.S.Parab and Dr. R.S.Gad

Electronic Department,Goa University,Taleigao,Goa,India

***Abstract*—the voiceless community of our society use sign language to communicate their views to the general public. Sign Language is basically making gestures by combining arm and hand movement along various orientations with facial expression to convey what they want to communicate. Since the general public do not have the knowledge of Sing Language it becomes difficult for the voiceless community to interface with general public. We have tried to bridge this communication gap for the Indian population by providing a system which gives voice to the voiceless community. We propose a system which converts the hand gestures performed by a person to text. The Signs will be from the Indian Sign Language and will correspond to each letter in the English alphabet. This system will be equipped with Inertial Measurement Unit(IMU) and the surface electromyography(sEMG) signal will be picked from the surface of the forehand in order to perform a sensor fusion of the data collected from the two different sources. The data collected will be fed to the classifier algorithm of Support Vector Machine(SVM).The detected Sign Language gesture will be displayed on a display as Text.**

I. INTRODUCTION

Embedded systems have influenced the modern life style tremendously. It safe to say that today most people possess on an average at least one such system on them at any given time. Day by day the embedded system are evolving in aspects of low-power consumption, higher processing power and small footprint. This has made possible many embedded application which enrich our life style for example pacemaker, hearing aid etc. Here in this work we are trying to propose another application which will improve the quality of life for differently abled group of our society, the voiceless community. We propose to develop a system which will convert the sign gestures performed by our user to text which will be displayed on a display device. The user in a real life setting will be a voiceless person.

Hand gesture has been one of the most common and natural communication media among human being. Most of the recent works related to hand gesture interface techniques [1] has been categorized as: glove-based method [2,3] and vision-based method bio-potential based methods. Hand gesture recognition research has gained a lot of attentions because of its applications for interactive human-machine interface and virtual environments. Glove-based gesture interfaces require the user to wear a cumbersome device, and generally carry a load of cables that connect the device to a computer. There are many vision-based techniques, such as model-based [4] and state-based [5] which have been proposed for locating objects and recognizing gesturers.

Sign language, which is a highly visual–spatial, linguistically complete and natural language, is the main mode of communication among deaf people. Sign language is an expressive and natural way for communication between normal and dumb people (information majorly conveys through the hand gesture) [6]. However, deaf people still experience serious problems communicating with people who hear normally, almost all of whom do not understand sign language systems such as Indian Sign Language(as shown in Fig 1). This communication barrier affects deaf people's lives and relationships negatively. Deaf people usually communicate with hearing people either through interpreters or text writing. Although interpreters can facilitate communication between deaf persons and hearing persons, they are often expensive, and their involvement leads to a loss of independence and privacy. While writing is used by many deaf people to communicate with hearing people, it is very inconvenient while walking, standing at a distance, or when more than two people are involved in a conversation.

The physical gesture communication consist of hand gestures that convey respective meaning, the non physical is head movement, facial appearance, body orientation and position. Sign language uses both physical and non-physical communication [7]. Sign language is not a universal language and it is different from country to country. America have developed American Sign Language (ASL) [8], Thailand developed Thai sign language system (TSL) [9] and British developed British sign language system (BSL). India has two sign languages Indian sign language (English version) and Hindi sign language [10].The similarities among signs in a sign language are created by complex body movements, i.e., using the right hand, the left hand, or both. Sign language speakers also support their signs with their heads, eyes, and facial expressions. When signs are created using both hands, the right hand is more active than the left hand.

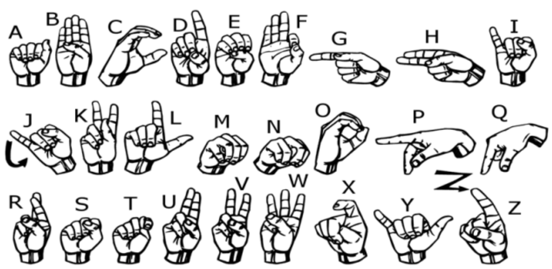

Fig 1.Indian Sign Language

The image processing technique [11] [12] using the camera to capture the image/video. Analyze the data with static images and recognize the image using algorithms and produce sentences in the display, vision based sign language recognition system mainly follows the algorithms are Hidden Markov Mode (HMM) [13],Artificial Neural Networks (ANN) and Sum of Absolute Difference (SAD) Algorithm use to extract the image and eliminate the unwanted background noise. The main drawbacks of vision based sign language recognition system image acquisition process have many environmental apprehensions such as the place of the camera, background condition and lightning sensitivity. Camera place to focus the spot that capture maximum achievable hand movements, higher resolution camera take up more computation time and occupy more memory space. User always need camera forever and cannot implement in public place. Another research approach is a sign language recognition system using a data glove [14] . User need to wear glove consist of flex sensor and motion tracker. Data are directly obtained from each sensor depends upon finger flexures and computer analysis sensor data with static data to produce sentences. It's using neural network to improve the performance of the system. The main advantage of this approach less computational time and fast response in real time applications. Its portable device and cost of the device also low.

The third approach is using Bio-Potential and orientation signatures of the gestures which will be explored in this paper.

II. IMPLEMENTATION

Signal Acquisition

The signs can involve one hand or two hands. If they system is deployed on two hands, it will increase the recognition accuracy. Fig. 1 shows the sensor placement on right forearm of the user. Four major muscle groups are chosen to place four channel sEMG electrodes: (1) extensor digitorum, (2) flexor carpi radialis longus, (3) extensor carpi radialis longus and (4) extensor carpi ulnaris. The IMU sensor is worn on the wrist where a smart watch is usually placed. To improve signal-to-noise ratio of sEMG readings, a bi-polar configuration is applied for each channel. The electrode are shown in the below figure.

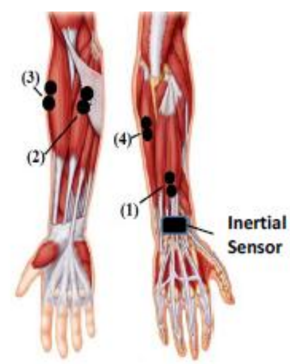

Fig. 2. Electrodes Placement

Inertial Measurement Unit

Fig 3. MPU-9150

The MPU-9150 is first 9-axis MotionTracking device. It combines the MPU-6050, which contains a 3-axis gyroscope, 3-axis accelerometer, and an onboard Digital Motion Processor capable of processing complex MotionFusion algorithms;and the AK8975, a 3-axis digital compass[15].

It features include user-programmable gyro full-scale range of ±250, ±500, ±1000, and ±2000°/sec (dps), a user-programmable accelerometer full-scale range of ±2 g, ±4 g, ±8 g, and ±16 g, and compass with a full scale range of ±1200 µT.The device is accessed and programmed using I2C interface.

ADS1293

ADS1293 is a Low-Power, 3-Channel, 24-Bit Analog Front-End for Biopotential Measurements. The ADS1293 features three high-resolution channels capable of operating up to 25.6 ksps[16]. Each channel can be independently programmed for a specific sample rate and bandwidth allowing users to optimize the configuration for performance and power. All input pins incorporate an EMI filter and can be routed to any channel through a flexible routing switch. Flexible routing also allows independent lead-off detection, right-leg drive, and Wilson/Goldberger reference terminal generation without the need to reconnect leads externally. A fourth channel allows external analog pace detection for applications that do not use digital pace detection. The ADS1293 incorporates a self-diagnostics alarm system to detect when the system is out of the operating conditions range. Such events are reported to error flags. The overall status of the error flags is available as a signal on a dedicated ALARMB pin. The programming and communication with the ADS1293 is done using SPI interface.

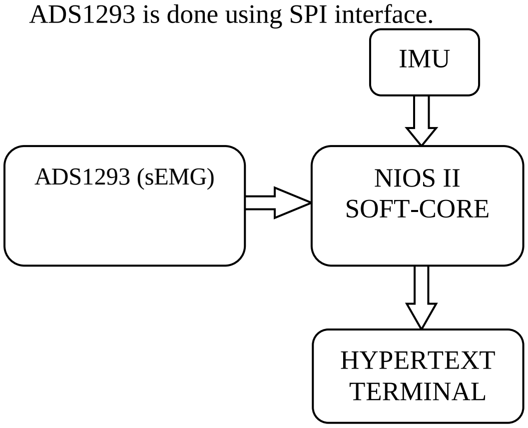

Fig 4. Block diagram

Fig 5.NIOS II SOFT-CORE

NIOS II SOFT-CORE

The Nios-II soft-core processor is implemented on a Altera Cyclone II FPGA is a 32- bit general purpose embedded RISC processor [17]. We have used a DE-0 Nano board for our system. The data collected is processed on the embedded processor using a Support Vector Machine Algorithm, which is a classifier algorithm. The detected gesture than is displayed on the hypertext terminal.

Support Vector Machine

In machine learning, support vector machines are supervised learning models with associated learning algorithms that analyze data used for classification and regression analysis[18]. Given a set of training examples, each marked as belonging to one or the other of two categories, an SVM training algorithm builds a model that assigns new examples to one category or the other, making it a non-probabilistic binary linear classifier. An SVM model is a representation of the examples as points in space, mapped so that the examples of the separate categories are divided by a clear gap that is as wide as possible. New examples are then mapped into that same space and predicted to belong to a category based on which side of the gap they fall

III. References

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