International Journal of Research in Engineering, Science and Management
Volume-2, Issue-9, September-2019
www.ijresm.com | ISSN (Online): 2581-5792

Sign Language to Speech Conversion Using Smart Hand

N. Madan Yadav[1], H. Prasanna Kumar[2]

[1]*PG Student, Department of Electrical and Electronics Engineering, University Visvesvaraya College of Engineering, Bangalore, India*

[2]*Assistant Professor, Department of Electrical and Electronics Engineering, University Visvesvaraya College of Engineering, Bangalore, India*

***Abstract*: This paper describes the development of a sign language translator that converts Sign language into speech and text by using wearable device. The glove-based device is able to read the movements of a single arm and five (5) fingers. The device consists of five (5) flex sensors to detect finger bending, and an accelerometer to detect arm motions. Based on the combination of these sensors, the device is able to identify any particular gestures that correspond to words and phrases in Indian Sign Language (ISL), and translate it into speech via a speaker and text which is displayed on an LCD screen. This article explains mainly on the hardware design of the device. Based on preliminary experimental results on simple sign languages, the device demonstrated an average value to convert a sign language into speech and text, which demonstrate the usefulness of the proposed device.**

***Keywords*: Hand gestures; Wearable glove; Flex sensors; Meme Sensor; Arduino UNO.**

1. Introduction

Every human being in the world utilizes their respective language to communicate with each other's. The listening to disabled persons likewise utilizes sign language to communicate among there deaf and dump communities. Communication through signing is a very well organized non-verbal language using both non-manual and manual signals. Non manual signals are basically outward appearance, head movement, and orientation of the body. While manual signals deals with hands and finger movements.

On the other hand, communication with normal individuals is a major task for them since not every ordinary people have knowledge on gesture based communication. To overcome this issue, sign language recognition system is expected to develop for the deaf and dump people to communicate with ordinary people. Hence, the design of the standardized sign language interpretation system will be based in order to suit the local people environment.

In this project, the technology for hand gesture recognition done by using data-glove approach which use special glove-based device. The glove will utilize Arduino microcontroller as the processor, and flex sensors, accelerometer sensors are responsible to collect the gestures data which is further helpful to identify particular hand pose which represents an alphabet, number and several words from Sign Language. The translation of the gesture will be displayed on LCD and further converted into speech.

2. Literature Review

This section reviews understanding the existing system and methodology and also help for researching on the important elements in developing the sign language recognition device. Nowadays, automatic sign language translation systems generally use two approaches, which are data-glove and visual-based approaches. Under data approaches Goyal et. al [1], have identified Indian sign language which is completely based on scale invariance fourier transform (SIFT) algorithm, with the help of this algorithm they are identifying the matched similar sets of data between the input image and image stored in a database. But this method has poor processing time. S.P.More and sattar [2], continued same method but with reduced dimensions of the feature vector using different algorithm called principle component analysis (PCA) algorithm which results in speeding up the processing time but the design made complex. By taking these cases has a references Murakami and Taguchi [3], developed dynamic hand gestures for Japanese sign language, in this method they used neural networks which has a capacity to collect the data from the orientation and movement of fingers to identify corresponding alphabets. The main drawback of this technology is, it takes more time to form a single word from a set of alphabets gesture. Chowdary et. al [4], has proposed same model of Japanese technology in addition they have used some electromagnetic sensors with DSP coding to display sign language alphabets, the drawback is due to the utilization of electromagnetic sensor the entire system is affected by small interference.

In visual data approaches Siby et. al [5], used late progression in PC and data innovation, there has been an expanded regard for visual-based methodology. Images of the signer is captured by a camera and video processing is done to perform acknowledgment of the sign language. This method is greatly affected by the processing of the images, such as image filtering, background cancellation, colour segmentation and boundary detection. Also there might be other uncontrolled situation like some other background images detected other than movement detection. Many researches have failed to address these complications and hence alternatively we went to a non-vision based method.

3. System design

Based on the requirements of the consumer the design consists of one glove with several subsystems: a flex sensing system, a rotation sensing system, a processing system, a power system, and the output system shown in Fig. 1. The design is meant to be comfortably worn on the hands, just like a normal glove and is aimed towards complying with the user defined specifications, such as portability, low weight, market appeal, and accuracy. Given the scope and time limitations of this project, a simple high level design was implemented to avoid unnecessary complications.

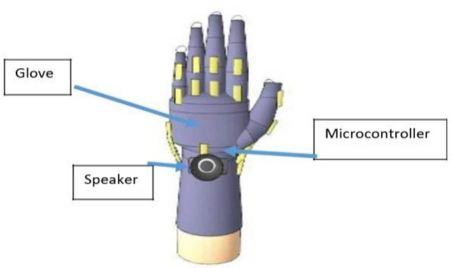

Fig. 1. Design of Smart Hand

The block diagram is divided into three parts: a sensor region, processing region and application region as shown in Fig. 2. All these modules are implemented on a smart wearable hand device. Flex sensor and IMU data are collected using a pro mini 328, which runs at 5V with an ATmega processor operated at 16MHz. the features which are extracted from the sensor will be given as an input to the built in SVM classifier to identify the correct sign language. The detected sign is translated into text and displayed on LCD screen. Finally, the displayed text is converted into speech using speaker module. The entire hardware components are powered using 3.7V 500mAh ion lithium polymer battery.

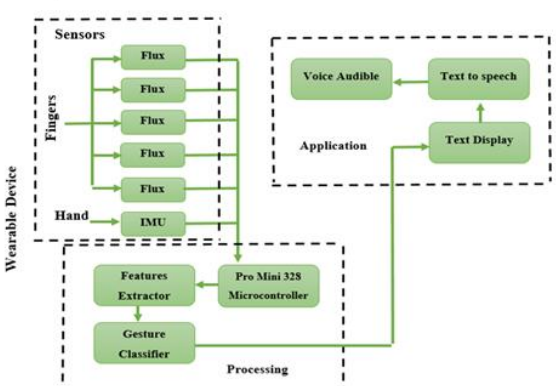

Fig. 2. Block Diagram

Two sensor plays an important role in identifying gestures of sign languages, they are explained bellow in detail.

A. *Flex sensor*

A flex sensor is a variable resistor, whose resistance changes as the sensor body is bent, more the bend more the change in resistance. This property is utilized to detect the physical movement of the object under observation. Fig. 3 shows a flex sensor of 4.4 inch.

Fig. 3. Flex Sensor (4.4 inch)

Working principle of the sensor involves a polymer ink printed on one side of the sensor body that has conductive particles embedded in it. When the sensor is straight, the ink provides a low resistance of about 30KΩ, and when sensor is bent away from the ink, the conductive particles move further apart, increasing the resistance. When the sensor straightens out again, the resistance returns to the original value. Fig 4 shows the placing of flex sensors on fingers. By measuring the resistance, the amount of bend can be determined. A voltage divider circuit is used to detect the change in resistance. By combining the flex sensor with a static resistor a voltage divider is created and the variable voltage is read by the analog to Digital converter (ADC) of the microcontroller.

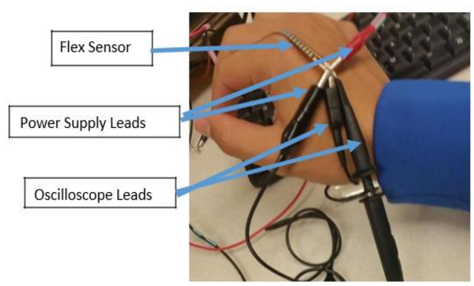

Fig. 4. Placing of flex sensors on fingers

The output of flex sensor is variable resistance which will be further converted into voltage signal using a signal conditioning circuit (voltage divider biasing). The formula for converting variable resistance to voltage signal is shown below "(1)".

$$V_0 = Vcc\left[\frac{R2}{(R1+R2)}\right] \quad (1)$$

- R1 is constant resistance.
- Rx is variable flex sensor resistance.
- V_0 is the output voltage.
- Vcc is the supply voltage.

Using the above formula, the flex sensor is tested for different angle deflection and output voltage is calculated in eq. (2), (3), (4).

For V_0 (min) when sensor deflection is 0^0, R_1=51KΩ, R_2=10 KΩ and V_{CC}= 3.7V.

$$V_0\ (min) = 3.7\left[\frac{10K}{(51K+10K)}\right] = 0.60656\ V \quad (2)$$

For V_0 (mid) when sensor deflection is 45^0, R_1=51KΩ, R_2=20 KΩ and V_{CC}= 3.7V.

$$V_0\ (mid) = 3.7\left[\frac{20K}{(51K+20K)}\right] = 1.04225\ V \quad (3)$$

For V_0 (max) when sensor deflection is 90^0, R_1=51KΩ, R_2=30 KΩ and V_{CC}= 3.7V.

$$V_0\ (max) = 3.7\left[\frac{30K}{(51K+30K)}\right] = 1.37037\ V \quad (4)$$

Based on the above values, the voltage and resistance response for the bending of each sensor is close to linear. This satisfies our algorithm's requirement that the input data be linear, so that the tolerances and typical values can be used best.

B. MEME Sensor

The Accelerometer shown in Fig. 5 is a 3-axis acceleration measurement system. The Accelerometer has a measuring range ±3 *g*. A polysilicon surface micro machined sensor and signal conditioning circuit is present in accelerometer.

Fig. 5. MEME Sensor (ADXL335)

It has a mass attached to a spring which is confined to move along one direction between two parallel plates. When acceleration is applied in an X, Y, Z-axis direction, the mass will move and capacitance between two plates will change, this change in capacitance will measure the acceleration.

This axial data is fed to the microcontroller and uses the bellow formula "(5)", the angular tilt (pitch) of the body is calculated.

$$\theta = tan^{-1}\left(\frac{Ax}{Ay+Az}\right) \quad (5)$$

Where, Ax, Ay, Az are the normalized voltage output of the accelerometer for each of the three axes.

C. Processing Module

Arduino is an open source computer hardware and software company, project, and use community that designs and manufactures single board microcontrollers and microcontroller kits for building digital devices and interactive objects that can sense and control objects in the physical and digital world. Arduino board designs use a variety of microprocessors and controllers.it has digital and analog input/output pins, which can be used to interface Arduino with other circuits. Arduino gives an IDE (Integrated Development Environment). Most commonly Arduino Uno is used as controller but lager digital pins Arduino Mega is used.

The controller performs various functions in the system as listed below:

i. Receives output signals from flex sensor, compares it with the threshold value and displays the results on the LCD.
ii. Receives output signals from IMU sensor, compares it with the upper and lower threshold value and displays the results on the LCD.
iii. Receives the output signal from software after classifying the gesture of the sign language sample and same text of gestures will be send to the display.
iv. Continuously displays the status of the system on the LCD.

4. Process Flow

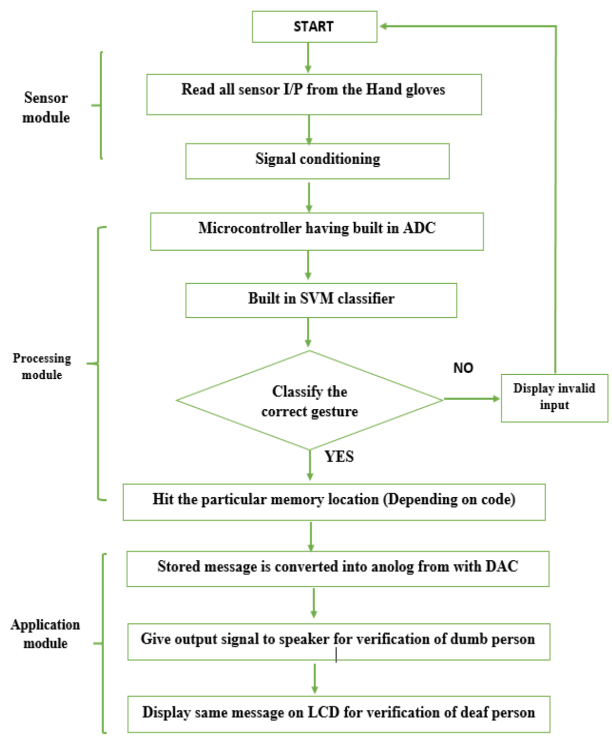

Fig. 6. Flow chart of sign language to speech conversion

The flow chart represents in the bellow Fig. 6 shows how the prototype is working. First the data of gestures are collected by flex and IMU sensor, the input signal of sensor is given to signal conditioning circuit. Then the signal is send to the controller which has inbuilt SVM classifier, where it classifies the data for correct prediction of gesture, further displayed on LCD and same message is converted into speech. If the signal is not classified based on the input given, invalid input is displayed.

5. Results and discussions

A. Glove Action

A Smart hand is developed by using glove and sensors are designed and implemented on wearable device. In the control glove method of control, it has been observed that movements of each fingers can be measured smoothly using flex sensor and IMU sensor. Movements of the sensors is calibrated in the program. Fig. 7 shows the control glove for the smart hand glove.

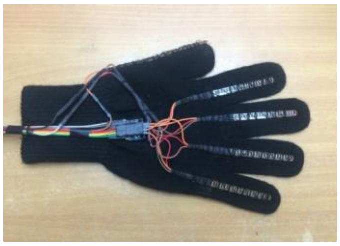

Fig. 7. Smart hand

The above section says how to prepare a subsection. Just copy and paste the subsection, whenever you need it. The numbers will be automatically changes when you add new subsection. Once you paste it, change the subsection heading as per your requirement.

In Fig. 7. it can be observed that the glove has flex sensor fixed on each finger of the glove and a MPU6050 gyroscope module is fixed at the center of the glove. When fingers are flexed, voltage variation are generated and sent to controller through wires. The output value of sensors is shown in Fig. 8. Tests are performed to measure the reliability of the control glove with 50 iterations and the result are tabulated in the table. 1. Test involves closing and opening of the smart hand with movements of individual fingers.

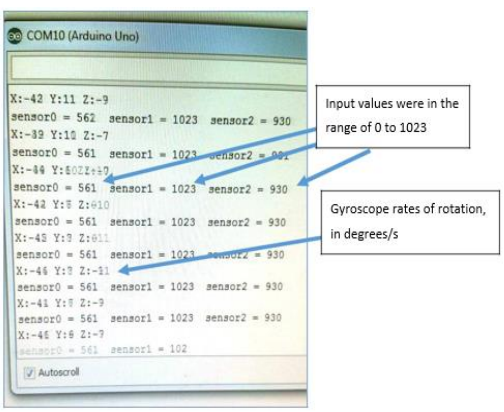

Fig. 8. Input values of sensor displaying on serial monitor

Table 1
Reliability performance of smart glove

Glove actions	Correct action	Wrong action	Accuracy (%)
Closing	48	2	96
Opening	46	4	92
Individual fingers	48	2	96

B. Procedure of using Sign Language Translation Device

First, the user has to plug in the power supply of 5V for the smart hand, then LCD will turn ON and displays “Sign Language Translator” as shown in the Fig. 9.

After a few seconds, controller will take the gestures data from the sensor and it will start checking the condition of the data. At the initial stage, user’s hand and all five fingers are made to be in normal position as shown in the Fig. 9.

Fig. 9. LCD displays “Sign Language Translator” at initial stage.

Now, the user can start to move the hand and fingers, and the device is ready to translate predetermined sign language. Fig. 10 to Fig. 15 Shows the example of sign language gestures done by the user being converted into texts displayed on the LCD screen, and speech is played on the speaker simultaneously.

Fig. 10. Sign language for “Hello!”

Fig. 11. LCD displays “Hello!”

Fig. 12. Sign language for “Good”

Fig. 13. LCD displays “Good”

Fig. 14. Sign language for “Evening”

Fig. 15. LCD displays “Evening”

Similarly, we can identify other gestures also. Suppose the input of the gesture is not in the sign language format then LCD will display “Invalid Sign”. Thus, the various functionalities of the smart hand for Sign language converter is demonstrated.

6. Conclusion

As a final remark, the progress made in the development of the glove prototype. Although it is not a finished product, it shows that using a glove outfitted with sensors, a microcontroller, and wireless communications can be used to translate signs. It satisfies all of the major requirements, and it may lead to further developments in translation devices. With increased attention to the challenge of sign language translation, by this technology the communication gap between sign language users and the hearing may soon be diminished. The completion of this prototype suggests that sensor gloves can be used for practical sign language recognition. More sensor can be employed to recognize full sign language. The advantages of the proposed model for the disabled persons are as follows.

- Easy to communicate with the people.
- Accuracy is high.
- Faster response.
- Long life, easily maintained and safe.
- Flexible and portable.

References

[1] S. Goyal, I. Sharma, and S. Sharma, "Sign language recognition system for deaf and dumb people," *Int. J. Eng. Res. Technol.,* vol. 2, no. 4, pp. 382-387, April 2013.

[2] S. P. More and A. Sattar, "Hand gesture recognition system using image processing," presented at the Int. Conf. Elect., Electron., Opt. Techn., Chennai, India, March 2016.

[3] K. Murakami and H. Taguchi, "Gesture recognition using recurrent neural networks," in *Proc. SIGHI Conf. Hum. Factors Comput. Syst.,* New York, NY, USA, 1991, pp. 237-242.

[4] P. R. V. Chowdary, M. N. Babu, T. V. Subba Reddy, B. M. Reddy, and V. Elamaran, "Image processing algorithms for gesture recognition using MATLAB," presented at the Int. Conf. Adv. Commun. Control Comput. Technol., Ramanathapuram, India, Jan. 2015.

[5] J. Siby, H. Kader, and J. Jose, "Hand gesture recognition," *Int. J. Innov. Technol. Res.,* vol. 3, no. 2, pp. 1946-1949, Mar. 2015.