Sign Language Interpretation Using Pseudo Glove

Mukul Singh Kushwah, Manish Sharma, Kunal Jain and Anish Chopra

Abstract The research work presented in this paper explores the ways in which, people who are unable to speak, can communicate easily with the people around. The research incorporates a system comprising of a glove-based mechanism, constituting sensors and a controlling system to recognize the hand gestures and movements and communicate accordingly. This research work is significant as there are a number of ways to convey the message, which includes, display on LCD, on a Bluetooth device and as well as via a speaker. This hardware is integrated with a program embedded in a microcontroller chip capable of correctly determining the specified alphabets from the hand positions with the use of flex sensors. With the use of minimum tools and maintaining the efficiency certain alphabets and few common words used in conversations have been implemented, further scope for more with complex glove system.

Keywords ATmega16 · Microcontroller · Playback IC · Flex sensors

1 Introduction

Sign language is a language through which communication is possible without the means of acoustic sounds. Instead, sign language relies on sign patterns, i.e., body language, orientation, and hand movements such as a wave, to facilitate understanding between people. It requires a special training to learn the sign language, so the research presented would be able to bridge the gap between the differently abled people and the people who are unable to understand their language.

M.S. Kushwah (✉) · Manish Sharma · Kunal Jain · Anish Chopra
Electronics and Communication Engineering, Amity University,
Sector – 125, Noida, Uttar Pradesh, India
e-mail: mukul.singh8447@gmail.com

Manish Sharma
e-mail: manish.nsit07@gmail.com

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1.1 Background Information

Many research works related to Sign languages detection have been done as for example the American Sign Language (ASL), the British Sign Language (BSL), the Japanese Sign Language (JSL), and so on. But very little research has been done in Indian Sign Language (ISL) recognition till date [1].

There are, originally, two approaches toward the interpretation of sign language. One of them is through the use of glove-based systems which can be used for measuring different parameters of gestures such as hand and finger position, angles, and tip recognitions, which is known as glove-based method. The second approach revolves around the use of machine vision and image processing techniques to formulate vision-based hand recognition systems, known as vision-based method. Sensor gloves for measurements of finger movements are a promising tool for objective assessments of kinematic parameters and new rehabilitation strategies [1]. What we have implemented in our project is glove-based method due to various advantages of it, discussed further in the paper.

2 Objective

The objective in this research is to create a system comprising of a glove fitted with flex sensors on all the fingers. These sensors would be connected to a microcontroller, which would be interfaced with an LCD screen for the alphabets to be displayed, as well as a Bluetooth module so that the alphabets can be displayed on a Bluetooth-enabled device. For each alphabet and word, there being a different recorded sound.

3 Components Used

The model that we have come up with consists of several components integrated with each other to fulfill the objective. Following is the description of each of them.

3.1 Flex Sensors

These sensors depict the change in terms of resistance on bending, resistance being the greatest when bent maximum. They convert the change in bend to electrical resistance; the more the bend, the more will be the resistance value.

They are usually in the form thin strips, with length ranging from 1 to 5 in. [2]. Since, the sensors show the change in output in terms of resistance, we use a reference resistance of 10 kΩ and applying the voltage divider rule, send in a variable voltage, in accordance with the output resistance from the sensor, to the ADC ports of the microcontroller.

3.2 Bluetooth Module

We have incorporated the use of Bluetooth technology to get the output on any Bluetooth-enabled device. There are applications that connect via Bluetooth for mobile devices. When connected to a mobile device, any output from the glove can be seen on the user application. This gives the model a wireless connectivity with ease of use.

3.3 Playback IC

This is an IC which stores voice clips and plays when a certain signal is passed onto it. Whenever an alphabet or a word is recognized, the speaker connected to this IC will play the clip stored corresponding to that alphabet. Also, no extra programming is needed to store the voice clips. The recording is available from the chip only.

3.4 16 × 2 LCD Screen

A 16 × 2 LCD screen is used to display the alphabets decided on the basis of sensor values, i.e., according to the hand positions.

3.5 Microcontroller

The microcontroller used here is ATmega16. It is a 40-pin IC with low power consumption and 16 K bytes of In-System Programmable Flash Memory. In addition to this, it has 32 × 8 general purpose registers, 32 programmable I/O lines along with 8 channel 10bit ADC ports (Fig. 1).

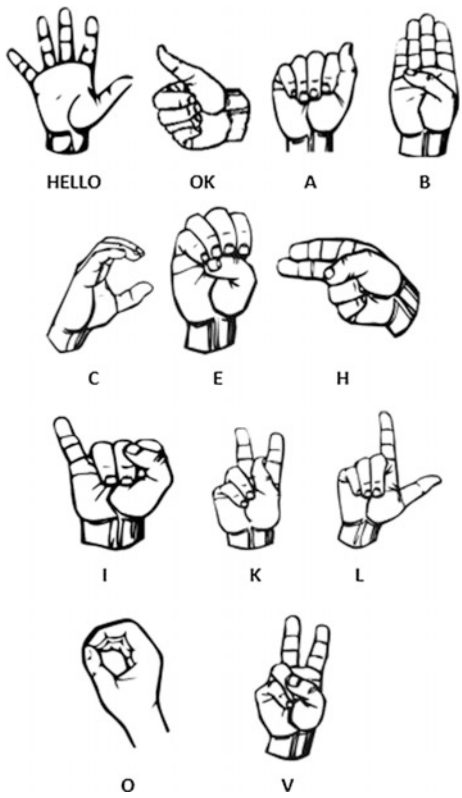

Fig. 1 Hand positions for different alphabets as key

4 Proposed Model

The primary component, the flex sensors are placed at each of the finger and the thumb. Figure 2 shows the connections of flex sensors with the microcontroller.

The flex sensors are connected via 10 kΩ resistances to obtain a voltage value instead of the resistance measure, using the voltage divider rule. The ADC (analog to digital) ports convert the analog output from sensors to feed in a digital input to the microcontroller (Fig. 3).

The main circuit board contains the microcontroller as well as an LCD screen and Bluetooth module interfaced with it. The playback IC and the development board, containing the microcontroller, share a power source.

The LCD is interfaced onto the port C of the microcontroller along with any required power source through AVCC and GND terminals. The code developed has functions that transfer data in parallel mode. The Playback IC for the sound output is connected through the port B of the microcontroller. The Bluetooth communication is provided through the serial communication via UART (universal asynchronous receiver/transmitter) interface (Figs. 4 and 5).

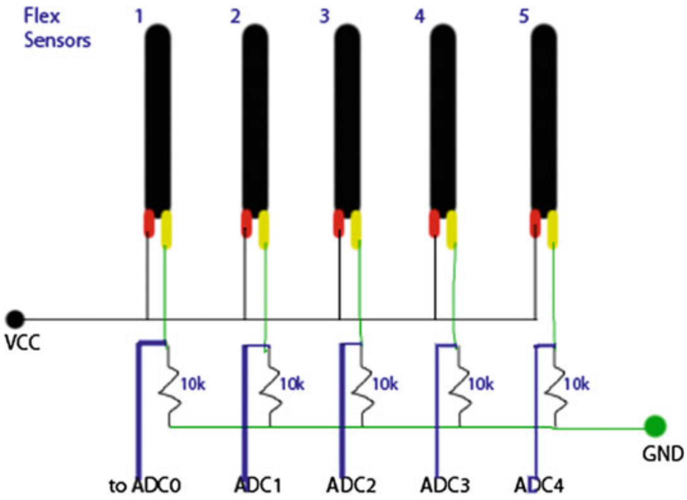

Fig. 2 Flex sensors connections

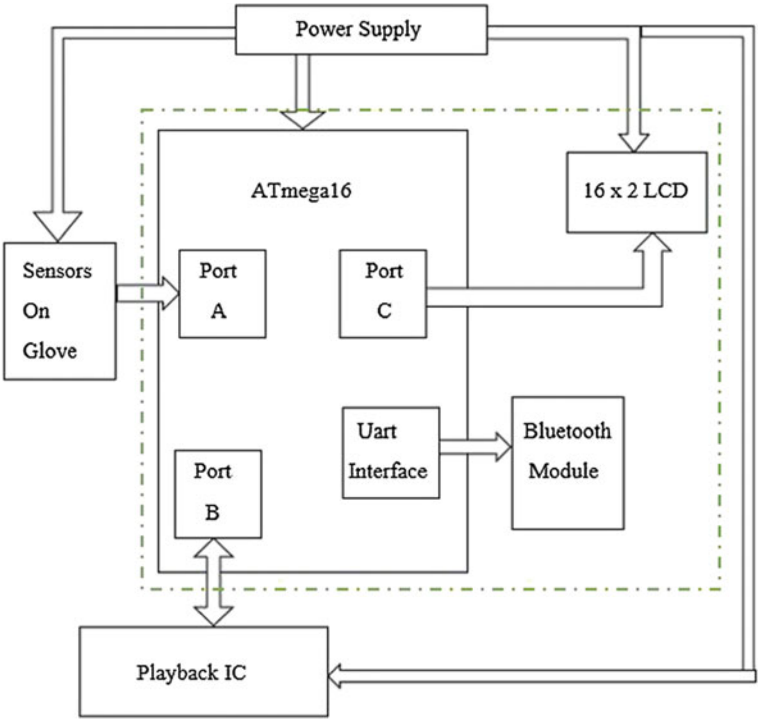

Fig. 3 Block diagram

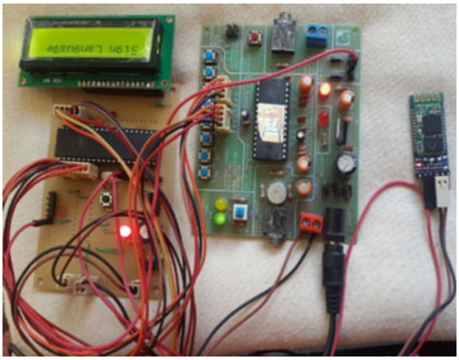

Fig. 4 Image of all the components

Fig. 5 Image of the glove fitted with flex sensors

The microcontroller is loaded with a program code designed to recognize the chosen alphabets and words and demonstrate output through various means on a number of devices. The program is designed such that it keeps on taking input from the flex sensors at certain intervals of time. The code generates an output corresponding to that set of predefined values and sends it to LCD and via Bluetooth. The port B is programmed such that each stored sound for an alphabet is played on detection of that alphabet. When an alphabet is detected, that port in enabled for a certain time and then it is disabled.

5 Computation, Testing, and Results

The flex sensors here play the primary role. With each of the step in the process and output determination depends on the values coming out of the flex sensors. The ADC ports convert the analog value (in terms of voltage measure) from the flex sensor to a digital one by the following formula:

$$\text{Digital value} = (V_{in}/V_{ref}) * 1024 \quad (1)$$

- The value V_{in} here referring to the value input to ADC port.
- V_{ref} being the reference value of the voltage. Here we have used internal source of reference and the value of this is 2.56 V.
- 1024 signifies that the microcontroller has 10bit ADC ports.

It was found that upon bending, the output resistance from the flex sensors increased as prescribed in the component specifications. Thereby, the output voltage, in converted form, decreased. By the Eq. 1, we can see that the input value to the microcontroller will decrease upon bending (Fig. 6).

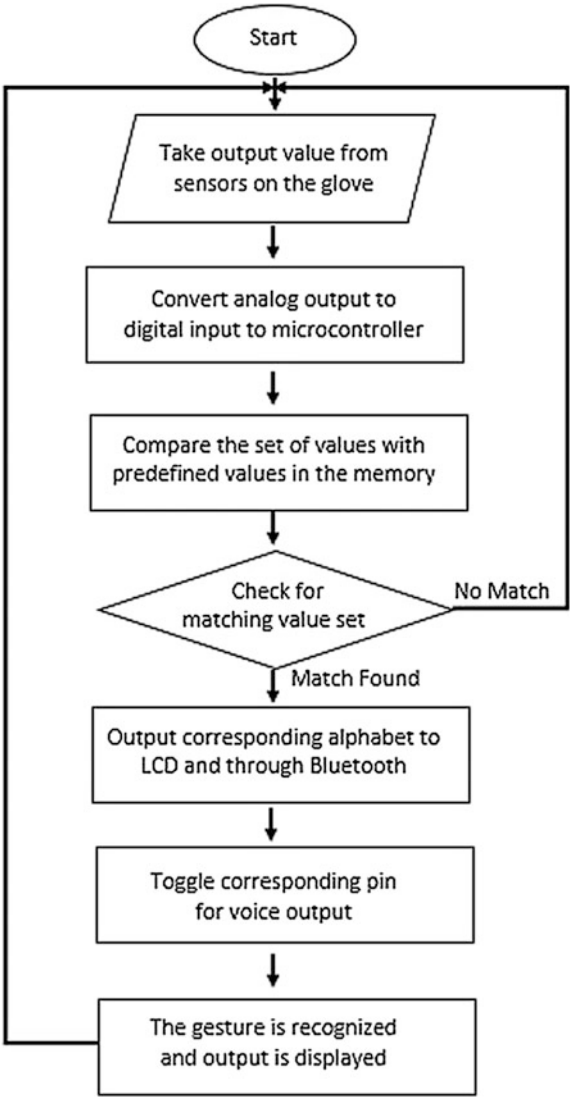

Fig. 6 Flow chart for the system

According to the provided key of the hand positions, the range is specified for each alphabet/word. When the flex sensors value set matches with the specified range set, the output is displayed (Figs. 7 and 8).

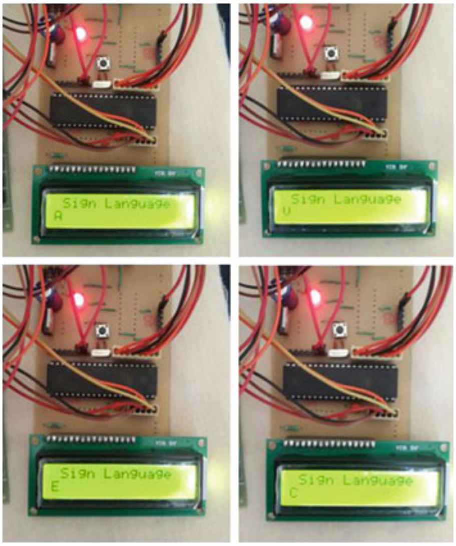

Fig. 7 Some results during testing phase

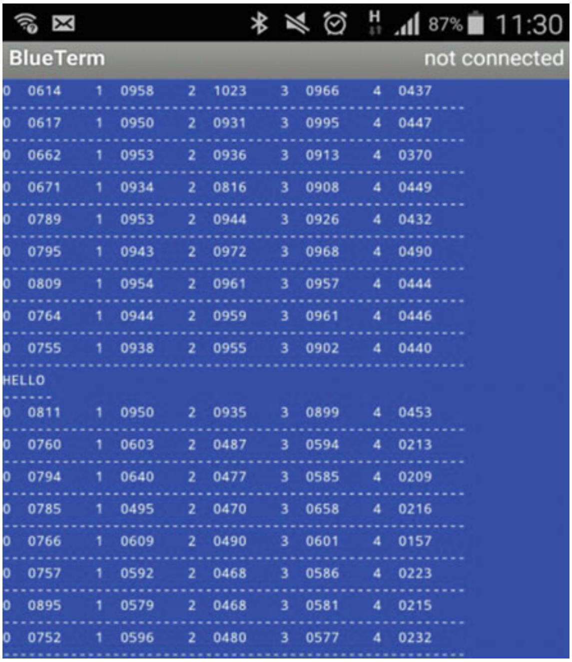

Fig. 8 Output on mobile screen

6 Comparison with Related Work

- As we have learned that, in of the gesture recognition methods, vision-based methods, computer camera is required as the input device for observing the movements of hands or fingers. Since, the movements to be captured must be of the hands only, there is a challenge of designing the system and incorporating heavy imaging processing tools to make the system background invariant, light insensitive, and also achieve efficient real-time performance. Thus, vision-based methods tend to prove complex and costly [3].
- Unlike other models available in the market, our model is capable to communicate in various ways, like, through Bluetooth, sound output, and also the output is visible on the generic LCD screen, which is mostly the only output form available in other models.
- Other models, in which wireless communication is used, come with RF (Radio Frequency) technology implementation. The performance of an RF module will depend on a number of factors such as a rise in the transmitter power and greater communication distance. However, this will also result in a greater electrical power drain on the transmitter device, which will result in shorter working life for battery-operated devices. Likewise, using a higher transmit power will make the system more prone to interference with other RF devices and also by increasing the receiver sensitivity will also increase the effective communication range, but will also potentially cause malfunction due to interference with other RF devices [4]. This problem is solved using Bluetooth instead of RF to communicate.

7 Conclusion

Summing up the research work here, the glove designed has a lot of benefit for a person with speech disability. Our model is of the simplest form. By using just the flex sensors, the complexity of the project is minimized. Covering all the alphabets is a bit difficult with the number of sensors we have used, because with the increase in number of outputs the sensitivity increases, thereby making it difficult for the user. It is not just one hand position will convey one word, but with suitable programming we can also map one position to even a word, thereby easing it out for the user. Also, with the use of Bluetooth, it is very easy and useful for anyone to use it, extending its compatibility and connectivity.

8 Future Scope

- With the implementation of more kinds of sensors, we can achieve a system comprising of all the alphabets. Moreover, with extensive use of this glove, all the circuit boards could be synthesized on one board, eliminating the complexity altogether. Also, because of the use of one of the latest technologies available, i.e., Bluetooth, the glove is highly compatible, further the Bluetooth app can be specifically programed for this purpose to achieve more from the application itself, which would add up to the functions the glove can perform.

- This glove can also be used to control various other appliances like a T.V., computer, etc. Just like the microcontroller is programmed to convert the finger movements into recognizable alphabets, it can also be programed to do various other things upon certain movements of the hand.

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