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International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

# Design and Development of a Sign Language to Speech Converter for Dumb People

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DOI: https://doi.org/10.55248/gengpi.2022.3.9.52

**ABSTRACT**

The Purpose of this work is to develop an interactive device to help dumb people. This is a special electronic device for the mute people which enables them to communicate with normal people by means of customized sign language system. Sign language is the medium for expressing feelings and thoughts using symbols and different patterns made by the bending of fingers. Flex sensor detects the angle of bend of each finger and sends analo signal to the processor. By processing the signal Speech synthesizer makes desired voice output. The device has been more interactive as output quality of voice is quite natural and can be customized as required.

**Keywords:** Sign language, Speech synthesizer, Flex sensor, Arduino, Analog Signal.

## 1. Introduction

In this world, the number of mute or deaf people is roughly 72 million, and of these nearly 63 percent are said to be deaf and mute by born, the others losing their hearing by different accidents [1]. About 2 to 3 out of 1000 children are born deaf or dumb in United States according to national institute of deaf and other communication disorder [2]. It is said by WHO, by 2050 approximately 2.5 billion people will have some degree of dumb and hearing loss, at least 700 million people will need some sort of rehabilitation. The communication between blind and seeing people are easier than the communication between mute and unmute people. In this paper we preamble a sign language system which translates special signs to spoken language by means of a data driven method.

A hand glove can be used to translate gesture of different approaches into spoken language. Sign language converter is a device for the mute people which enables them to communicate easily with others using special finger patterns. These patterns are predefined to different words. The device can identify different patterns and show the words according to database. It also can speak by combining different words.

Technology is advancing fast and improving our lifestyle. Researchers are developing devices to help disables. They are making advanced hardware and software with the help of machine learning, deep learning and artificial intelligence. A good amount of scientific work were done on sign language processing system. A robotic hand that can pronounce words was developed in 1977 [3].

In 1993, a system based on neural network using speech synthesizer was developed. The synthesizer was connected to a VPL Data Glove. [4]. It used to recognize hand gestures and convert it to speech based on five neural networks.

An AI based sign language processing system was developed using boosted classifier tree [5]. It detects human hand present in an image and classifies the hand shape. Boosted tree structure classifier recognizes and detects the location of the hand in the grey scale image. Weak classifiers were filtered out by AdaBoost and FloatBoost algorithms.

Researchers are trying to make different robots to help disables. Humanoid robot can be used as a helper to assist disables, deaf or mute people. In 2014 a multifunctional humanoid robot named “SM-1805” was developed in Bangladesh that could assist mute people regarding their communication. [6].

## 2. Methodology

To make this device Speech Synthesizer V1.1, Flex Sensors are used. Arduino Mega is used for processing. The code in the system are written in Arduino IDE software. As the device is for mute people, the structure and maintenance of the device is made quite user friendly specially, for the users. However, according to the experimental data the gesture detection of the system is as high as possible and sign to sound conversion quality is moderate. A glove is used for adopting the hand movements and patterns of the user. Here, flex sensors are placed along the fingers and thumb. The sensors measure the amount of bending of fingers and gives output which is variation of voltage. This variation of voltage produces the required voice while converting to analog form. The analog outputs are then sent to microcontroller for processing. The microcontroller merges the data values from all the sensors and sends this input data to the server. The processing side takes the data and based on their combinations, matches the patterns with already fed patterns in the database. Thus the gestures of the user are recognized and according to them, the text information is delivered.

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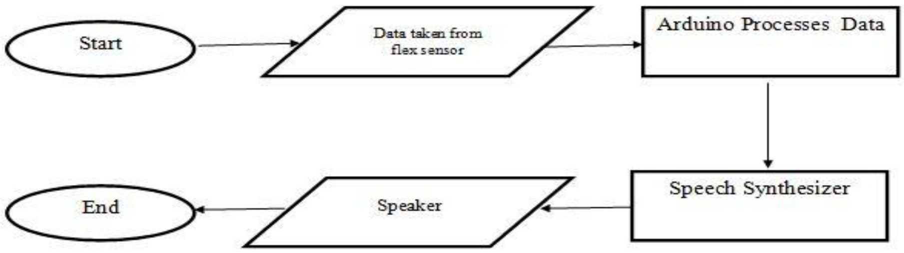



**Fig. 1 – Flow Chart of Data Analysis with Speech Synthesizer**

Signals that are sent from flex sensors are scanned and processed by the processor. The sensed data are processed using an Arduino and checked whether the sensed data matches to the database or not. If the sensed data is matched, it produces output through a speaker. And if the sensed data doesn't match to the database, it will go back to the Arduino and will be processed again to be modified to match to the database. So, this is the basic procedure of both the text-to-speech conversion and gesture controlled motion generation process. We have implemented a prototype for signs to speech conversion which is shown below:

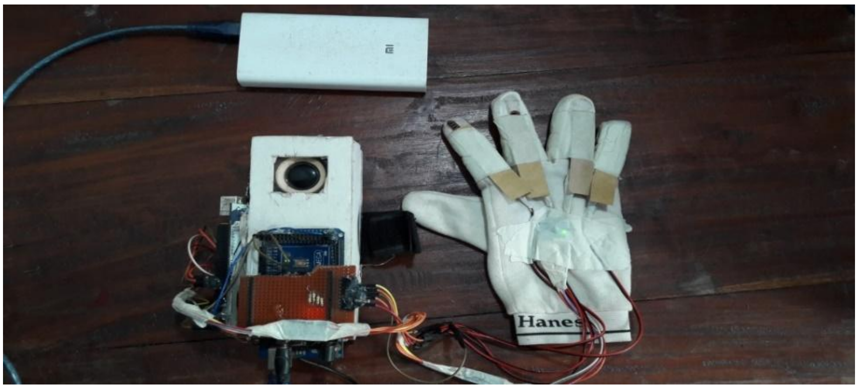
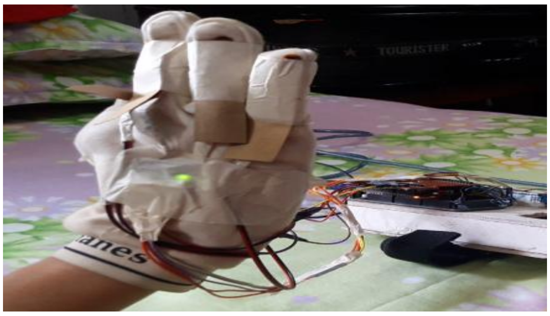



**Fig. 2– Signs to speech converter**

By using this prototype a user can express his/her feelings by means of different gestures. S/he just has to show the signs according to the database of our prototype. The user needs to know the signs of particular words or sentences. There is no limit of signs. More patterns or signs can be added in the database. The new gesture introduced must be stored to the system. A few tests of these gestures are described below. 25k ohm is taken as the threshold value of the resistance of flex sensors.

a

b



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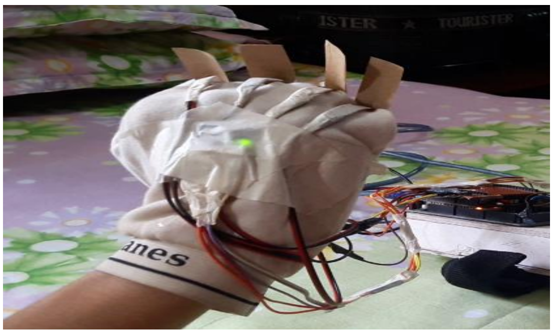


**Fig. 3 - (a) Pattern I (Food); (b) Pattern II (Fine); (c) Pattern III (washroom) (d) Pattern IV (Help).**

### *2.1. Test Case I*

If the user is hungry, So S/he wants food. For food, we have set a particular sign (Pattern I) which is shown in figure 3(a). The sign of food is set by keeping the first (thumb), second (index) and last (little) Fingers straight and the two other Fingers bent. The resistance of the straight Fingers are below a threshold value set for the flex sensors. The resistance of the bent Fingers are above the threshold value. So the bending of the Fingers will send signals to the processor that the user wants food and processor will process this data and send to the speech synthesizer which will say "Food".

### *2.2. Test Case II*

Suppose, the user wants to say that he is fine. For fine, we have set a particular sign (Pattern II) which is shown in figure 3(b). The sign of fine is set by keeping the first two fingers (i.e. thumb & index) bent and the last three (i.e. middle, ring & little) fingers straight. The resistance of the straight fingers are below the threshold value set for the flex sensors. The resistance of the bent fingers are above the threshold value. So the bending of the fingers will send signals to the processor that the user wants to say 'Fine' and processor will process this data and send to the speech synthesizer which will say "Fine".

### *2.3. Test Case III*

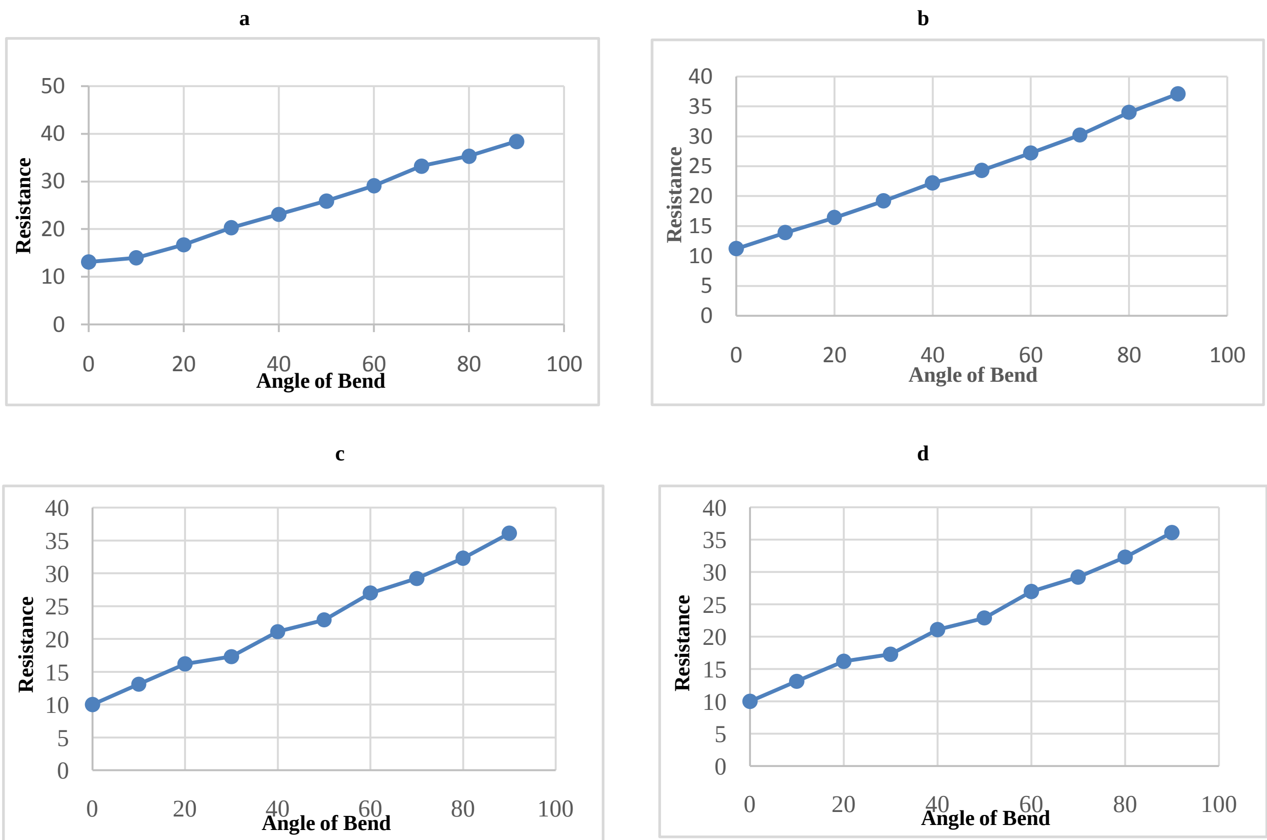
Suppose, the user wants to go to the washroom. For washroom, we have set a particular sign (Pattern III) which is shown in figure 3(c). The sign of washroom is set by keeping the first four Fingers bent and the last (little) Finger straight. The resistance of the straight Fingers are below a threshold value set for the flex sensors. The resistance of the bent Fingers are above the threshold value. So the bending of the Fingers will send signals to the processor that the user wants to say 'Washroom' and processor will process this data and send to the speech synthesizer which will say "Washroom".

### *2.4. Test Case IV*

Suppose, the user needs help. For help, we have set a particular sign (Pattern IV) which is shown in figure 3(d). The sign of help is set by keeping all the Fingers bent. The resistance of the bent Fingers are above a threshold value set for the flex sensors. So the bending of the Fingers will send signals to the processor that the user wants to say 'Help' and processor will process this data and send to the speech synthesizer which will say "Help".

## 3. Result and Analysis

### *3.1 Response of Flex sensor resistance to angle of bend of each finger*



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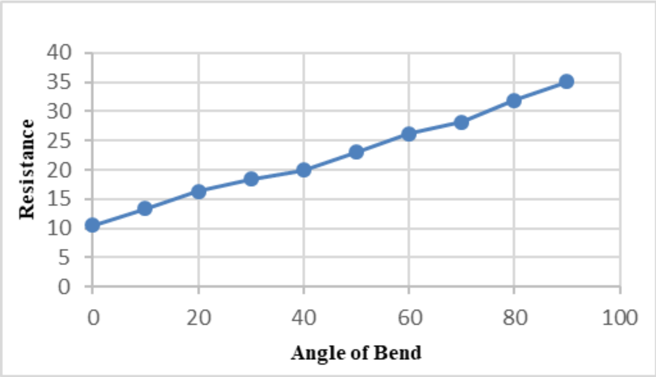


**Fig. 4 – Graph of Resistance Vs Angle of bend for (a) Finger I (Thumb)); (b) Finger II (Index); (c) Finger III (Middle) (d) Finger (Ring); (e) Finger V (Little)**

### *3.2 Response of Flex sensor resistance to angle of bend for tested Patterns*

**Table 1 - Resistance according to Angle of bend for pattern I (Food)**

| Serial | Angle of bend | Resistance |
|---|---|---|
| Finger1 (Thumb) | 0 | 11.0k |
| Finger2 (Index) | 0 | 11.2k |
| Finger3 (Middle) | 85 | 33k |
| Finger4 (Ring) | 87 | 32.7k |
| Finger5 (Little) | 0 | 11.7k |

**Table 2 - Resistance according to Angle of bend for pattern II (Fine)**

| Serial | Angle of bend | Resistance |
|---|---|---|
| Finger1 (Thumb) | 80 | 34.2k |
| Finger2 (Index) | 87 | 38.1k |
| Finger3 (Middle) | 0 | 11.2k |
| Finger4 (Ring) | 0 | 12.1k |
| Finger5 (Little) | 0 | 11.7k |

**Table 3 - Resistance according to Angle of bend for pattern III (Washroom)**

| Serial | Angle of bend | Resistance |
|---|---|---|
| Finger1 (Thumb) | 81 | 37.3k |
| Finger2 (Index) | 87 | 38.2k |
| Finger3 (Middle) | 87 | 37.9k |
| Finger4 (Ring) | 85 | 32.7k |
| Finger5 (Little) | 0 | 11.7k |

**Table 4 - Resistance according to Angle of bend for pattern IV (Help)**

| Serial | Angle of bend | Resistance |
|---|---|---|
| Finger1 (Thumb) | 81 | 34.2k |
| Finger2 (Index) | 87 | 38.2k |
| Finger3 (Middle) | 87 | 37.9k |
| Finger4 (Ring) | 85 | 37.2k |
| Finger5 (Little) | 86 | 37.7k |

It is analysed about the extent that this project is successful in achieving the objective defined at the beginning of this paper. For the experiment, some samples were taken. The samples were pre-processed. The signs were converted into speeches and commands. We have carried a test on twenty users and calculated the accuracy by finding the number of correctly recognized gestures and unrecognized gestures introduced previously.

**Table 5 – Gesture Recognition accuracy test**

| **Serial** | **Gesture Name** | **Total Tests** | **Correctly Recognized Gestures** | **Unrecognized Gestures** |
|---|---|---|---|---|
| 01 | Food | 20 | 18 | 03 |
| 02 | Fine | 20 | 20 | 0 |
| 03 | Washroom | 20 | 19 | 01 |
| 04 | Help | 20 | 18 | 02 |
| **Total** | | 80 | 74 | 06 |

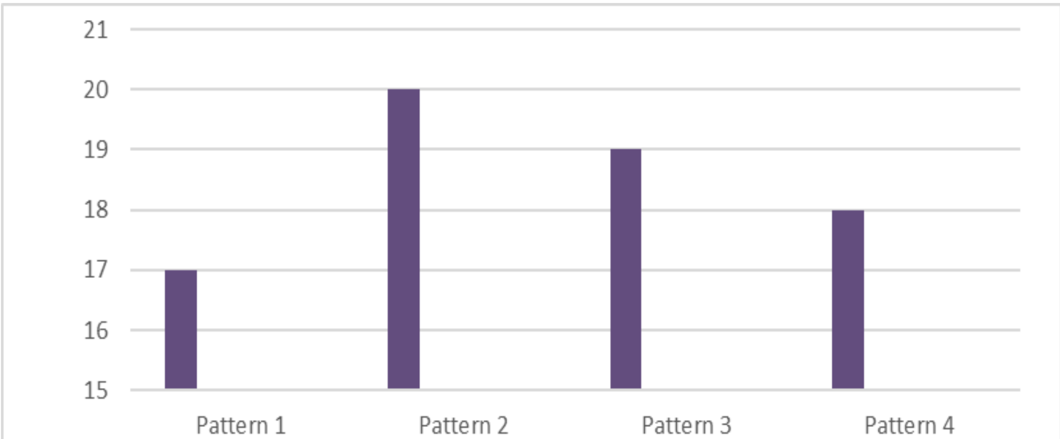


**Fig. 5 – Gesture Recognition Accuracy Test for Different Patterns**

The bar chart shows the number of test processed correctly out of twenty tests by the system for each command. Four commands are taken as ideal for the experiment which are denoted by pattern 1, pattern 2, pattern 3, pattern 4.

Percentage of Error= (74 / 80) * 100 % = 92.5%

## Conclusion

The primary focus of the work is to develop a system to help mute people and to enable them to communicate others virtually using special patterns and commands from gestures. For this purpose, different gestures and commands are taken as experimental data to find the accuracy rate of this system. By experimenting on those success rate is calculated. So here it is seen that though the project can't give a hundred percent accuracy but it gives a good successrate about 92.5%

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