# AUGMENTATIVE AND ALTERNATIVE COMMUNICATION USING SMART GLOVE

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***ABSTRACT***

*There is a very popular aphorism in India "Kosh kosh pe pani badle, dedh kosh pe vani". In a country like India where there are many languages and dialects spoken, people face problems in communicating. When a person with all sense organs working intact, faces such setback, how difficult it would be for those who don't have either of the sense organs functioning properly!*

*For a person with disability (deaf and dumb) faces difficulty in communication with normal person. Because of this, a person who lacks in hearing and speaking ability is not able to stand in race with normal person. Generally dumb people use sign language for communication but they find difficulty in communicating with others who don't understand sign language. So there is a barrier in communication between these two communities. This work aims to lower this barrier in communication.*

*A sign language usually provides sign for whole words. There are a total of 26 alphabets in the English vocabulary. Each alphabet may be assigned a unique gesture. It can also provide sign for letters to perform words that don't have corresponding sign in that sign language. In this project Flex Sensor plays the major role, Flex sensors are sensors that change in resistance depending on the amount of bend on the sensor. The main aim of the proposed project is to develop a system which can give voice to voiceless person with the help of Smart Gloves. The wireless arrangement makes the device more comfortable to be used by the disabled person. Few attempts have been made in the past to recognize the gestures made using hands but with limitations of recognition rate and time. This paper accentuates the fully functional system with significant improvement from the past works.*

***KEYWORDS:*** *AAC, Indian Sign Language (ISL), Arduino NANO.*

## 1. Introduction

The term "Augmentative/Alternative Communication" (AAC) refers to any mode of communication other than speech. This includes systems such as sign language, symbol or picture boards, electronic devices and synthesized speech. Although the same systems can be used for either augmentative communication or alternative communication, there is a difference between the two. Augmentative systems are used by people who already have some speech but are either unintelligible or have limited abilities to use their speech. In such case, other modes of communication are used to support, or supplement what the person is able to say verbally. Alternative communication is the term used when a person has no speech. These people must completely rely on another method to make all of their ideas, wants, or needs known.

Many different electronic communication systems are available. Some communication systems are custom designed for a specific user or can only be used in specific situations. For example, a communication system that works through a desktop computer cannot travel with the patient to doctor visits, but a laptop or notebook computer is more portable and will allow the patient to travel with the system. In selecting an electronic system, the individual must understand the features offered by the system and determine if those features best meet his or her needs.

Electronic communication devices can be broken down into two categories: dedicated and undedicated systems. A dedicated device is strictly a communication device—the only thing it does is speak. Undedicated devices, which are computer based, not only speak, but also feature all the functions of a regular PC or laptop—word processing, e-mail, web surfing, etc. Smart Glove comes under the category of dedicated device.

The paper is organized as follows: the initial section of this paper consists of a literature review of some past attempts made in the area of our interest. The paper further gives a detailed discussion of problem identification and its solution. The solution of the problem is suggested by the proposed design of our project under the category ‘Proposed Design Implementation’. The discussion deepens further under the section ‘Results and Discussion’. Then the conclusion is given with some probable future changes in the design. The past work done in this area is also appreciable and we have taken much reference from the past attempts. But further changes might be possible in the proposed design in this paper as stated in the ‘conclusion’ section.

## 2. Literature Review

**M. Mohandes et al.** proposed an image based system for recognizing Arabic sign language. First, the system detects the signer’s face by using the Gaussian skin model. Centroid of the detected face region is taken as the origin for each frame and then the hands movement is tracked by applying region growing technique. Hidden Markov Model (HMM) is used to perform the classification of the signs during the recognition stage, through some computation based on the features extracted from the input images **[1]**.

**K. Park, et al.** implemented a real-time embedded FPGA-based gesture recognition system using 5DT data glove. This approach is used in order to reduce the problems of space limitations, movement limitations and lighting limitations. The architecture of the system consists of three main modules that are input module, recognition module and display module. The system recognizes the hand gesture by performing data calculations with a checksum function on the input data and compares the result to the header byte before proceeds to the matching process. The matching process compares the input hand gesture with the pre-defined hand gesture. Then, the result is displayed on the LCD screen. **[2]**

**W. K. Chung et al.** presented a real-time hand gesture recognition system based on Haar wavelet transform. They proposed a code word scheme based on features of hand gestures for matching process. Besides, the system reduces the database size by standardizing the orientation of hands using the principal axis. In the project, recognition algorithm based on Haar wavelet representation has been developed. Hand images with resolution of 160×120 pixels are captured by using ICE digital webcam. Skin color approach is used to extract the hands from the image. **[3]**

**M. P. Paulraj et al.** presented a simple sign language recognition system that is capable of recognizing nine phonemes in English using a machine vision system. The system had been developed based on skin color segmentation and Artificial Neural Network (ANN). There are three processing stages in the system; preprocessing, feature extraction and gesture classification. Skin color detection and region segmentation are carried out during the preprocessing stage. Skin color of the hand is detected based on the RGB values in the image frame. The feature extraction stage extracts moment invariant features, obtained by calculating the blob in the set of image frames, from the right and left hand gesture images. The gesture classification stage then uses these features as its input to ANN to recognize the sign. It is reported that the average recognition rate for this system is 92.85%. **[4]**

**Wang et al.** presented a sign language recognition system that uses tensor subspace analysis to model a multi-view hand gesture. The hand recognition process is achieved through color segmentation. Input image that is in RGB color space is converted to YCbCr color space to ease the process of detecting the skin that employs the Back Propagation (BP) networks model. The sign language recognition is modeled and recognized using tensor. Then, the matching process is carried out to identify the input hand gesture. **[5]**

The sign signal translation system created by **Kuo Chue Neo, et al.** is recognized as a set of hand gestures, which is the sign signal, present in an image that captured using a camera. The sign signals are recognized based on the finger counts detected in the image. They develop a sign signal translation system that is able to detect and translate the hand gesture (sign signal) from individual captured images. The detected sign signal is then translated into its corresponding numerical representation.

They used Altera's DE2 board that features Cyclone II FPGA chip with Nios II soft core processor inside, to construct the system. FPGA is used to construct the system as FPGA is considered to have the capability to perform the image processing faster. Their approach is based on the image processing techniques to capture the different signs in different image. **[6]**

**Tushar Chouhan, et al.,** developed a smart system which is able to serve as best friend to the hearing and speech impaired person. Their system uses bend sensors which consist of three components: a flexible tube, an infrared sensitive (photo diode) and an infrared diode. Accelerometer is used to detect the orientation of the hand. This accelerometer gives information of x, y, z axes (voltages) as per the orientation of the hand in different positions. They have seven bend sensors whose outputs are fed to the analog multiplexer. The output of this multiplexer is given to a current to voltage converter circuit. Sensor outputs obtained are then given to the inbuilt ADC (analog to digital converter) of MSP430G2553(by Texas Instruments)for sampling the values given by the sensors, which is also used for interfacing the glove with a computer running the machine learning algorithms. The machine learning algorithm used helps the user to define his own symbols according to his convenience. **[13]**

**Harmeet Kaur, et al.** in their paper, presented a brief description about the past attempts that were made to convert sign language to understandable form. In their paper, they have thoroughly scrutinized the previous attempts over this technology and also suggested various possible ways to implement the design of a simple smart glove. **[18]**

**Abhishek Tandon, et al.** in their paper presented a brief introduction of their proposed design of 'Smart Glove' along with the previous attempts done in the area of augmentative and alternative communication (AAC). The proposed design of their glove converts the Indian Sign Language (ISL) into text and speech. Their proposed design consists of five flex sensors, one for each finger of the hand. These flex sensors are connected to five analog inputs of the microcontroller. They used microcontroller to process input voltage of the flex sensors and send the desired text output to the android device (smart phone) using Bluetooth module. Their android device has a software application which can convert the text into audible (speech) signals. **[19]**

## 3. Problem Identification

India constitutes 2.4 million of Deaf and Dumb population, which holds the world's 20% of the Deaf and Dumb Population. These people learn sign language to communicate. Unfortunately, most of the average people don't understand their gestures and thus are unable to identify what they are trying to say.

## 4. Problems Faced

The problems faced by the deaf and dumb people in India can be broadly classified into categories like

- social interaction,
- education,
- behavioural problems
- mental health
- Safety concerns.

These problems have worsened by the absence of a proper medium of interaction between deaf and dumb community and normal masses. According to a recent survey out of every 100 deaf and dumb only 40 are graduate and less than 20 are employed. It is a result of the physical disability of hearing for deaf people and disability of speaking for dumb people.

As of now the law provides for 3% of reservation for the persons with disabilities as per the act 1995, wherein the visually handicapped is entitled for 1%, orthopedically handicapped 1% and for hearing impaired 1%.. Firstly, the reserved percentage is very less and also the sections dealing with recruitment of PWDs must also have staff from the person with same disability in order to select the deserving candidates, which is not possible every time. Also sign language is not easy to learn due to its natural differences in sentence structure and grammar.

## 5. Proposed Solution to these Problems

Most of the problems mentioned above and particularly the problem of having staff from the person with same disability for recruitment of deserving PWDs can be solved and simplified easily using **"Smart Glove"** that recognises hand movements and converts them into the relevant text and speech. Much like Google Translate can give anyone a basic grasp of a foreign language in an instant, this glove is designed to help sign language users make themselves understood by those who can't usually interpret it.

## 6. Proposed Design Implementation

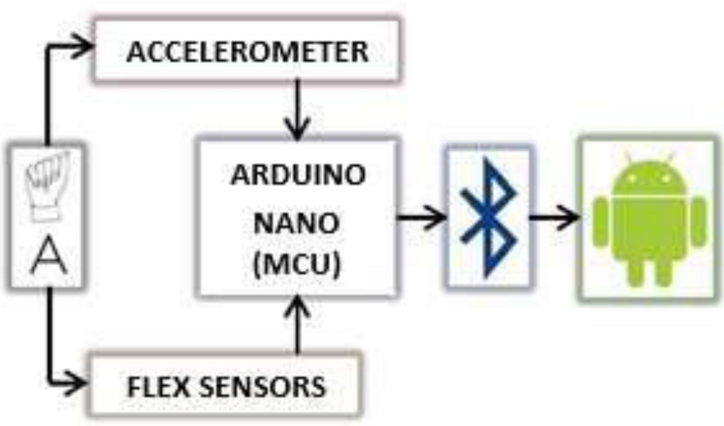


**Fig. 1:** Block diagram of the proposed design

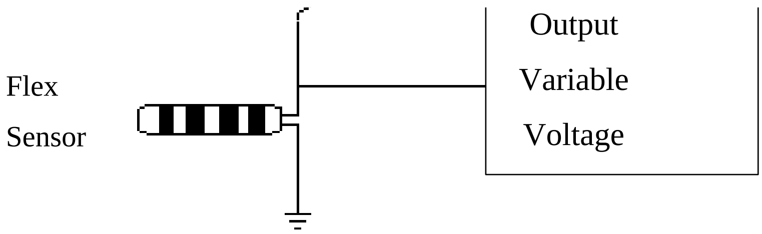


**Fig. 2:** Voltage divider circuit using a flex sensor

The major concern of the proposed project is its design implementation. Any electronic device, when seen at a first glance, appears attractive to the eye. But this project, with its complex circuitry and large mesh of wires, makes it difficult to make it attractive, simple and presentable. The basic block diagram of this project is shown in the figure 1. The proposed design utilizes two basic electronic components named 'Flex Sensors' and 'Accelerometer'. A flex sensor is glued to each finger of the glove thus making the glove utilize five flex sensors for one glove.

Flex sensors are special type of sensors which senses the change of curvature. It is basically a type of variable resistor whose resistance varies according to the change in curvature or bend of the sensor. Flex sensor then produces a different value of resistance corresponding to each changed bend of the fingers.

These flex sensors can be utilized in a voltage divider circuit so that with every changed value of resistance, we get a variable voltage at the output of the voltage divider circuit.

By voltage divider rule, output voltage is determined and given by,

$$V_{out} = V_{in} \times R_1/(R_1 + R_2),\ldots\ldots\ldots\ldots(i)$$

This arrangement is shown in figure 2. The variable output voltage is then fed to the analog input pin of a microcontroller. In our case, we have used a microcontroller named 'Arduino NANO'.

To increase the accuracy of sensing correct gestures, we have utilized another electronic component named ‘Accelerometer’. As shown by the figure 3 the sign for English alphabet ‘I’ and ‘J’ are very much common to each other but only a difference of orientation is there for the two alphabets**.** So here, the flex sensors become incapable of differentiating between the two signs. Accelerometer is a device which measures the tilt with respect to the horizontal plane of the earth. It is also connected to the microcontroller and gives its readings to the controller for further processing.
Now, Arduino NANO (microcontroller), processes the received values accordingly and sends the encoded data to the Bluetooth module which is connected to its serial port. The Bluetooth module then transmits the received data through a wireless channel which is then received by a Bluetooth receiver in the smartphone.
The flow chart of proposed design is shown in figure 4. The flex sensors are used to detect the gesture of subject’s hand and pass these detected gestures to Arduino NANO. The controller then processes these received digital signals (an inbuilt ADC converts the input analog signals to corresponding digital signals) and send it to the Bluetooth module connected to the controller to send the data through a wireless medium to an android smartphone. The smartphone has an application software which converts these received text signals to corresponding speech signals and thus the desired task is accomplished.

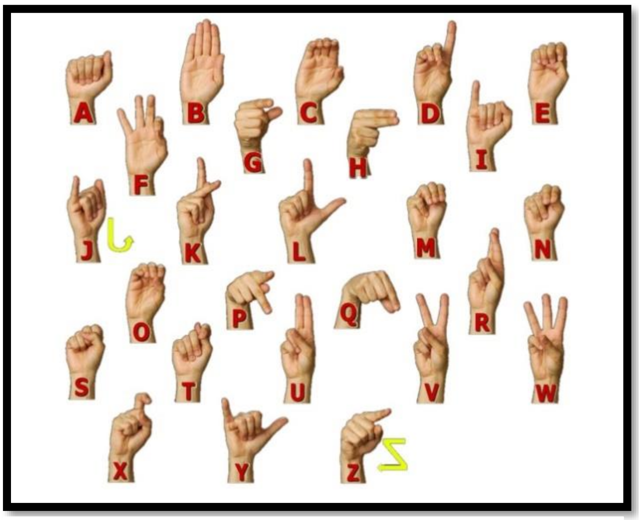


**Fig. 3:** Sample Sign Language [14]

Figure 1 show clearly that the microcontroller takes the input from flex sensors and an accelerometer (used for improved accuracy) and then after processing this input signal, it sends it right away to a Bluetooth module which in turn forwards the data to an android smartphone. The smartphone does the desired task of text to speech conversion.

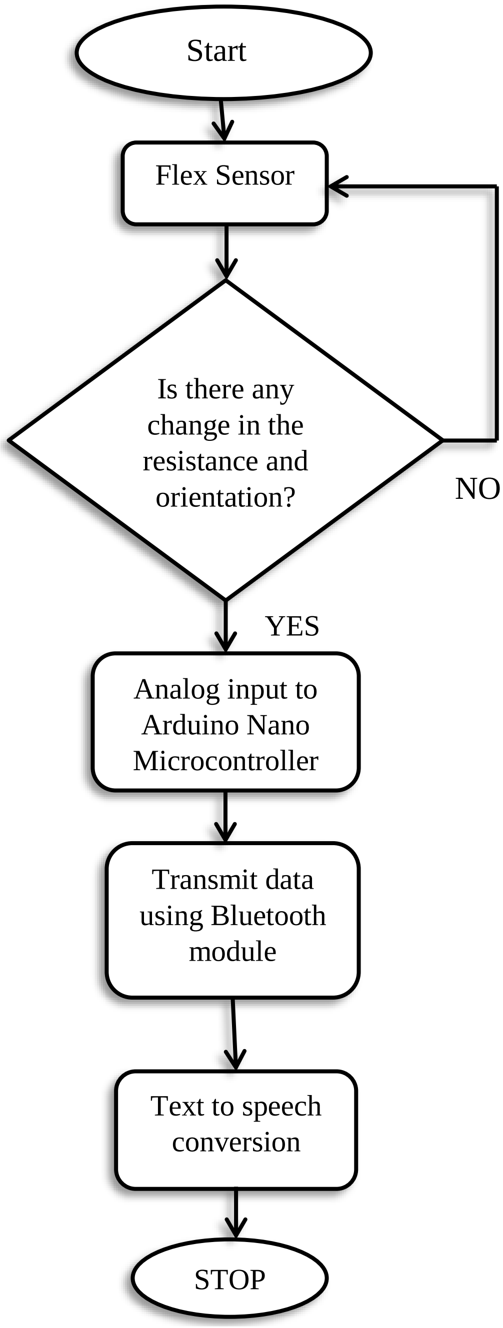


**Fig. 4:** Flowchart of the Proposed Design

## 7. Results and Discussion

The proposed design aims to provide a cost effective, light-weight and portable device which can be used to bridge the gap between the deaf & dumb community and the normal masses. There are several design issues related to this device including the problem of portability and handling. Practical flex sensors are difficult to calibrate and also, they do not offer an acceptable range of values to be decoded by the microcontroller. Our research has led us to implement the design presented in this paper, but more efficient designs can also be made which may overcome the difficulties faced by our design of 'Smart Glove'.


**Fig. 5:** Hand Gesture being converted to text using the proposed design

The design presented in this paper, requires a tedious job of making a table or chart for selecting different readings given by the flex sensors and accelerometer so that the appropriate gesture may be sensed and the same may be displayed or converted to speech accordingly. The algorithm to be made for sensing a correct gesture also requires long and time taking calculations which increases the complexity for design of 'Smart Glove'.

Figure 5 shows the practical implementation of proposed design that we have made. The hand is making a gesture of alphabet 'A' and the LCD screen displays the corresponding alphabet. The figure shows only three alphabets displayed on the LCD but in a similar way, more alphabets and words can be displayed on the LCD screen and then these corresponding words or alphabets are sent to the Bluetooth module and further working has already been explained. Other designs may be implemented which use another logic and other circuitry to convert 'Sign Language' gestures to corresponding speech signals.

## 8. Conclusion

Sign language is one of the useful tools to ease the communication between the deaf and mute communities and normal society. Though sign language can be implemented to communicate, the target person must have an idea of the sign language which is not possible always. Hence our project lowers such barriers. The glove is capable of translating their sign language gestures into speech through android phone. Smart glove focuses the translation of gestures of the alphabets. Comparing with other approaches, smart glove uses Principle Component Analysis to classify the real time input data for feature extraction.

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