# SIGN LANGUAGE ANALYSIS AND RECOGNITION TO AID SPECIALLY ABLED COMMUNICATORS

*Project Report submitted in partial fulfillment of the requirement for the degree of*

## BACHELOR OF TECHNOLOGY

## IN

## ELECTRONICS AND COMMUNICATION ENGINEERING

By


**RUBAL SHARMA 131003**
**DIVYANSHU RAGHUVANSHI 131047**

UNDER THE GUIDANCE OF

**Dr. MEENAKSHI SOOD**



JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY, WAKNAGHAT

**MAY-2017**

# TABLE OF CONTENTS

# DECLARATION BY THE SCHOLAR

We hereby declare that the work reported in the B-Tech project work entitled **"SIGN LANGUAGE ANALYSIS AND RECOGNITION TO AID SPECIALLY ABLED COMMUNICATORS"** submitted at **Jaypee University of Information Technology, Waknaghat, India** is an authentic record of our work carried out under the supervision of **Dr. MEENAKSHI SOOD.** We have not submitted this work elsewhere for any other degree or diploma.

| | |
|---|---|
| RUBAL SHARMA | DIVYANSHU RAGHUVANSHI |
| 131003 | 131047 |

Department of Electronics and Communication Engineering

Jaypee University of Information Technology, Waknaghat , India

Date - 02.05.2017

**JAYPEE UNIVERSITY OF INFORMATIO TECHNOLOGY**

(Established by H.P. State Legislative vide Act No. 14 of 2002)
P.O. Waknaghat, Teh. Kandaghat, Distt. Solan - 173234 (H.P.) INDIA
Website: www.juit.ac.in
Phone No. (91) 01792-257999
Fax: +91-01792-245362

# CERTIFICATE

This is to certify that the work reported in the B.tech project report entitled **"Sign Language Analysis and Recognition to Aid Specially Abled Communicators "** which is being submitted by **Rubal Sharma, Divyanshu Raghuvanshi** in fulfillment for the award of Bachelor of Technology in Electronics and Communication Engineering by the Jaypee University of Information Technology, is the record of candidate's own work carried out by him/her under my supervision. This work is original and has not been submitted partially or fully anywhere else for any other degree or diploma.

----------------------------

**Dr. Meenakshi Sood**

Assistant Professor (Senior Grade)
Department of Electronics & Communication Engineering
Jaypee University of Information Technology, Waknaghat,

# ACKNOWLEDGEMENT

**"EXPRESSION OF FEELINGS BY WORDS MAKES THEM LESS SIGNIFICANT WHEN IT COMES TO STATEMENT OF GRATITUDE"**

The joy and sense of fulfilment that comes along the successful completion of any task is incomplete without thanking all those people who made it possible with their guidance and constant word of encouragement. We especially thank **Dr. Meenakshi Sood**, our **project guide** for giving extremely valuable guidance and support throughout the course of the project. We would also like to express sincere appreciation to our **Head of Department**, **Prof. S.V. Bhooshan** for having extended all department facilities without hesitation. We thank almighty for giving us such excellent facilities and support through the way of **JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY**, for giving us the opportunity for completion of this project. We would also like to extend our heartfelt gratitude to our lab incharge Mr. Kamlesh whose constant encouragement and help and support made this project a fun-to-do activity. Last but far from least, we thank all the staff members of **Electronics and Communication Engineering Department** for their kind co-operation and timely help.

# ABSTRACT

Most people are capable to interact with each other through verbal communication methods such as speech, with the help of different languages developed across time. But all humans are not gifted equally to communicate with the aforementioned technique. These specially abled communicators who lack the ability to hear and speak are commonly called deaf and dumb respectively by the society. These specially abled communicators interact with the help of 'sign language'. Sign Language is defined as a manual communication method to interact, as opposed to traditional speech. This method involves simultaneous movements and orientation of hands, arms or body. In this project, a real time integrated solution of hardware and software is developed to help the specially abled people all across the globe to support the communication and interaction of such individuals, thus fostering their independence. We aim to develop a sign glove, an interdependent glove for these special communicators in the event they have to communicate with general population who might not be aware of their sign language semantics. The advantages of automaticity of this project are that it is a hand-held user interdependent device, it uses flex sensors to detect movement of figures and 3 axis accelerometer and gyroscope to decode movement of the hand. The device is programmed in such a way that it recognizes defined gestures which are pre saved in the data base in accordance to American Sign Language. In view of this, aforementioned system is a source of developing a product which is affordable and easy to be used for such people who are specially abled, which helps in lessening the communication gap between specially abled and general population. The glove can be worn on the right hand that uses a specially designed algorithm to translate sign language into spoken English.

# LIST OF FIGURES

# LIST OF TABLES

# CHAPTER 1

# INTRODUCTION

## 1.1 SIGN LANGUAGE

A sign language is a language that uses manual methods rather than the conventional acoustic method to convey meaning. This is also accompanied by various hand shapes, orientation and motion of various other body parts, along with facial expressions to convey thoughts and information. Various Sign languages have many similarities with their oral counterparts (sometimes called "oral languages", which chiefly depends on sound waves), this is the reason why linguists consider both these languages to be natural languages.

Linguistically in general sign language do not show any resemblance to the acoustic languages of the lands in which they originate. The correlation between sign and oral languages is quite complex and it changes depending on the locality or country more than the spoken language itself. For example, the United States, Canada, United Kingdom, New Zealand and Australia all have English as their mainstream communication medium , but American Sign Language, used in the United States and Canada, originates from French Sign Language while the sign languages of the other three countries like Britain, Australia and New Zealand vary greatly and do not have a French origin. Similarly, the sign languages of countries of Spanish dominion likes Mexico and Spain are very different, and the sign language used in Bolivia is based on American Sign Language and do not show much resemblance to other sign languages prominent in various Spanish-speaking countries. Variation is also seen within a 'national' sign language and its not necessary that they correspond to various existing dialect differences in the national spoken language, these variations are usually correlated to the geographic location of schools for the acoustically challenged community.

Sign Languages are usually organized, and they can be analyzed at the morphological, phonological, lexical and grammatical levels, and there are differences at each of these levels between the many different sign languages. There are however language families of sign languages: Indian Sign Language, Chinese Sign Language and American Sign Language (ISL) are some of the sign language family names.

Sign languages are as diverse, complex and rich as any oral language, despite the existing misconception about them being a "real languages". Professional linguists have researched many sign languages across the globe and have concluded that mostly all of them show the fundamental properties that can be found in all languages.

## 1.2 ORIGIN OF SIGN LANGUAGE

The genesis of the sign language of the specially abled in a society should not be taken as a pre-judgement of the basic question of the language origin. The response of the individual takes importance in picking up of manual or vocal or facial signalling systems.The special system signalling of the acoustically challenged can only develop in a supportive culture. Despite many challenges and hurdles today human culture has made much progress to reach to a level where some individuals who are not able to communicate through the conventional methods of communications could be given an alternative channel of communication leading to development of substitutes.

In the past various methods such as lip reading, gesture making alternatively/artificially acquired speech etc were used to educate and teach people who are born deaf to communicate. From the ancient time to the of half the $18^{th}$ century these account for a very rare case or instance.

The history of the American Sign Language or ASL began in France. It was year 1750 the Abbe´ de l'E´ pe´e started teaching two deaf-mute sisters. What differentiated him from many other good practitioners involved in the teaching the silent language to those who were deaf by birth, was a relatively open mind and a will of charity. While other practitioner have had taught either one or at most a small bunch of pupils, and seeking fame and payments, had flaunted their successes while keeping their methods a secret. On the other hand l'E´ pe´e gave his life along with a seizable amount of his private savings, and his skill to a school which was open to every deaf child born Europe. He taught for nearly thirty odd years and managed the school, made its results known only via demonstrations held monthly and was open to the general mass until the year 1776. It was in 1776 when he realized the need to answer his rivals who were often pointing finger at his methods in a full fledged display of his teaching method of teaching. This work, L'institution des sourds et muets, par la voie des signes me´thodiques in Paris in the year 1776 points out that the basis of his success is based on his strong grip on language facts.[1]

In 1815 Thomas Hopkins Gallaudet from Hartford, Connecticut, landed in Europe to learn various methods of teaching the deaf. First he visited England, he did not found much motivation in the London Asylum at Watson; but he was welcomed by Sicard, he also introduced him in the methods used in school in Paris. He was accompanied by Laurent Clerc who was the first teacher for deaf students in United States. In 1817 with Gallaudet as head the American School for the Deaf was established, and was later followed by the New York School soon after that. At both of these and at various other schools which followed all over the country at that time, the natural sign language as well as the methodical sign system originated by l'E´ pe´e was firmly established as the medium of instruction.[1]

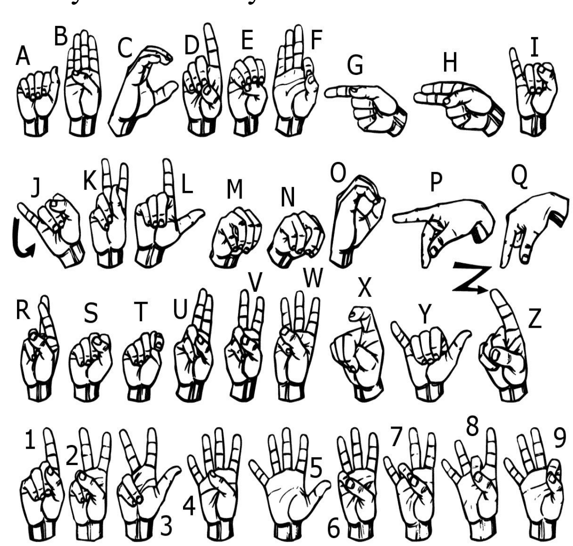
Various bibliographers have credited l'E´ pe´e for starting a dictionary of signs which was later completed and issued by Sicard. Actually this work also known as The´orie des signes, Paris, 1808 is a list of French words contained in two separate volumes, they are arranged by subject matter and content, with their proper translation into methodical signs.

The Sign language flourished on the international platform even in the later years. A hearing linguist and English professor at Gallaudet named Dr. William Stokoe, started formal analysis of the sign language. He noted that some particular facial expressions signified specific grammatical constructions consistently from individual to individual. He also noted that American Sign Language is “rule governed” and has its own grammar. This “discovery” began both modern ASL linguistic research and its acceptance as true language.[2]

## 1.3 AMERICAN SIGN LANGUAGE

American Sign Language is the quite popular and followed sign/gesture language of acoustically disabled community not only in The United States but also in Canada. Dialects of American Sign Language and ASL-based creoles are used in various regions around the globe, including much of Southeast Asia and most of West Africa.American Sign Language is also learned as a second language, serving as a lingua franca. American Sign Language is most closely related to French Sign Language, although ASL shows features atypical of a derived language, such as synthetic morphology.

American Sign Language originated in the early 19th century in the American School for the Deaf (ASD) in Hartford, Connecticut. Since then, ASL use has spread widely via Deaf community organizations and various schools for the deaf.




Although American Sign Language is Used widely though out the globe,there have been no accurate or exact data available for is usage. Some reliable figures for American Sign Language users range from 250,000 to 500,000 individuals,which also includes dependants specially children of deaf adults. American Sign Language users have been found to suffer from stigma due to perceived superiority of spoken language to gesture language, compounded by the fact that American Sign Language is often glossed in English because of lack of a standard writing system.

American Sign Language signs have a number of phonemic components, which includes movement of the face and upper body/torso along with hands.Words which are loaned from English are often borrowed through fingerspelling, although grammar of American Sign Language is merely related to that of English. Many linguists believe ASL to be a subject–verb–object (SVO) language, but there are several alternative proposals to account for ASL word order.

## 1.4 CHALLENGES WHILE USING SIGN LANGUAGE

There is a communication gap between the common masses and sign language users community because not everyone uses or understands it. The demand for interpreting services has also created economic and business practice issues in some communities. Some interpreters are requesting fees in excess of the suggested fee grids within the community. Some are cancelling previously booked assignments in order to take more lucrative paying assignments. Some are requesting fees to be paid up front. These situations can result in people being unwilling to use interpreters on a regular basis or simply being unable to pay for interpreting services. These practices breed an environment of mistrust between consumers and interpreters, and create professional disputes among interpreters.[3]

A research paper titled "**Computer technology education and the deaf student: observations of serious nuances of communication**" by *Curtis Robbins,* Gallaudet University published in 1996 who was looking at the importance of taking computer courses as a deaf student at a "regular" university. He points out the difficulty in the visual inspection of the gestures made by the instructor due to the regular set up of the computer labs, which certainly are not designed keeping in mind the needs of acoustically challenged students.The size of various computer lab equipments such as large monitors and CPU’s along with various other bulky furnitures hinder the line of sight based communication, like sign language.He also points out the difficulty of multitasking while operating computer as well as taking class notes. [4]

In yet another dissertation titled “**The Academic Status of Sign Language Programs in Institutions of Higher Education in the United States**” by *Sheryl B. Cooper* which did indeed specifically look at ASL in higher education settings. This dissertation was presented by Cooper.It notes generally, in regular educational institutions the number of acoustically challenged students is insignificant compared to the general population.Therefore, providing special services such as translators, telecommunication devices for the deaf, note takers etc. is quite expensive. These organizations generally are not able to keep up with this cost and hence prefer not to provide these services, despite their will to do so.[5]

# CHAPTER 2

# LITERARY WORK

There has been a vast communication gap and a considerable void in technological growth. Scientific community is now pacing up to abridge this gap and make communication easy irrespective of the knowledge of sign language. There have been a lot of research going on to decrease this communication hurdle.

## 2.1 LITERATURE REVIEW

An extensive research has been done including various paper and journals some of the prominent ones have been mentioned below:

A device named JhaneGlove has been proposed under a paper named **A Sign-to-Speech Glove a paper** by Olga Katzenelson, Solange Karsenty, Hadassah Academic College HaNeviim 37, Jerusalem, Israel. It has been built using three types of sensors which can be turned on and off. It has 5 flex sensors, accelerometer and gyroscope, and 8 contact pads. Each flex sensors has 3 states and enables 20 degrees of freedom which helps in making more than hundred different hand gestures.[6]

The proposed has 26 alphabet signs, a space sign to mark the end of a a word, and a dot sign to mark the end of a sentence. The system uses Arduino which helps in developing the pre-processing software in order to pre-process the data to be sent to our main agent i.e. a server side component. The board is attached to the glove and in order to use the system, the user must first calibrate the glove. Initially the user must record the minimum and maximum values that can be emitted with the glove. But as the number of signs increases there is a gradual decrease in the accuracy of he sign recognition, which is the major drawback of the proposed system.

A sensory glove system has been proposed using *LPC2148 Microcontroller* in another Research Paper named **Hand Gesture Recognition for Dumb People using Indian Sign Language** given by *Prakash B Gaikwad*, *Dr. V. K. Bairagi*, Department of

Electronics Engineering, All India Shri Shivaji Memorial Society's, Institute of Information Technology, Pune, Maharashtra, India published in Volume 4, Issue 12, December 2014 of 'International Journal of Advanced Research in Computer Science and Software Engineering'. [7]

On each finger flex sensors are placed and are interfaced with the analog part. Digital ports are connected directly to accelerometer and contains circuit for signal conditioning. The microcontroller receives and operates on the data for every individual gesture. It reads data from various sensors and transmits to the other Cell phone via Bluetooth module. With the help of a cell phone as a gesture recognition section, the predefined data is compared with the received data . If compared data is matched with predefined reading then matched gesture sent with text to speech conversion module.

In yet another paper titled **"Sign language converter"** by *Taner Arsan* and *Oğuz Ülgen* Department of Computer Engineering, Kadir Has University, Istanbul, Turkey published in International Journal of Computer Science & Engineering Survey (IJCSES) Vol.6, No.4, August 2015 Microsoft Kinect Sensor XBOX 360 is proposed for capturing abilities and technical features to the motion capture of sign to voice conversion. For voice to sign conversion CMU Sphinx is used . A java based program is used to make voice recognition and motion capture and further it helps to convert both of them to each other. To let the Kinect sensor to process 3D scenes in any environmental light conditions, a 3D sensor combines infrared laser projector with a CMOS sensor. By using a grip of infrared light from projector on an area of any view, sensor receives from reflections of objects in the scene. Distance of object surfaces from the visibility point of the camera specified by the depth map called as A Time of Flight. Gif images are used in the program to show the proper meaning for the recognized speech. Each word or word groups have a meaning on the Sign Language. The program can capture 12 motions and interprets them to the text.[8]

## 2.2 RELATED WORK

Below are some devices based on sign language which are implying innovative ideas that try to break down the communication barriers.

### 2.2.1 SIGNALOUD

A pair of entrepreneurial technology students named Thomas Pryor and Navidazodi in the US has designed a pair of gloves called SIGNALOUD to break down the communication barriers by translating hand gestures into speech. The gloves uses embedded sensors to monitor the position and movement of the user's hands, while a central computer analyses the data and converts gesture into speech. The glove transmits the captured data of the positioning and movements of user's hand via Bluetooth to a computer which analyses the movements and checks them against a library of gestures. If a hand gesture matches then the appropriate sound is spoken through the speakers by the computerized voice.

**Figure 2.1:** Signaloud Glove

### 2.2.2 ENABLETALK

A team of Ukrainian inventors have developed a hi-tech glove capable of converting sign language into speech using a mobile device to translate the hand gestures. It even allows users to create and program their own signs, which the app will then recognize. Enabletalk is still in a prototype stage but has won many awards such as Microsoft Imagine Cup in 2012 in Australia. [9]

**Figure 2.2:** Enable Talk Glove

### 2.2.3 VERBAVOICE

The verbavoice web player app enables hearing impaired people to attend events through sign language stream and live text. The sound is sent to a speech-to-text reporter or sign language interpreter online which helps in transferring it into live text or sign language video. German authorities has accepted verbavoice as a communication aid doing their best in giving voice to deaf-mute society.

**Figure 2.3:** A Verbavoice Web App

### 2.2.4 ABJAD

ABJAD is a product that bridges the communication gap between deaf mute people and normal people. It is primarily a wearable digital glove with English alphabets on it enabling deaf and mute people to communicate without the prior knowledge of sign language from both communicators.[10]

### 2.2.5 MUDRA

Bengaluru students of engineering college has developed a smart glove called MUDRA which works on Indian sign language. It converts the hand gestures into spoken English, recognizing the hand gestures in all possible directions and angles using flex resistors, accelerometer and gyroscope. Currently it is capable of recognizing numbers from 1 to 10 and about 70 Indian sign language gestures.[11]

## 2.3 MOTIVATION

Dumb population in this world is of considerable number. The communication between a acoustically challenged person and general English speakers has always been a challenging task. Communication for these people is constrained in many ways. One of the powerful tools for specially abled people is sign language. To elaborate their meanings, it uses gestures instead of sound patterns.

We believe that every human being has the right to express them self and communicate their thoughts. For some time there has been a push in our society to reword the expression *"Viklang* - a disabled person" into the phrase "*Divyang'*- a person who is specially abled", because we believe in the importance of stating that they are humans before claiming that they possess a disability. And just like many will agree 'It's not a disability, it's a different ability'. While some people are not able to communicate in the same verbal way that many of us do, but they can express their thoughts using their hands. So our project aims at giving them a mouth to speak the common language. So, this project is a step towards improving the quality of life for the deaf and dumb people. Reducing their dependency on their friends and family by developing such self-help devices will help them to live a better life.

## 2.4 OBJECTIVE

We aim to develop a glove to be worn on the right hand that uses a specially designed algorithm to translate sign language into spoken English. Our project uses five Flex-Sensors that will quantify how much each finger is bent, and detects the orientation and rotational movement of the hand (using a three-axis accelerometer and gyroscope, if need arises).

So we propose a design of a simple autonomous smart glove that bridges the gap between spoken and sign languages. The main purpose for developing this gloves is to bridge the gap between American Sign Language users and users of acoustic languages especially English. For everyday use, many of the devices already out there are not practical. Some of them cover the user's entire limb, while other uses video inputs. We believe it is the design of our device that will allow them to one day be as ubiquitous as hearing aids or contacts, Our glove is compact, lightweight and worn on the right hand, but viable and economic enough to use as an everyday accessory. Of all the different systems we have chosen the American Sign Language (ASL), which is shown in Figure 2.1, as the basis of functioning of this device. This smart glove has sufficient sensors such as flex sensors and accelerometer to decipher the gestures as defined in the ASL to the spoken language.

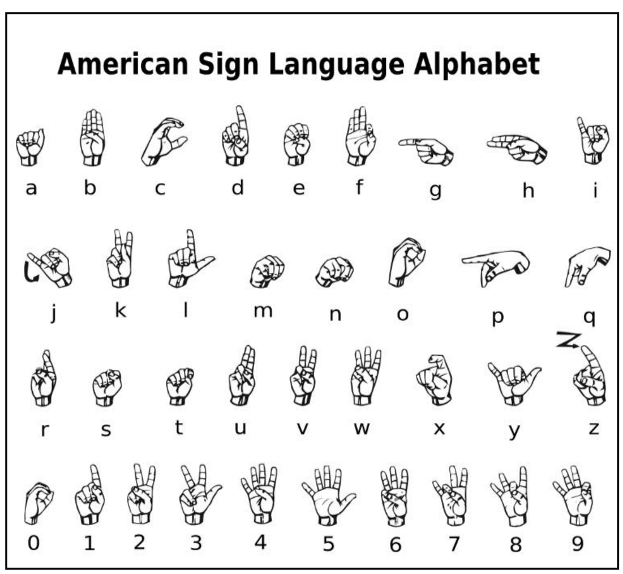



**Figure 2.4**: American Sign Language Gestures.

# CHAPTER 3

# PROPOSED METHODOLOGY

There is a lot of research going in smart wearables to help the needy to feel connected with the common population which uses different methods to interact. And as observed, most of the general population is unaware or have no knowledge of the special mode of communication such as sign languages where different gestures have different meanings. So we propose a system that can help those special communicators to interact with everyone with help of an autonomous smart glove that anyone can wear and moving hands to make different gesture according to ASL the sensors over the glove decodes the gesture and converts that message to a string that is displayed over LCD.

## 3.1 COMPONENTS

There are five flex sensors (2.2 inches) put on every finger so as to get the angle bent by each user's finger. Every letter in English language has different orientation of finger which can be decoded easily but letters such as 'I' and 'j' which contains similar finger orientations differ in movement of entire hand as shown in figure 1, so a combination of 3 axis accelerometer and gyroscope is used to decipher the movement of entire hand in 3 dimensional space. The glove can be worn by any user and is hands-free where user have just to wear the smart glove and it will be ready to use.

### 3.1.1 FLEX SENSORS

The Flex Sensor (Fig 3.1) is a patented technology based on resistive carbon elements. Flex sensors are the variable printed resistor which achieves great form-factor on a thin flexible substrate. When the substrate is bent, the sensor produces a resistance output correlated to the bend radius. The smaller the radius, the higher the resistance value.

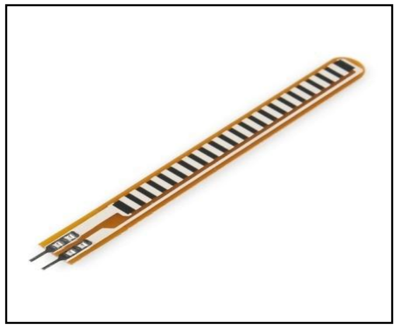


**Figure 3.1 :** Flex Sensor

The black strip is a thin layer of carbon/graphite (for flexibility). The light gray patterned material is a segmented metal electrode. Deformation of the flex apparently increases or decreases the amount of metal in contact with the carbon.

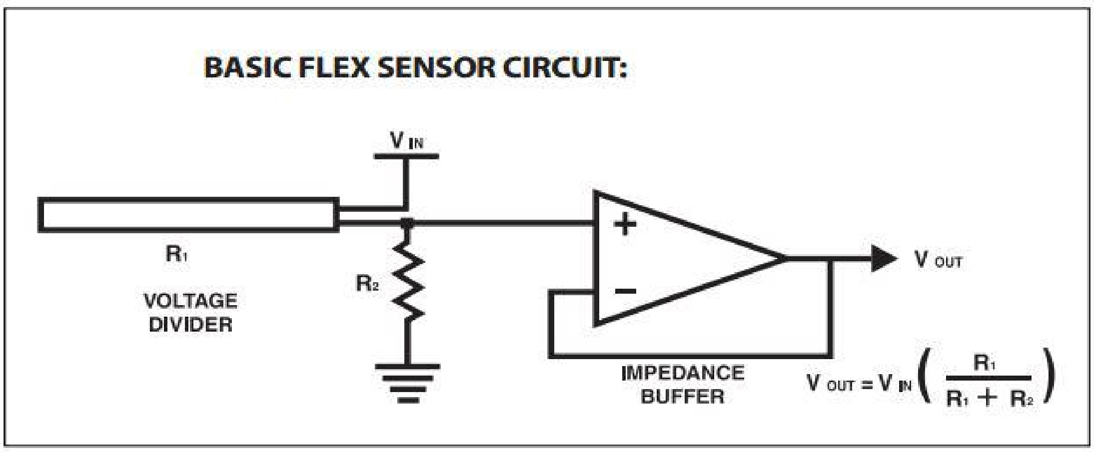



**Figure 3.2:** Flex Sensor Circuit

The Basic Flex Sensor Circuit consists of an Impedance Buffer which is a single sided op-amp. These sensors are used with the impedance buffer because the low bias current of the operational amplifier reduces the error. This is so because the flex sensor acts as voltage divider circuit.

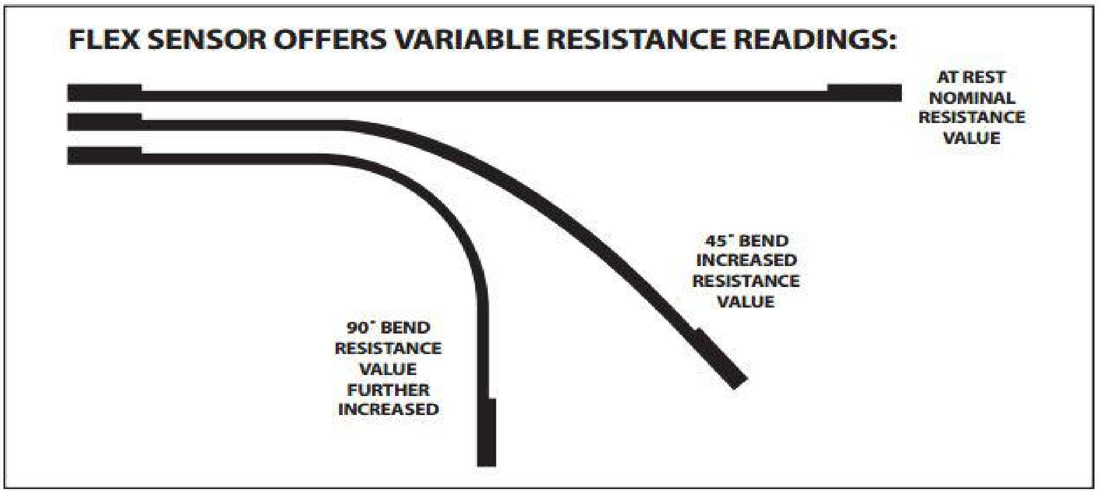



**Figure 3.3:** Variable Resistance Offered By Flex Sensors

**Specifications**

| Parameter | Value |
|---|---|
| Life cycle | >1 million |
| Height | <0.43mm |
| Temperature range | -35C to +80C |

**Figure 3.4:** Specifications of Flex sensor

### 3.1.2 SENSORY GLOVES

A wired glove (also called a "data glove" or "cyber glove") is an input device for human to computer interaction worn like a glove.

Various sensor technologies are used to capture physical data such as bending of fingers. Often a motion tracker, such as a magnetic tracking device or inertial tracking device, is attached to capture the global position/rotation data of the glove. These movements are then interpreted by the software that accompanies the glove, so any one movement can mean any number of things. Gestures can then be categorized into useful information, such as to recognize sign language or other symbolic functions. Expensive high-end wired gloves can also provide haptic feedback, which is a simulation of the sense of touch. This allows a wired glove to also be used as an output

device. Traditionally, wired gloves have only been available at a huge cost, with the finger bend sensors and the tracking device having to be bought separately.
Wired gloves are often used in virtual reality environments.

### 3.1.3 ACCELEROMETER

One of the most common inertial sensors is the **accelerometer.** It is a dynamic sensor capable of a vast range of sensing. There are accelerometers which can measure acceleration in one, two, or three orthogonal axes. They are typically used in one of three modes:

- As an inertial measurement of velocity and position
- As a sensor of inclination, tilt, or orientation in 2 or 3 dimensions
- As a vibration or impact (shock) sensor.

#### [*A*] Principles of Operation

Most accelerometers are Micro-Electro-Mechanical Sensors (MEMS). The basic principle of operation behind the MEMS accelerometer is the displacement of a small proof mass etched into the silicon surface of the integrated circuit and suspended by small beams. Consistent with Newton's second law of motion (**F = ma**), as an acceleration is applied to the device, a force develops which displaces the mass. The support beams act as a spring, and the fluid (usually air) trapped inside the IC acts as a damper, resulting in a second order lumped physical system. This is the source of the limited operational bandwidth and non-uniform frequency response of accelerometers.

#### [*B*] Types of Accelerometer

There are several different principles upon which an analog accelerometer can be built. Two very common types utilize capacitive sensing and the piezoelectric effect to sense the displacement of the proof mass proportional to the applied acceleration.

##### *I. Capacitive*

Capacitive sensing accelerometers outputs a voltage dependent on the distance between two planar surfaces. The plates are charged with an electrical current. Changing the gap between the plates changes the electrical capacity of the system, which can be measured as a voltage output. This method of sensing is known for its high accuracy and stability. Capacitive accelerometers are also less prone to noise and variation with temperature, typically dissipate less power, and can have larger bandwidths due to internal feedback circuitry.

**II. Piezoelectric**

Piezoelectric sensing of acceleration is natural, as acceleration is directly proportional to force. When certain types of crystal are compressed, charges of opposite polarity accumulate on opposite sides of the crystal. This is known as the piezoelectric effect. In a piezoelectric accelerometer, charge accumulates on the crystal and is translated and amplified into either an output current or voltage.

### 3.1.4 GYROSCOPE

A gyro sensor, angular rate sensor or angular velocity sensor is a device that can sense angular velocity. Gyro sensors can sense rotational motion and changes in orientation and therefore augment motion. Vibration gyro sensors can sense angular velocity due to the Coriolis force which is applied to a vibrating element. This motion produces a potential difference from which angular velocity is sensed. The angular velocity is converted into an electrical signal output.

There are several different kinds of gyro sensors. At Future Electronics we stock many of the most common types categorized by output type, supply voltage, supply current, sensing range, operating temperature range and packaging type. The parametric filters on our website can help refine your search results depending on the required specifications.

The most common sizes for supply voltage are 2.7 to 3.6 V. We also carry gyro sensors with supply voltage up to 5 V. The output type can be analog, digital, linear or ratio metric, with the most common chips having an analog output.

### 3.1.5 MICROCONTROLLER (Arduino Nano)

This bread-board friendly microcontroller is small and complete and is based on the ATmega328 or ATmega168. The functionality displayed by this microcontroller board shows resemblance to Arduino Duemilanove, but of courese in a different package.A DC power jack is missing from this board. A Mini-B USB cable is required for its proper working.

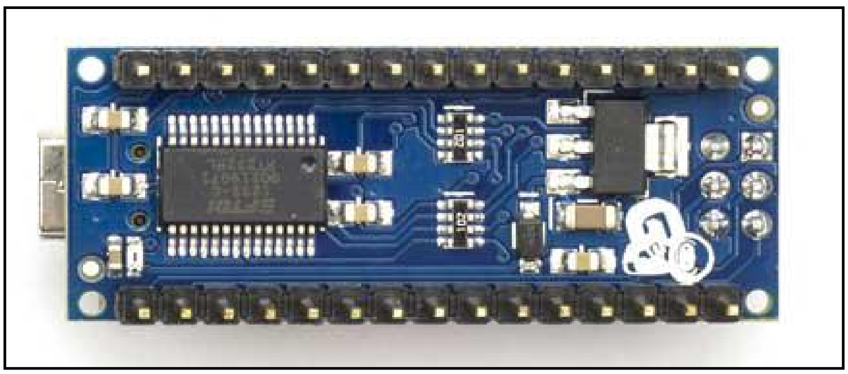


**Figure 3.5:** Arduino Nano Front

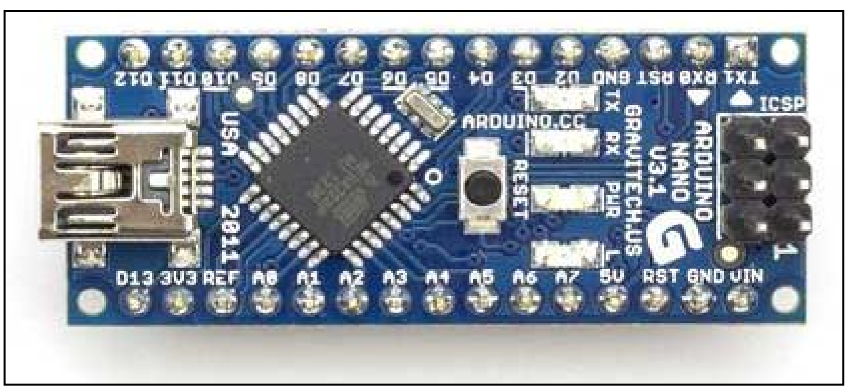



**Figure 3.6:** Arduino Nano Rear

**[*A*] Specifications:**

**Table 3.1:** Specifications of Arduino Nano

| | |
|---|---|
| Microcontroller | Atmel ATmega168 or ATmega328 |
| Operating Voltage (logic level) | 5 V |
| Input Voltage (recommended) | 7-12 V |
| Input Voltage (limits) | 6-20 V |
| Digital I/O Pins | 14 (of which 6 provide PWM output) |
| Analog Input Pins | 8 |
| DC Current per I/O Pin | 40 Ma |
| Flash Memory | 16 KB (ATmega168) or 32 KB (ATmega328) of which 2 KB used by bootloader |
| SRAM | 1 KB (ATmega168) or 2 KB (ATmega328) |
| EEPROM | 512 bytes (ATmega168) or 1 KB (ATmega328) |
| Clock Speed | 16 MHz |

**[*B*] Power Consumption**

The Arduino Nano can be powered via the Mini-B USB connection, 6-20V unregulated external power supply (pin 30), or 5V regulated external power supply (pin 27). The power source is automatically selected to the highest voltage source.

**[*C*] Input And Output**

Using pinMode(), digitalWrite(), and digitalRead() functions, each of the 14 digital pins on the Nano can be used as an input or output. They operate at 5 volts and each pin can provide or receive a maximum of 40 mA. It has an internal pull-up resistor (disconnected by default) of 20-50 kOhms.

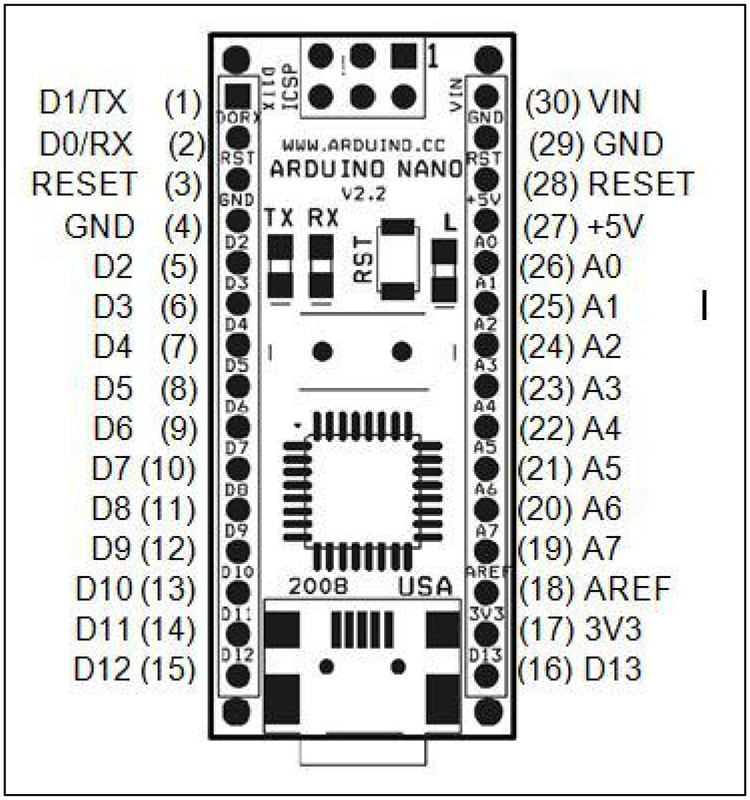



**Figure 3.7**: Pin diagram of Arduino Nano

**Some pins have specialized functions as given below:**

I. **Serial**: 0 (RX) and 1 (TX) pins are used to receive (RX) and transmit (TX) TTL serial data. These pins are connected to the corresponding pins of the FTDI USB-to-TTL Serial chip.

II. **External Interrupts**: Pin number 2 and 3 can be configured to trigger an interrupt on a low value, a rising or falling edge, or a change in value by using attachInterrupt() function.

III. **PWM**: Pin number 3, 5, 6, 9, 10, and 11 provides 8-bit PWM output with the analogWrite() function.

IV. **SPI**: 10 (SS), 11 (MOSI), 12 (MISO), 13 (SCK) pins support SPI communication.

V. **LED:** There is a built-in LED connected to digital pin 13. When the pin is HIGH value, the LED is on. When the pin is LOW, it's off.

VI. **Pins:** The Nano has 8 analog input. Each pin provides 10 bits of resolution (i.e. 1024 different values). By default they measure from ground to 5 volts. But it is also possible to change the upper end of their range using the analogReference() function. Analog pins 6 and 7 cannot be used as digital pins.

VII. **I²C:** A4 (SDA) and A5 (SCL). Support I²C (TWI) communication using the Wire library (documentation on the Wiring website).

There are a couple of other pins on the board:

I. **AREF**. Reference voltage for the analog inputs. Used with analogReference().

II. **Reset:** Bring this line LOW to reset the microcontroller.

**[*D*] Communication**

The Arduino Nano has a various communication facility available which enables it to communicate with other devices which includes different microcontrollers like Pi, Arduino and even computers for that matter.
The ATmega328 and ATmega168 facilitates 5 volts UART TTL serial communication, this facility can be availed via digital pins namely 0 (Receiver) and 1 (Transmitter). An FTDI FT232RL present on the microcontroller board directs this serial communication via Universal Serial Bus and the FTDI drivers which often comes along with the microcontroller package, provides a virtual communication port to other software present on the computer. The Microcontroller software even includes a serial monitor which is quite necessary for text data to be transferred to and from the Arduino board. The Receiver (RX) and Transmitter (TX) LEDs on the board will blink indicating that data transmission is in the process.

**Table** 3.2: Optimum Hardware Specification

| HARDWARE SPECIFICATIONS | |
|---|---|
| Controller | Arduino Nano |
| Flex sensors | Flex Sensor 2.2" |
| 3 axis accelerometer + gyroscope | Mpu-6050 3-axis Accelerometer And 3-axis Gyroscope |
| Text to speech module | Text-to-Speech Module - Emic 2 |
| Display unit | 16x2 Character LCD Display Module -HD44780 Controller |

## 3.2 PHYSICAL DESIGN

The hardware consists of a woollen hand glove of universal size, which consists of a 9 volt battery which can power the glove for 2 days, where all the sensors are put over the glove, the flex sensors are placed on each finger with accelerometer on the back of the palm along with the central processor Arduino. The green chip shown is Arduino nano, the microcontroller, red chip is the accelerometer, and 5 strips shown are the flex sensors, with the text to speech.

The red wires and black wires shows the high voltage wire and ground respectively, blue wires are used for the analog inputs from each flex sensor and green wires are used to get analog input from accelerometer.

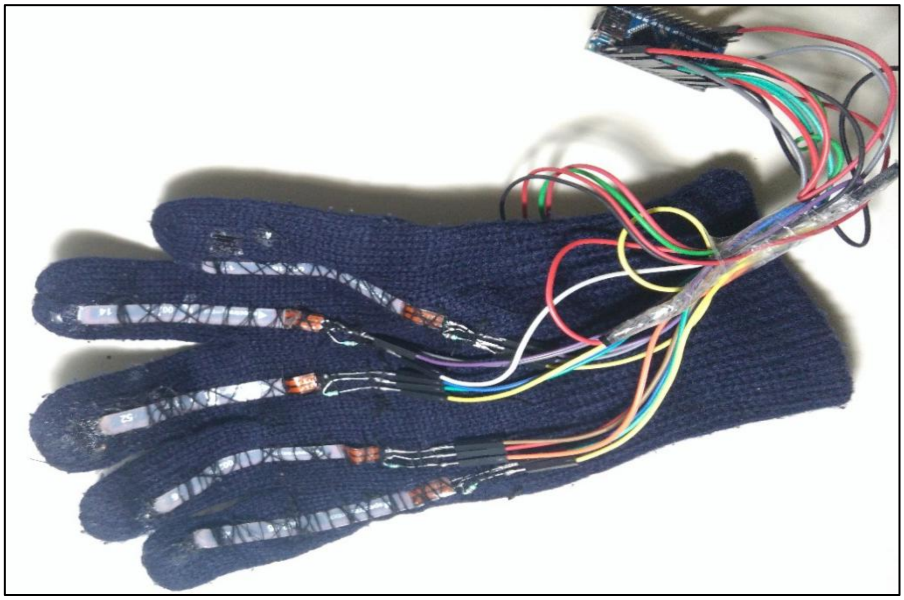


**Figure 3.8:** Front View of the smart Glove

**Figure 3.9:** Rear View of the smart Glove

## 3.3 GESTURE RECOGNITION AND RECOGNITON ALGORITHM

The gesture control works on the basis of five 2.2 inches flex sensors that are fixed within the glove, one on each finger. The flex sensor having a resistive strip gives analog readings. The resistance of the flex starts differ and it varies as and according to the bent on the flex strip. It indicates the angle bent at the flex sensor by output which is a variable analog resistive input to the microcontroller. To differentiate between different letters with same finger positions combination of 3axis accelerometer and gyroscope is used to decode the movement and orientation of whole hand, the flow in which sensors readings are taken into account is:

1. Readings from 3 axis accelerometer and gyroscope
2. The consecutive readings from all five flex sensors

Each gesture is decoded by comparing the readings from the pre-defined gesture database, and the letter is appended into a string and to complete the word a special gesture mutually exclusive form the ASL is chosen, as a fully open palm, to finish off the appending process and complete the word and finish the decoding portion.

The algorithm flowchart as shown in Figure 3.10 constantly is polling the readings from flex sensors and accelerometer, those readings and the signals are passed to the controller Arduino which process that information comparing it with the ASL structure guide and also by analyzing the readings from accelerometer to differentiate between similar finger gesture letters.

As soon as the end gesture, an open palm, written as the flag in the flow chart, is performed letter appending to the continuing string ends and the full word is passed onto the display unit and to the text to speech module afterward.

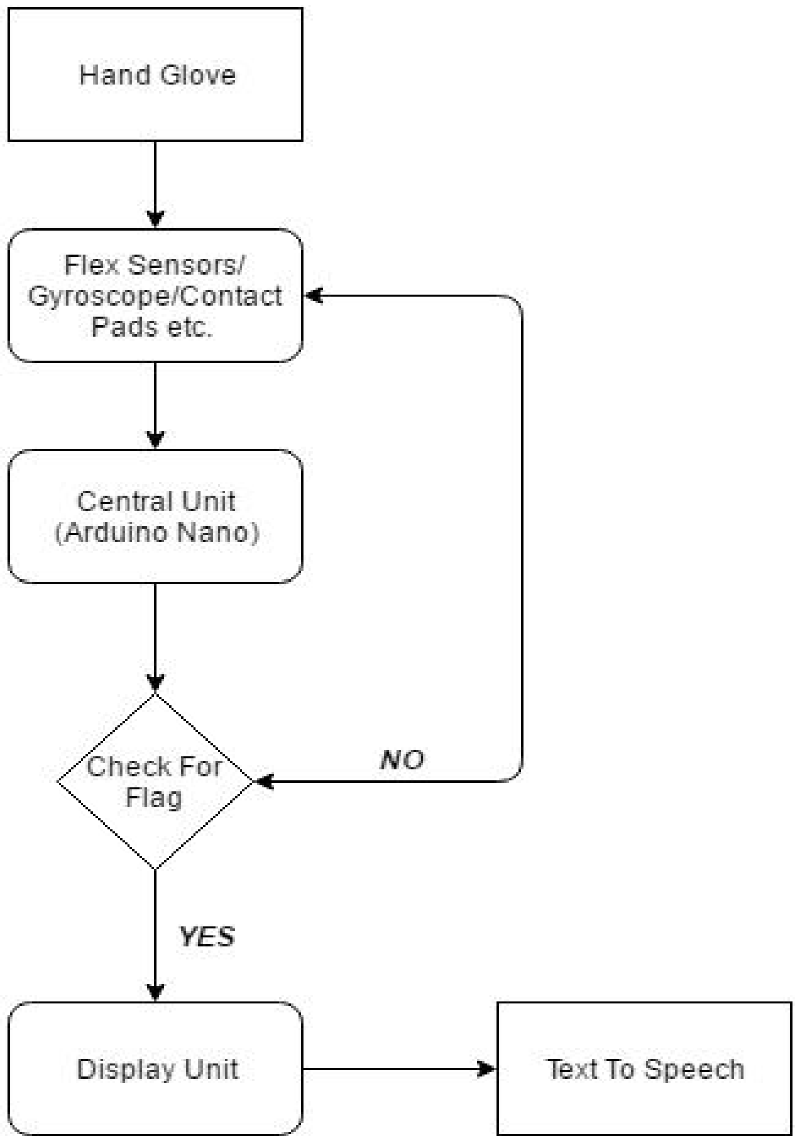



**Figure 3.10:** Flow chart of smart glove

# CHAPTER 4

# ALGORITHM AND CODE

## 4.1 ALGORITHM

1. A gesture is made by the user.

2. The flex sensor takes the analog reading. Other sensors like gyroscope and accelerometer take their respective readings.

3. These analog values are fed into the Micro-controller.

4. The code first divides these analog value range into quantized blocks, based on the requirements and these blocks span over a range of values.

5. A reference code section uses the quantized code blocks to give output if a particular combination of values is available (conditional).

6. The output is then appended and sent to out screen.

7. Two extra flags are coded in for removing an appended letter and for clearing the scree completely.

8. Option of displaying the readings of various sensors is also available in order to understand the working and as an assistance in debugging.

## CODE

```
#include "I2Cdev.h"
#include "MPU6050.h"
#if I2CDEV_IMPLEMENTATION == I2CDEV_ARDUINO_WIRE
#include "Wire.h"
#endif

MPU6050 accelgyro;
```

```
int16_t ax, ay, az;
int16_t gx, gy, gz;
int d1=12,d2=11,d3=10,d4=9;
int b1=0,b2=0,b3=0,b4=0;
int high =  13;

#define OUTPUT_READABLE_ACCELGYRO

String out="";
String oo="";
int i = 0;
int f1,f2,f3,f4;
// the setup routine runs once when you press reset:
void setup()
{
     #if I2CDEV_IMPLEMENTATION == I2CDEV_ARDUINO_WIRE
        Wire.begin();
    #elif I2CDEV_IMPLEMENTATION == I2CDEV_BUILTIN_FASTWIRE
        Fastwire::setup(400, true);
    #endif
    Serial.begin(9600);
    accelgyro.initialize();

      pinMode(high, OUTPUT);
    digitalWrite(high, HIGH);
      pinMode(d1, INPUT);
      pinMode(d2, INPUT);
      pinMode(d3, INPUT);
      pinMode(d4, OUTPUT);
    digitalWrite(d4, LOW);


}

String check()
{
 accelgyro.getMotion6(&ax, &ay , &az, &gx, &gy, &gz);
```

```
i=0, f1=0, f2=0 ,f3=0 ,f4=0;
if(az<0 && ax>14000&& ay<4000)
{
i=0;
}
else if(ay>4000 && ax<14000 && az <5000)
{i=1;}
else if(az>5000 && ax<5000)
{i=2;}
      int a = analogRead(A0);int y = map(a, 0, 1023, 0, 102300);
      int a1 = analogRead(A1);int y1= map(a1, 0, 1023, 0, 102300);
      int a2 = analogRead(A2);int y2 = map(a2, 0, 1023, 0,
102300);
      int a3 = analogRead(A3);int y3 = map(a3, 0, 1023, 0,
102300);
      int a4 = analogRead(A6);int y4 = map(a4, 0, 1023, 0,
102300);
  // print out the value you read:
      // delay in between reads for stability

//---------------------------readsense---------------------------
---
    if(y>1100) // straight
    f1=1;
    else if(y<400)  //full bent
    f1=3;
    else   //half bent
    f1=2;

    if(y1>200)
    f2=1;
    else
    f2=2;

    if(y2>1400)
    f3=1;
    else if(y2<400)
    f3=3;
    else
    f3=2;
```

```
     if(y3>2500)
     f4=1;
     else
    f4=2;

//----------------------------read sense---------------------------------------
if(b1+b2+b3>0)
{

   if(b2==HIGH && b3==LOW)
     out = "n";

   if(b3==HIGH && b2==LOW)
   out = "m";

   if(y<800 && i==0 && b2==HIGH && b3==HIGH)
   out = "e";

   if(y>800  && i==0 && b2==HIGH && b3==HIGH)
   out = "x";

   if(y>1200 && f3!=1 && f4!=1 && y4>600 && y4<1500 && i==0 && b1==
   HIGH && b2!=HIGH && b3!=HIGH)
   out = "r";

   if( y<500 && f2==2 && f3!=1 && f4!=1 &&   y4<1000  && i==0 && b1==
   HIGH && b2==LOW && b3==LOW)
   out = "o";

}
else
{
  if(f1==3 && f2!=1 && f3==3 && f4==2 && y4>1400 && i==0)
  out = "a";
  if(f1==1 && f2==1 && f3==1 && f4==1 && y4 < 1000 && i==0)
```

```
  out = "b";
  if(((f1==2 && f2!=1 && f3==2 && f4==2) || ((f1+f2+f3==7 ||
f1+f2+f3==6) && f4==2 && f1!=1 && f2!=1) ) &&   y4>1300  && i==0
&&
b1== LOW)
  out = "c";
  if(f1==1 && f2!=1 && f3 !=1 && f4==2 && y4<2000 && i==0)
  out = "d";
  if(f1!=1 && f2==1 && f3!=3 && f4==1  && y4>2000 && i==0)
  out = "f";
  if(f1==1 && f2!=1 && f3!=1 && f4==2 && i==1)
  out = "g";
  if(f1!=3 && f2==1 && f3!=1 && f4==2 && i==1)
  out = "h";
  if(f1!=1 && f2!=1 && f3!=1 && f4==1 &&  y4<1500 && i==0 )
  out = "i";
  if(f1!=1 && f2!=1 && f3!=1 && f4==1 && y4<1500 && i==1)
  out = "j";
  if(f1==1 && f2==1 && f3!=1 && f4==2 && y4>1500 && i==0)
  out = "k";
  if(f1==1 && f2!=1 && f3!=1 && f4==2 && y4>1800 && i==0)
  out = "l";
  if(f1==1 && f2==1 && f3!=1 && f4!=1  && i==2)
  out += "p";
  if(f1==1 && f2!=1 && f3!=1 && f4!=1 && y4>1000 && y4<3000 &&
i==2)
  out += "q";
  if(y<400 && f2!=1 && f3!=1 && f4!=1 &&   y4<1400  && i==0)
  out = "s";
  if(y>400 && y<1000 && f2!=1 && f3!=1 && f4!=1 &&   y4<1400  &&
i==0)
  out = "t";
  if(f1==1 && f2==2 && f3!=1 && f4==1 && y4>600 && y4<1500 && i==0)
  out += "u";
  if(f1==1 && f2==1 && f3!=1 && f4!=1 && y4>600 && y4<1500 && i==0)
  out = "v";
  if(f1==1 && f2==1 && f3==1 && f4!=1 && y4>400 && y4<1500 && i==0)
  out = "w";
  if(f1!=1 && f2!=1 && f3!=1 && f4==1 && y4>1500 && i==0)
```

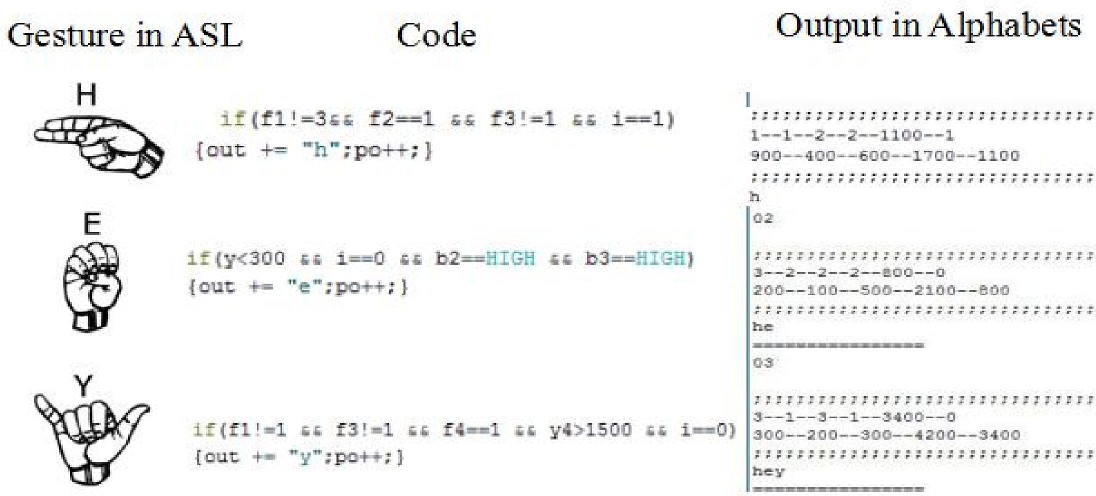
```
  out = "y";
  if(f1==1 && f2==1 && f3!=1 && f4==1 && y4>500 && i==0)
  out = "z";
  if(f1==1 && f2==1 && f3==1 && f4==1 && y4>1500)
  out = "";
 }
   //Serial.print(i);
     Serial.println("\t");
   Serial.println(";;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;");
   Serial.print(f1);
   Serial.print("--");
   Serial.print(f2);
   Serial.print("--");
   Serial.print(f3);
   Serial.print("--");
   Serial.print(f4);
   Serial.print("--");
   Serial.println(y4);
   Serial.print(y);
   Serial.print("--");
   Serial.print(y1);
   Serial.print("--");
   Serial.print(y2);
   Serial.print("--");
   Serial.print(y3);
   Serial.print("--");
   Serial.println(y4);
   Serial.println(";;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;");

/*   Serial.print("a/g:\t");
        Serial.print(ax); Serial.print("\t");
        Serial.print(ay); Serial.print("\t");
        Serial.print(az); Serial.print("\t");
        Serial.print(gx); Serial.print("\t");
        Serial.print(gy); Serial.print("\t");
        Serial.println(gz);
*/
```

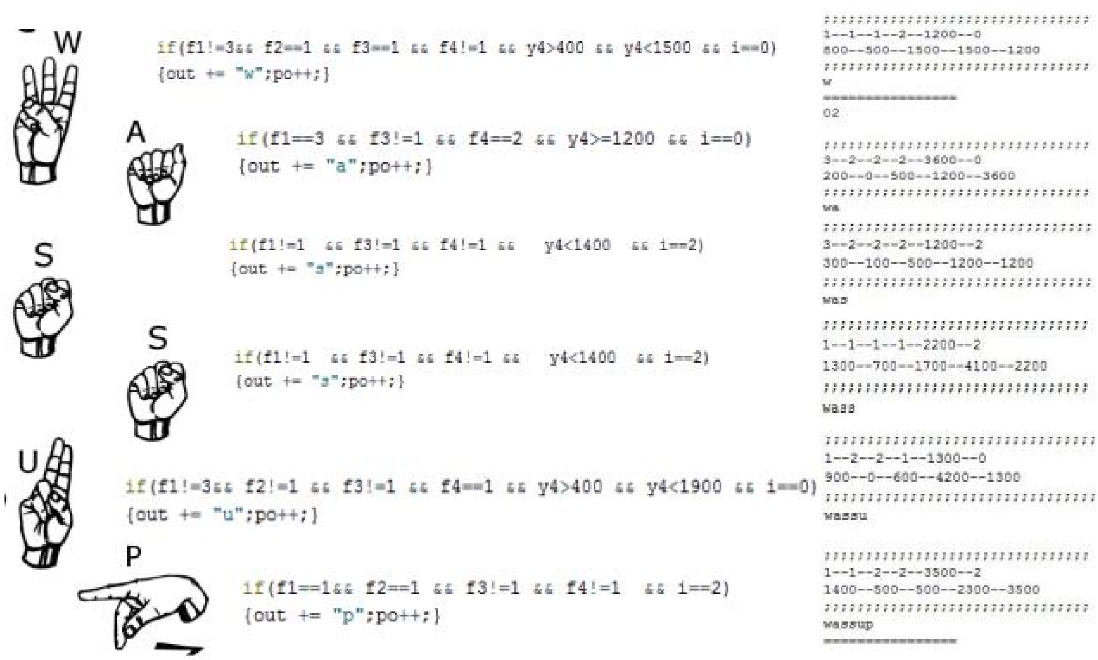
```
    return out;
}
// the loop routine runs over and over again forever:
void loop() {
  b1 = digitalRead(d1);
    b2 = digitalRead(d2);
      b3 = digitalRead(d3);

  String o1=check();
  delay(200);
  Serial.println("================");
  //Serial.print(b1);Serial.print(b2);Serial.println(b3);
  //Serial.println("================");
  Serial.println(o1);
  Serial.println("================");
  out="";
  if(b2==HIGH &&b3==HIGH)
  {
   delay(2000);
  }
  else{
  if(b1+b2+b3<2)
  delay(2000);
  else
  delay(1);
  }
```

# CHAPTER 5

# RESULTS

After implementation of the project the result can be seen on the computer screen. Given below are various gestures along with their respective code and how they are implemented on the result screen.



# CHAPTER 6

# CONCLUSION AND FUTURE SCOPE

Sign language helps in communication between the deaf and mute communities and normal society. To communicate through sign language the target person must have an idea of the sign. With this project, specially abled communities can use the gloves to form gestures according to sign language and then these sign gestures will be converted to text.

## 6.1 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. Our aim is to design a more reliable, user independent and portable system which consumes less power because of low ultra-power microcontroller which will help to overcome the limited communication between dumb people and rest of the world. A full-fledged system for communication between the deaf/dumb and normal people is developed. Simply by monitoring the hand movements, the respective data fed to the microcontroller is compared and the designated output is displayed. LCD serves the purpose of displaying. From this system we have achieved communication with the help of finger gestures. It exhibits a fluent communication mode between normal and deaf/dumb people. The gesture glove prototype is used for such purpose and experimented successfully.

## 6.2 FUTURE SCOPE

For deaf people or those with significant hearing loss, these gloves offer hope against the locked-in feeling that the community can experience due to the low numbers of signers in the general population. Perhaps one day, a glove like this could be part of a universal translator, which is something that will continue to be pursued as mobile computing, speech recognition, and translation advance.

While this smart glove is initially targeting the deaf community, the smart glove technology that they are developing has a much broader market, one that is embracing the very real prospect of wearable computing. The same hardware in the glove could easily be adapted to make keyboard commands faster or even be used as an alternative to a mouse, just as the Leap Motion is aiming to do through a completely different approach. In fact, touch computing has eliminated the mouse on mobile devices and speech recognition like Siri and Evi could eliminate the need for a keyboard. And of course, one of the most recognizable uses of a smart glove is to interact with a graphic interface as shown in the movie Minority Report.

In other words, smart gloves are poised to be a big part of the future of computing, so our work has the potential to have a much broader impact in the marketplace even if they started the project with a much more philanthropic motive.

For some the notion of using your hands to speak may seem odd, but considering how often we communicate through emails, chats, tweets, blogs, and articles without a single vocalization, those of us who can verbally communicate are in a better position than ever to celebrate our efforts alongside those look forward to the technology hitting the shelves.

# REFERENCES


[1] Sign Language Structure:An Outline of the Visual CommunicationSystems of the American Deaf by William C. Stokoe, Jr.Gallaudet University.

[2] American Sign Language: Roots and History - Geoffrey Poor.

[3] http://www.chs.ca/challenges-affecting-deaf-and-interpreter-communities.

[4]"Computer technology education and the deaf student: observations of serious nuances of communication" by Curtis Robbins, Gallaudet University published in 1996.

[5]"The Academic Status of Sign Language Programs in Institutions of Higher Education in the United States" by Sheryl B. Cooper.

[6]A Sign-to-Speech Glove a paper by Olga Katzenelson, Solange Karsenty, Hadassah Academic College HaNeviim 37, Jerusalem, Israel.

[7] Prakash B Gaikwad, Dr. V.K. Bairagi,"Hand Gesture Recognition for Dumb People using Indian Sign Language", International Journal of Advanced Research in Computer Science and Software Engineering, Volume 4, Issue 12, December 2014.

[8]'Sign language converter" by Taner Arsan and Oğuz Ülgen Department of Computer Engineering, Kadir Has University, Istanbul, Turkey.

[9] EnableTalk: http://enabletalk.com.

[10]https://www.wearable-technologies.com/2016/05/amazing-sign-language-can-now-be-spoken-by-the-latest-wearables.

[11] http://www.ndtv.com/bangalore-news/smart-glove-for-speech-impaired-developed-by-b-tech-students.

# PUBLICATION

Parth Sethi, Rubal Sharma, Divyanshu Raghuvanshi, Meenakshi Sood (2017). Sign Language Analysis and Recognition to Aid Specially Abled Communicators. Proceedings of the International Conference on Computing for Sustainable Global Development, BVICAM, . [4th : New Delhi : 1-3 March, 2017]

Proceedings of the 11thINDIACom; INDIACom-2017; IEEE Conference ID: 40353
2017 4th International Conference on "Computing for Sustainable Global Development", 01st - 03rd March, 2017
BharatiVidyapeeth's Institute of Computer Applications and Management (BVICAM), New Delhi (INDIA)

# Sign language analysis and recognition to aid specially abled communicators

Parth Sethi[1], Rubal Sharma[1],Divyanshu Raghuvanshi[1], Meenakshi Sood[2]
1 Students, 2 Faculty, Department of Electronics and Communication Engineering
Jaypee University of Information Technology Waknaghat, Solan, Himachal Pradesh
parthsethi16.ps@gmail.com , rubalsharma1202@gmail.com , divyanshu.25r@gmail.com, meenakshi.sood@juit.ac.in

***Abstract***— the paper presents development of a hand glove to provide a common tongue i.e. verbal communication to those who can't speak using Arduino microcontroller which is named as "Gesture Glove". The research goal of gesture glove is to develop an interdependent glove for those special communicators in the event they have to communicate with general population who might not be aware of their sign language semantics. The advantages of automaticity of this project are that it is a hand-held user interdependent device, it uses flex sensors to detect movement of figures and 3 axis accelerometer and gyroscope to decode movement of the hand. The device is programmed in such a way that it recognizes defined gestures which are pre saved in the data base in accordance to American Sign Language. In view of this, aforementioned system is a source of developing a product which is affordable and easy to be used for such people who are specially abled, which helps in lessening the communication gap between specially abled and general population. We aim to develop a glove to be worn on the right hand that uses a specially designed algorithm to translate sign language into spoken English.

***Keywords-Smartware; gesture recognition; Robotic assistanc ; sign language.***

## I. INTRODUCTION

Human is a social being, since the starting of time various methods to communicate and convey their ideas, thoughts, and experiences has been through verbal and non-verbal modes of communication. Most humans are capable to interact with each other through verbal communication methods or speech with the help of different languages developed across time. Though, all humans are not gifted equally to communicate with the aforementioned technique. These specially abled communicators who lack the ability to hear and speak are more commonly referred as deaf and dumb respectively by the society. These specially abled communicators interact with the help of 'sign language'.

Sign Language is defined as a manual communication method to interact, as opposed to traditional speech. This method involves simultaneous movements and orientation of hands, arms or body. Sign languages have similar traits as spoken languages, hence speech and sign languages are both considered to be ***natural languages***. Sign language exploit the features of visual sight and different physical gestures, whereas spoken languages convey the idea/meaning acoustically.

Although sign languages are used by both people who can talk or are unable to speak naturally, these languages have emerged naturally in deaf communities with different grammatical structures.

There are various sign languages around the world, each country has developed its own native sign language and multilinguistic countries like India have developed multiple sign languages corresponding to major prevalent languages with substantial similarities in them. This method borrows various elements from spoken languages but it does not have to depend on the spoken language in the region. Of all the prevalent sign language systems areFrench Sign Language family, American Sign Language (ASL) cluster, Russian Sign Language cluster, Czech Sign Language cluster, Danish Sign Language family, Swedish Sign Language family, German Sign Language family, Vietnamese sign languages & some Thai and

So we propose a design of a simpleautonomous smart glove that bridges the gap between spoken and sign languages. Of all the different systems we have chosen the American Sign Language (ASL), which is

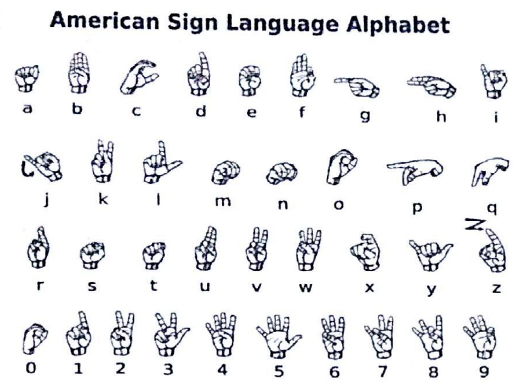



Fig 1. American Sign Language Gestures.

shown in figure 1, as the basis of functioning of this device. Thissmart glove has sufficient sensors such as flex sensors and accelerometer to decipher the gestures as defined in the ASL to the spoken language.

The rest of the paper is organized as follows. Section 2 discusses the related work in this field. Section 3 describes the design concept and the proposed system followed by the algorithm adopted with physical structure.

## II. Related Work

Researchers have been proposing various techniques to bridge the gap between the specially abled and the common masses. There has been a lot of work done in this area such as:

### A. *Signaloud*

A pair of entrepreneurial technology students named Thomas Pryor and NavidAzodi in the US has designed a pair of gloves called SIGNALOUD to break down the communication barriers by translating hand gestures into speech. The gloves uses embedded sensors to monitor the position and movement of the user's hands, while a central computer analyses the data and converts gesture into speech. The glove transmits the captured data of the positioning and movements of user's hand via Bluetooth to a computer which analyses the movements and checks them against a library of gestures. If a hand gesture matches then the appropriate sound is spoken through the speakers by the computerized voice.

### B. *EnableTalk*

A team of Ukrainian inventors have developed a hi-tech glove capable of converting sign language into speech using a mobile device to translate the handgestures. It even allows users to create and program their own signs, which the app will then recognize. EnableTalk is still in a prototype stage but has won many awards such as Microsoft Imagine Cup in 2012 in Australia.

### C. *VerbaVoice*

The VerbaVoiceweb player app enables hearing impaired people to attend events via live text and sign language stream. The sound is sent to a speech-to-text reporter or sign language interpreter online who transfers it into live text or sign language video. German authorities has accepted VerbaVoice as a communication aid doing their best in giving voice to deaf-mute society.

### D. *ABJAD*

ABJAD is a product that bridges the communication gap between deaf mute people and normal people. It is primarily a wearable digital glove with English alphabets on it enabling deafmute people to communicate without the prior knowledge of sign language from both communicators.

### E. *MUDRA*

Bengaluru students of engineering college has developed a smart glove called MUDRA which works on Indian sign language. It converts the hand gestures into spoken English, recognizing the hand gestures in all possible directions and angles using flex resistors, accelerometer and gyroscope. Currently it is capable of recognizing numbers from 1 to 10 and about 70 Indian sign language gestures.

## III. Proposed System

As mentioned above, there is a lot of research going in smart wearable's to help the needy to feel connected with the common population which uses different methods to interact. And as observed, most of the general population is unaware or have no knowledge of the special mode of communication such as sign languages where different gestures have different meanings.

So we propose a system that can help those special communicators to interact with everyone with help of an autonomous smart glove that anyone can wear and moving hands to make different gesture according to ASL the sensors over the glove decodes the gesture and converts that message to a string that is displayed over LCD and then is sent to text to speech unit.

There are five flex sensors (2.2 inches) put on every finger so as to get the angle bent by each user's finger. Every letter in English language has different orientation of finger which can be decoded easily but letters such as 'I' and 'j' which contains similar finger orientations differ in movement of entire hand as shown in figure 1, so a combination of 3 axis accelerometer and gyroscope is used to decipher the movement of entire hand in 3 dimensional space. The glove can be worn by any user and is hands-free where user have just to wear the smart glove and it will be ready to use.

The complete system constitutes to following components:

- Central controller
- Hand glove
- 3 axis sensor module
- Display unit
- Text to speech unit

Table 1: Illustrates the hardware specifications of Safe Sole

| HARDWARE SPECIFICATIONS | |
|---|---|
| Controller | Arduino |
| Flex sensors | Flex Sensor 2.2" |
| 3 axis accelerometer + gyroscope | Mpu-6050 3-axis Accelerometer And 3-axis Gyroscope |
| Text to speech module | Text-to-Speech Module - Emic 2 |
| Display unit | 16x2 Character LCD Display Module -HD44780 Controller |

*A. Gesture Recongnition*

The gesture control works on the basis of five 2.2 inches flex sensors that are fixed within the glove, one on each finger. The flex sensor has a Resistive strip which gives analog readings. The resistance varies as the flex strip is folded to indicate the angle bent at the flex sensor by giving the variable analog resistive input to the microcontroller.And to differentiate between different letters with same finger positions combination of 3axis accelerometer and gyroscope is used to decode the movement and orientation of whole hand, the flow in which sensors readings are taken into account is:

1. Readings from 3 axis accelerometer and gyroscope

2. The consecutive readings from all five flex sensors

Each gesture is decoded by comparing the readings from the pre-defined gesture database, and the letter is appended into a string and to complete the word a special gesture mutually exclusive form the ASL is chosen, as a fully open palm, to finish off the appending process and complete the word and finish the decoding portion.

*B. The Glove*

The hardware consists of a woolen hand glove of universal size, which consists of a 9 volt battery which can power the glove for 2 days, where all the sensors are put over the glove, the flex sensors are placed on each finger with accelerometer on the back of the palm along with the central processor Arduino.

Figure 2 shows the schematic of the glove where flex sensors are put over 5 fingers:

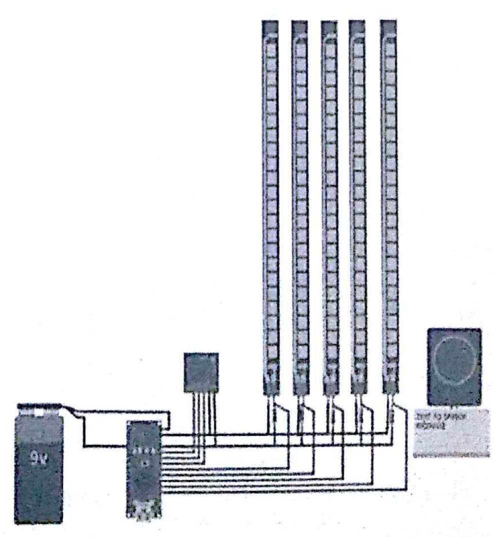



Figure 2 showing the schematic of glove

The green chip shown is Arduino nano, the microcontroller, red chip is the accelerometer, and 5 strips shown are the flex sensors, with the text to speech.
The red wires and black wires shows the high voltage wire and ground respectively, blue wires are used for the analog inputs from each flex sensor and green wires are used to get analog input from accelerometer.

### C. *Recogniton Algorithm*

The algorithm flowchart as shown in figure 3 constantly is polling the readings from flex sensors and accelerometer, those readings and the signals are passed to the controller Arduino which process that information comparing it with the ASL structure guide and also by analyzing the readings from accelerometer to differentiate between similar finger gesture letters.
As soon as the end gesture, an open palm, written as the flag in the flow chart, is performed letter appending to the continuing string ends and the full word is passed onto the display unit and to the text to speech module afterward.

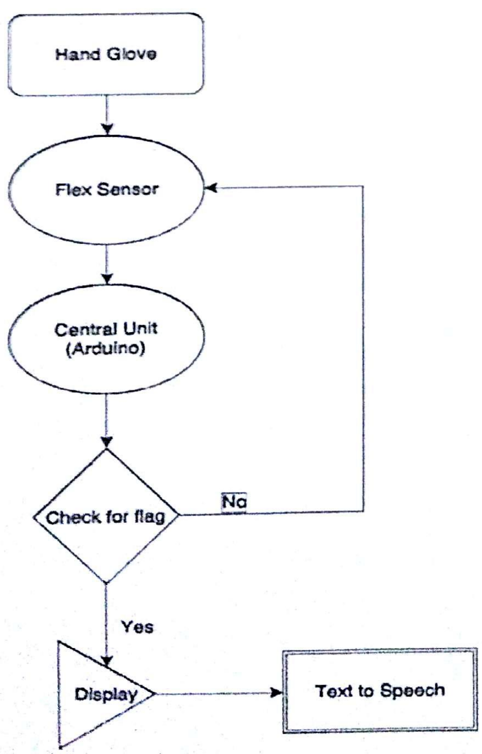



Figure 3 showing the flow chart of smart glove

## IV. RESULTS

This prototype version, the user forms a sign and holds it until the flag is sensed to ensure recognition of whole word correctly. The system is capable of recognizing signs quickly and the product can be adapted by any user with knowledge of ASL with very less time. Hence it is a low time consuming approach, furthermore real time recognition proportion of nearly 99% is achieved.

## CONCLUSION

A full-fledged system for communication between the deaf/dumb and normal people is developed. Simply by monitoring the hand movements, the respective data fed to the microcontroller is compared and the designated output is displayed. LCD serves the purpose of displaying. From this system we have achieved communication with the help of finger gestures. It exhibits a fluent communication mode between normal and deaf/dumb people. The gesture glove prototype is used for such purpose and experimented successfully.

## REFERENCES

[1] Priyanka Lokhande,Riya Prajapati,and Sandeep Pansare," Data Gloves for Sign Language Recognition System", S.P Pune University,National Conference on Emerging Trends in Advanced Communication Technologies (NCETACT-2015).

[2]Prakash B Gaikwad,Dr. V.K.Bairagi,''Hand Gesture Recognition for Dumb People using Indian Sign Language'',International Journal of Advanced Research in Computer Science and Software Engineering, Volume 4, Issue 12, December 2014.

[3] Kiratey Patil,Gayatri Pendharkar,and Prof. G.N.Gaikwad,"American Sign Language Detection'', International Journal of Scientific and Research Publications, Volume 4,Issue 11,November 2014.

[4] Carlos Pesqueira Fiel, Cesar Cota Castro, Victor Velarde Arvizu,Nun Pitalúa-Díaz, Diego Seuret Jiménez, and Ricardo Rodríguez Carvajal,"Design of Translator Glove for Deaf-Mute Alphabet",Universidad de Sonora Hermosillo, México,3rd International Conference on Electric and Electronics (EEIC 2013).

[5] https://www.wearable-technologies.com/2016/05/amazing-sign-language-can-now-be-spoken-by-the-latest-wearables

[6] http://www.ndtv.com/bangalore-news/smart-glove-for-speech-impaired-developed-by-b-tech-students.