# “SIGN LANGUAGE TO SPEECH CONVERSION SMART GLOVES USING IoT”

Third year B. Tech Mini Project

Submitted to

Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur in

Partial Fulfillment of the

Requirements for the degree of Bachelor of Technology in

Electronics and Telecommunications Engineering.

**by**


**Mrunal Sanjay Tarwatkar**

**Shriyansh Chandrashekhar Thote**

**Tushar Sanjay Vaidya**

Guide

**Dr. D. S. Chaudhari**

Professor and Head of Department

DEPARTMENT OF
ELECTRONICS AND TELECOMMUNICATIONS ENGINEERING

GOVERNMENT COLLEGE OF ENGINEERING


2023-24

**GOVERNMENT COLLEGE OF ENGINEERING NAGPUR**

**Department of Electronics and Telecommunication Engineering**

## CERTIFICATE

This is to certify that the Mini Project entitled "**SIGN LANGUAGE TO SPEECH CONVERSION SMART GLOVES USING IoT**", which is being submitted herewith for the award of Third Year B. Tech, is the result of the work completed by (1) Mrunal Sanjay Tarwatkar, (2) Shriyansh Chandrashekhar Thote, (3) Tushar Sanjay Vaidya.

**Dr. D.S. Chaudhari**

Professor and Head of Department

# CONTENTS

# 1. INTRODUCTION

According to estimates from the World Federation of the Deaf and the WHO, 70 million people are deaf and mute globally. 32 million of the 300 million individuals on the planet are deaf. The majority of people who have speech and hearing problems are illiterate in widely spoken languages. Deaf and mute people use sign language (SL), which is their natural speech, to communicate with others. In sign languages, gestures such as hand and finger movements and facial expressions are utilized to convey messages more frequently than spoken words. Real-time communication for people with hearing and speech impairments is the main objective of this research.

Technologies are created by combining software and hardware. The device will process human gesture input using the micro-controller before generating voice and a display. Communication is the only way for us to express our thoughts to one another. It is not expected that this will place any restrictions on them. Because of this, it is challenging for people who are deaf and dumb to communicate with others, so it is essential to develop a model that is acceptable and useful for them. Because of this, we mostly use hand signals and a device known as the SIGN LANGUAGE TO SPEECH CONVERSION SMART GLOVES to communicate. The device that is attached to the gloves uses flex sensors to translate gestures into resistance, which the ESP32 then uses to translate into text. The family of flexible sensors that includes the flex sensors is sufficiently flexible. For accurate output, accelerometers and contact sensors are also utilized in addition to flex sensors. The hand's motion is tracked by the accelerometer and gyroscope sensor. The ESP32 is used to process the sensor output and produce text that is shown on a mobile. Additionally, that text is delivered to computers and mobile phones via a Bluetooth.

Many engineering applications, from gesture analysis to the biomedical sciences, require hand movement data gathering. Glove-based systems are among the most significant attempts to collect data on hand movements. As long as they have existed. They have been drawing attention from academics in an increasing variety of sectors for more than thirty years. A growing number of researchers have been involved in the development of glove-based systems, the most widely used devices for hand movement collection, since roughly 30 years ago. There isn't a commercial technology on the market that can translate sign language into spoken language. Nonetheless, efforts are underway to translate sign language into speech that is accurate, efficient, and portable.

# 2. AIM AND OBJECTIVE

## 2.1 Aim

To develop a smart speaking glove for speech-impaired people using flex sensor, ESP32, accelerometer and gyroscope sensor, which sense different sign language gestures for communication assistance.

## 2.2 Objective

The primary objective of the speech-impaired smart speaking glove with a Flex sensor, ESP32, Accelerometer and gyroscope sensor is to help with communication purpose. The glove uses technology to meet the unique needs of people with speech impairments, giving them a different way to communicate and a mechanism to signal for assistance when needed. Below are the primary goals:

- To build a glove device to detect the sign language using ESP32 and helping speech challenged individuals communicate with others without the help of translators.
- To make the device completely portable and make this technology available to everyone.
- To reduce the problem of miscommunication between the normal people and the speech impaired people.
- To develop a user friendly reliable automatic gesture recognition system that recognizes the hand gestures made by the speech impaired people.
- To convey the message produced by the speech impaired person and convey it to the normal person in a simple and unambiguous manner.
- To foster self-reliance and empowerment, the smart speaking glove provides speech-impaired individuals with an independent method of communication, enhancing their ability to interact with others and signal for assistance when needed.

# 3. METHODOLOGY OF SIGN LANGUAGE TO SPEECH CONVERSION SMART GLOVES USNIG IoT

## 3.1 Block Diagram of Sign Language to Speech Conversion Smart Gloves using IoT

The block diagram provides an explanation of how the System operates generally. It depicts the overall hierarchy and order of the project's different working units. Wearing a glove with accelerometer and flex sensors sewn into it, the user makes gestures. Signals from the accelerometer and flex sensors on the glove are collected by an ESP. The processed output is then sent to an Android smartphone or a personal computer via a Bluetooth connection, where test to speech software (application) is installed, and speech output is produced. The Android Application is then used to display the text output.

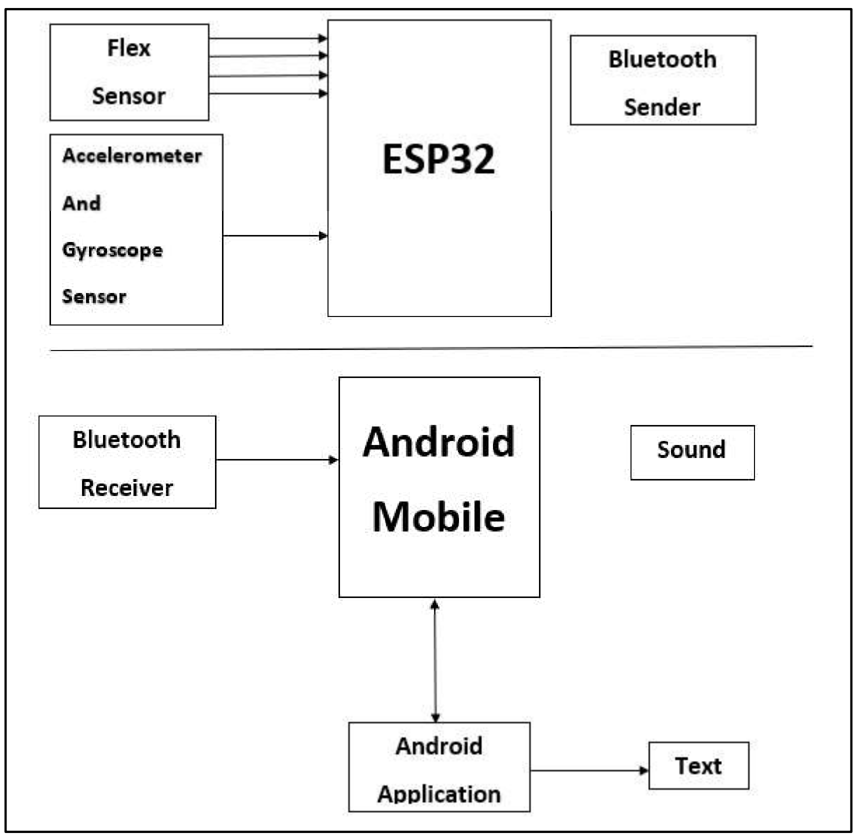


**Fig. 3.1 Block Diagram of Sign Language to Speech Conversion Smart Gloves using IoT**

**Table 3.1 Components/ Boards/ Devices/ Equipment's used in Sign Language to Speech Conversion Smart Gloves using IoT**

| Sr. No. | Components/ Boards/ Devices/ Equipment's | Specifications | Qty |
|---|---|---|---|
| 1 | ESP32 | Processor. Tensilica LX6 Dual-Core<br>Output Voltage: 3.3V<br>Memory: 4 MB<br>Communication Protocols: Wi-Fi, I2C, Bluetooth<br>ROM: 448Kb<br>SRAM: 520Kb | 1 |
| 2 | Flex Sensor | Bend Resistance: 45K to 125K Ohms<br>Flat Resistance: 25K Ohms<br>Resistance Tolerance: ±30% | 4 |
| 3 | Accelerometer and Gyroscope Sensor (MPU6050) | Gyroscope range: +/- 250 500 1000 2000 degree/sec<br>Acceleration range: +/- 2g, +/- 4g, +/- 8g, +/- 16g | 1 |
| 4 | Voltage Regulator (AMS1117 3.3V) | Output Voltage: 3.3V | 1 |
| 5 | Diode (1N4007) | Forward Current: 1A<br>Reverse Voltage: 1000V (peak) | 1 |
| 6 | Resistor (10K Ohm, 220 Ohm) | Resistance: 10K Ohms, 220 Ohms | 6 |
| 7 | Capacitor (0.1µF, 0.3µF, 100µF, 10µF) | Capacitance: 0.1µF, 0.3µF, 100µF, 10µF | 4 |
| 8 | LED | Light Emitting Diode<br>Operating Voltage: 1.2 – 3.6 V | 2 |
| 9 | Push Button | Pin Count: 4<br>Operating Voltage: 12V | 2 |
| 10 | Battery (9V) | Voltage: 9V<br>Capacity : 600 mAh | 1 |

## Circuit Diagram of Sign Language to Speech Conversion Smart Gloves using IoT

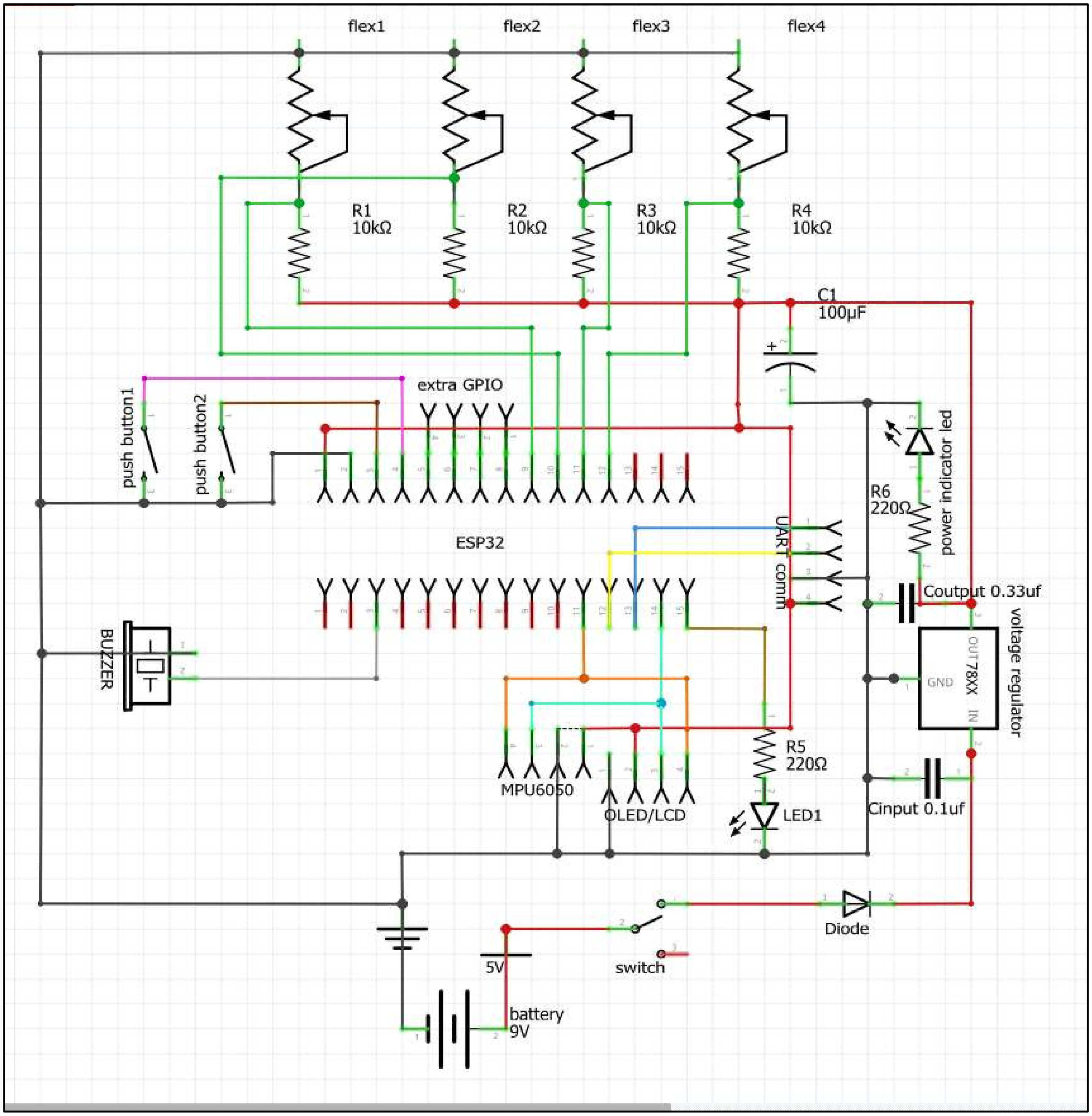


**Fig. 3.2 Circuit Diagram of Sign Language to Speech Conversion Smart Gloves using IoT**

## 3.2 Hardware Description

### 3.2.1 ESP32

A line of low-cost, low-power system-on-a-chip microcontrollers featuring dual-mode Bluetooth and integrated Wi-Fi is called ESP32. The ESP32 series incorporates built-in antenna switches, RF balun, power amplifier, low-noise receive amplifier, filters, and power-management modules. It uses either a Tensilica Xtensa LX6 microprocessor in both dual-core and single-core variations, Xtensa LX7 dual-core microprocessor, or a single-core RISC-V microprocessor. The Shanghai-based Chinese business Espressif Systems designed and developed ESP32, which is produced by TSMC utilizing their 40 nm technology. It is the ESP8266 microcontroller's replacement.

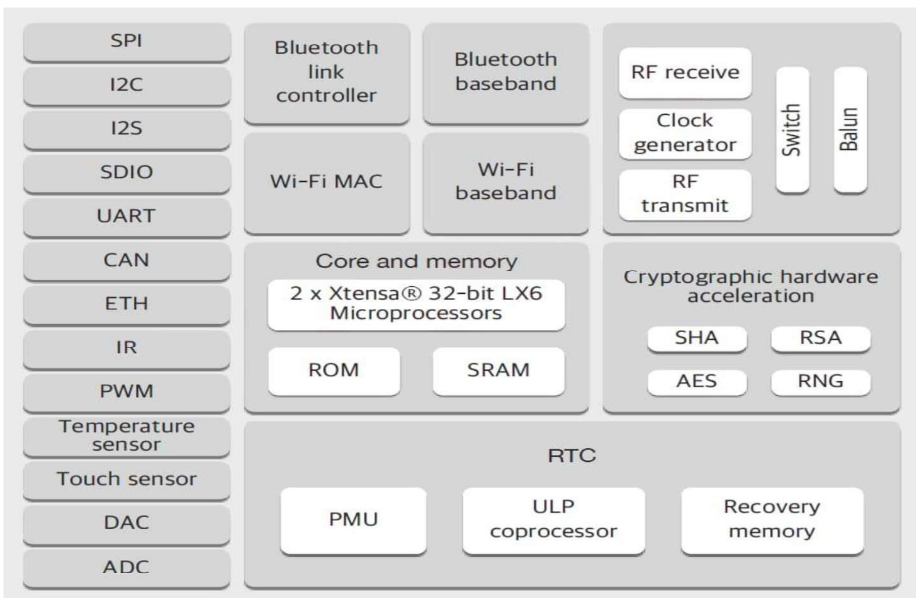


**Fig. 3.3 ESP32 Block Diagram**

### 3.2.2 Flex Sensor

Flex sensors, as the name suggests, are sensors that, depending on how they are bent, alter their resistance. The resistance increases as the bend increases. Additionally, flex sensors function as changeable analog voltage dividers. A carbon resistive element enclosed in a thin, flexible substrate makes up a flex sensor. The resistive element generates a resistive output in relation to the bend radius when the substrate is bent. Since the fingers are the primary component of gestures, the system comprises of four flex sensors that are sewn into the gloves' fingertips. This is necessary since each finger requires a distinct sensor. The bent position of each finger is detected by flex sensors, which provide the system with the hand gesture. The sensors begin to bend as the fingers do, and as the sensors bend, the resistances change as well. The ESP32 receives this resistance value.

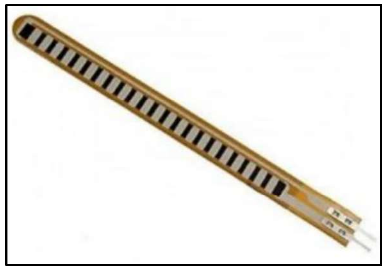

**Fig. 3.4 Flex Sensor**

### 3.2.3 Accelerometer and Gyroscope Sensor (MPU6050)

The complete 6-axis motion tracking device is the MPU6050 sensor module. It is a compact kit that includes a 3-axis Gyroscope, a 3-axis Accelerometer, and a Digital Motion Processor. It also includes an on-chip temperature sensor as an extra feature. It can communicate with the microcontrollers thanks to its I2C bus interface. It can interface with other sensor devices, such as a pressure sensor and a 3-axis magnetometer, thanks to its auxiliary I2C bus. The MPU6050 may offer a full 9-axis Motion Fusion output if a 3-axis Magnetometer is linked to an additional I2C bus.

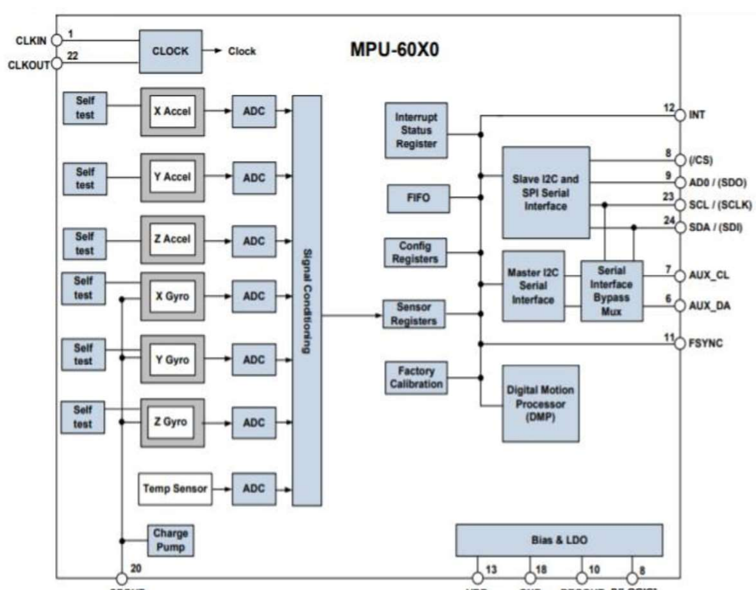


**Fig. 3.5 MPU6050 Block Diagram**

### 3.2.4 Voltage Regulator (AMS1117 3.3V)

The AMS1117 has a series of adjustable and fixed voltage regulators. This is a 3.3V Output Version of AMS1117. It provides up to 1A output current. It can also operate on 1V input to output differential. The dropout voltage of the device is maximum 1.3V, which decreases at lower load currents.

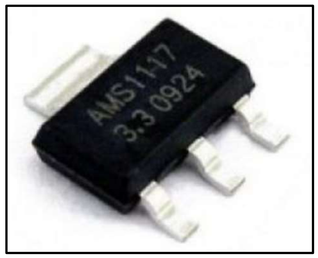


**Fig. 3.6 AMS1117 0.3V**

### 3.2.5 Diode (1N4007)

The 1N4007 rectifier diode is a versatile diode. It is typically designed to be utilized with other filter capacitors as a rectifier in the power supply portion of electronic equipment to convert AC voltage to DC voltage. Additionally, it can be applied to any generic application where a general diode is required. The 1N4007 diode can readily tolerate voltages below 1000V and is made to work at high voltages. It is the perfect diode for a wide range of applications due to its inexpensive cost, 3W power dissipation, tiny size, and average direct current of 1000mA or 1A.

**Fig. 3.7 1N4007**

### 3.2.6 Resistor (10K Ohm, 220 Ohm)

A resistor is a passive electrical component with two terminals that is used to implement electrical resistance in circuits. Resistors have a variety of applications in electronic circuits, including lowering current flow, adjusting signal levels, dividing voltages, biasing active components, and ending transmission lines. High-power resistors are useful in power distribution systems, motor controllers, and generator test loads because they can dissipate a lot of electrical power as heat. Resistances of fixed resistors only little vary with operation voltage, temperature, or time. Variable resistors can be force- or chemical activity-sensing devices, or they can be employed to alter circuit elements (such a lamp dimmer or volume control).

**Fig. 3.8.1 10K Ohm Resistor**

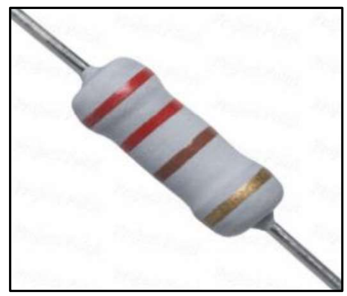

**Fig. 3.8.2 220 Ohm Resistor**

### 3.2.7 Capacitor (0.1µF, 0.3µF, 100µF)

By building up electric charges on two closely spaced, isolated surfaces, a capacitor is a device that stores electrical energy. The capacitor's initial name was "condenser", a term that can still be seen in the names of some compounds, like "condenser microphone." It has two terminals and is a passive electrical component. A capacitor's capacitance determines how useful it is. A capacitor is a component used to add capacitance to a circuit, but capacitance naturally exists in any circuit between any two electrical conductors that are close to one another.

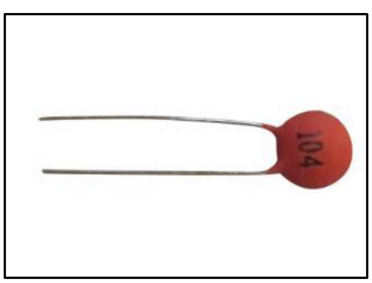


**Fig. 3.9.1 Capacitor 0.1µF**

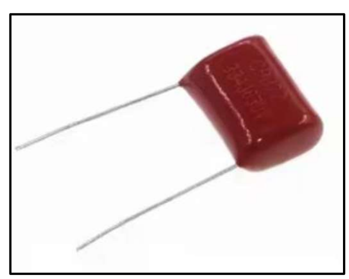

**Fig. 3.9.2 Capacitor 0.3µF**

Fig. 3.9.3 Capacitor 100µF

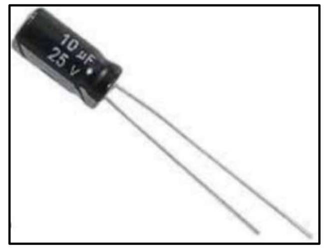

Fig. 3.9.4 Capacitor 10µF

### 3.2.8 LED

When current passes through a light-emitting diode (LED), a semiconductor device, light is released. Photons are released as a result of the semiconductor's electrons and electron holes recombining. The energy needed for electrons to pass the semiconductor's band gap determines the colour of the light, which is correlated with photon energy. Using numerous semiconductors or covering the semiconductor device with a coating of light-emitting phosphor allows for the production of white light.

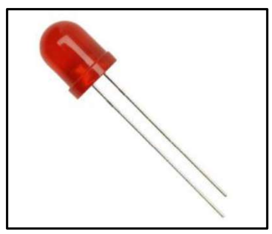

**Fig. 3.10 Led**

### 3.2.9 Push Button

A push-button, sometimes written pushbutton, is a straightforward switch mechanism used to operate a machine or a process. Most buttons are composed of a hard substance, usually metal or plastic. In order to make it easy to push or depress, the surface is often flat or contoured to fit a human finger or hand. Most switches are biased, yet many unbiased buttons still need a spring to get back to their un-pushed condition because of the way they are made.

**Fig. 3.11 Push Button**

### 3.2.10 Battery (9V)

An electric battery that provides a nominal voltage of nine volts is known as a nine-volt battery or 9-volt battery. 7.2 to 9.6 volts is the actual voltage, depending on the battery's composition. This kind is frequently utilized in a wide range of applications, including toys, clocks, and gas and smoke detectors for homes.


**Fig. 3.12 Battery 9V**

## 3.3 Software Description

### 3.3.1 Arduino IDE

The Arduino Integrated Development Environment - or Arduino Software (IDE) - contains a text editor for writing code, a message area, a text console, a toolbar with buttons for common functions and a series of menus. It connects to the Arduino hardware to upload programs and communicate with them.

Programs written using Arduino Software (IDE) are called sketches. These sketches are written in the text editor and are saved with the file extension .ino. The editor has features for cutting/pasting and for searching/replacing text. The message area gives feedback while saving and exporting and also displays errors. The console displays text output by the Arduino Software (IDE), including complete error messages and other information. The bottom righthand corner of the window displays the configured board and serial port. The toolbar buttons allow you to verify and upload programs, create, open, and save sketches, and open the serial monitor.

- **Verify:** Checks your code for errors compiling it.
- **Upload Compiles:** Compiles your code and uploads it to the configured board.
- **New:** Creates a new sketch.
- **Open:** Presents a menu of all the sketches in your sketchbook. Clicking one will open it within the current window overwriting its content.
- **Save:** Saves your sketch.
- **Serial Monitor:** Opens the serial monitor.

Additional commands are found within the five menus: **File**, **Edit**, **Sketch**, **Tools**, **Help**. The menus are context sensitive, which means only those items relevant to the work currently being carried out are available.

### 3.3.2 Talk to ESP32

The ESP32 Chat application provides an intuitive and user-friendly interface, allowing users to establish connections with ESP32 modules and start chatting quickly. You can search for and view a list of available ESP32 modules around you and select the module you want to connect to.

## 3.4 Working

The workings of the modules are explained as follows: sensors sense a gesture, identify it, send the output to the receiver modules, and the outcome is either shown on the Android application or is audible through the device's microphone.

Here are some modules described below:

- **Sensing the Gesture:** The gestures are detected using sensors. The flex sensor, accelerometer and gyroscope sensor are used to sense the movement of fingers i.e., change in direction of fingers, bent of fingers, backward and forward direction of fingers. It also identifies the bent angle of the palm some of the sign language gestures involves bending of palm also hence accelerometers are used. The analog signals are produced by these sensors and further process is done.

- **Recognition of gesture:** Here the gesture is identified by the values drawn from the sensors using the analog signal and converts it into digital signal. It verifies the gesture with the predefined code which is present in ESP32. If gesture matches with the code, it sends the respective output else it waits until the correct input is sensed.

- **Transmission of output:** The output recognized is then transmitted to the android application via Bluetooth which is a means of wireless communication. The output sent by the Bluetooth is received by the mobile Bluetooth receiver in the android mobile.

- **Final result:** The final result is obtained in the form of text in the android application and the voice in the android mobile using the microphone. In this way the sign language translation is done which is useful to communicate with deaf-mute.

### 3.4.1 Algorithm

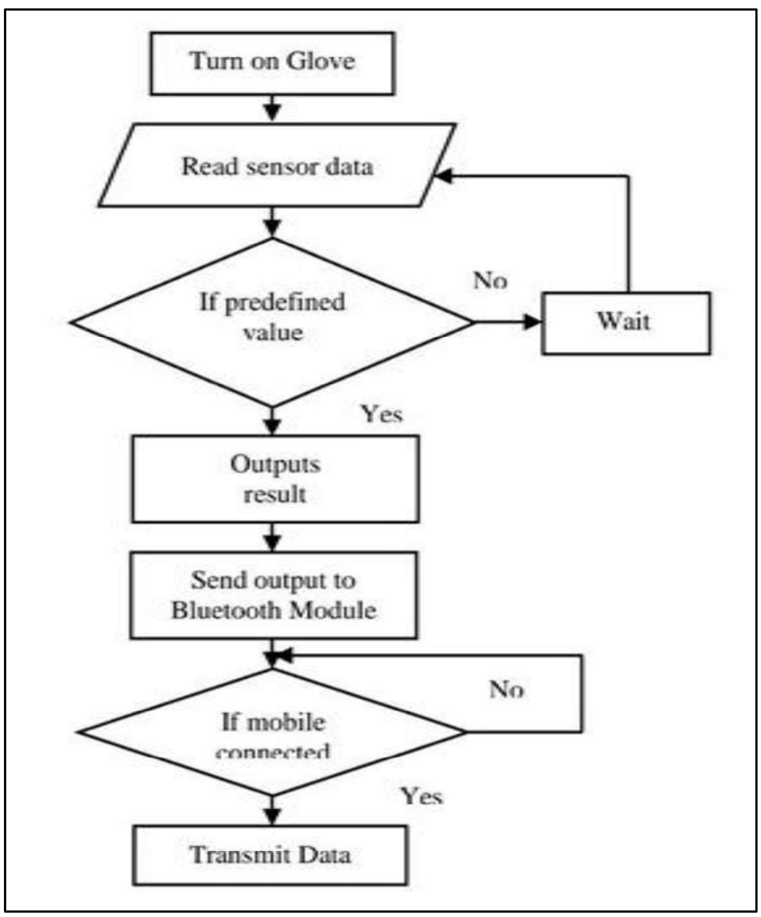


**Fig. 3.13 Algorithm**

# 4. RESULTS AND DISCUSSION

## 4.1 Results

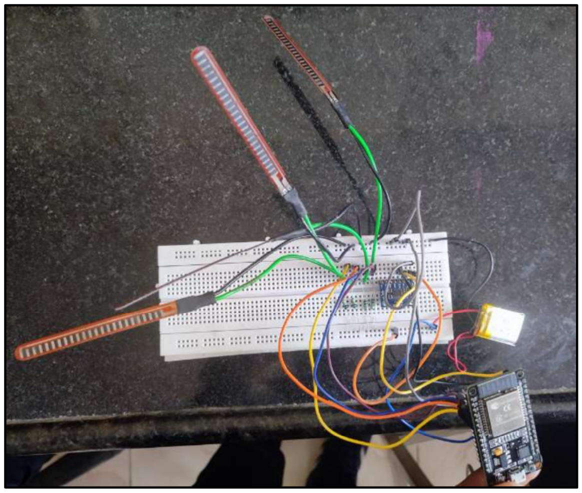

Fig. 4.1 Initial Prototype


Fig. 4.2 Final Prototype
Up Part

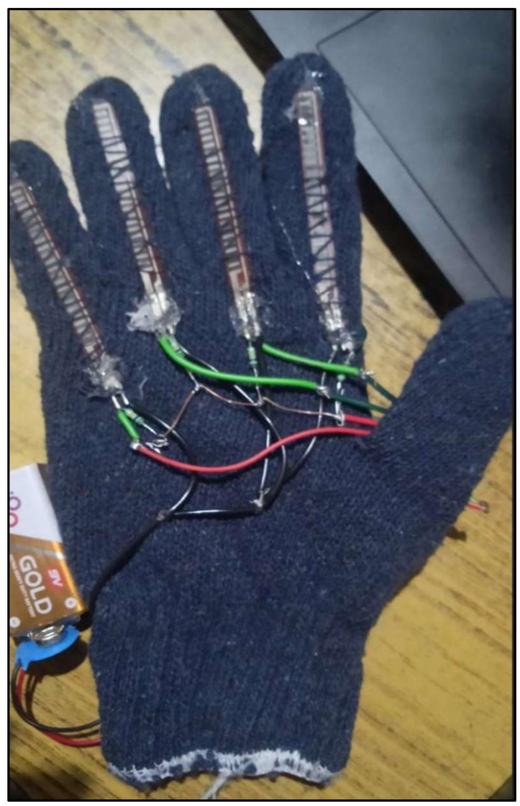


Fig. 4.3 Final Prototype
Down Part

With the help of the flex sensor, ESP32, accelerometer and gyroscope sensor the SIGN LANGUAGE TO SPEECH CONVERSION SMART GLOVES for people with speech difficulties can recognize hand gestures and translate them into audible speech. The matching movements were recorded by the flex sensor. The glove then processed the gathered data and produced spoken output by identifying gestures. The outcomes showed that the smart speaking glove was able to recognize and interpret hand gestures with an astounding degree of accuracy. Many different motions, such as finger movements, palm orientation, and hand forms, were effectively recorded by the flex sensor, accelerometer and gyroscope sensor. These movements were successfully converted by the glove into coherent speech output, and displayed on lcd screen. The study's findings demonstrate how well the smart speaking glove recognizes and converts gestures. For those with speech problems, the glove's high degree of precision in detecting and interpreting hand movements offers great potential. The glove's interface, which is user-friendly and translates motions into verbal output, provides a useful and effective way to communicate. To investigate possible enhancements and broaden the scope of supported gestures, more study is required. Improved signal processing methods or machine learning algorithms could improve the system's ability to recognize gestures. Long-term usability studies and user feedback are also necessary to guarantee the glove's efficacy and user pleasure in practical situations. Overall, the findings suggest that the flex sensor, ESP32, accelerometer and gyroscope sensor -equipped smart speaking glove has the potential to greatly enhance communication for people with speech impairments by giving them a dependable and user-friendly way to express themselves through hand gestures that are translated into audible speech.

## 4.2 Discussion

The SIGN LANGUAGE TO SPEECH CONVERSION SMART GLOVES presents a viable way for those with speech impairments to overcome their communication difficulties. The glove effectively translates hand gestures into audible conversation by using the flex sensor to detect and analyze hand movements, offering a substitute form of communication. With the use of this technology, people who are speech-impaired may live far better lives by being able to engage and communicate more effectively with others. The smart speaking glove's versatility is one of its main benefits. The system is adaptable to a broad spectrum of users, as it can be effortlessly adjusted to identify diverse hand motions and support several languages. Additionally, the glove's small size and portability make it easy to utilize on a daily basis in a variety of settings. Even though the preliminary findings are encouraging, there are a few areas that still need work and investigation. Improving gesture recognition accuracy is essential to reducing errors and guaranteeing system dependability. This can be accomplished by using sophisticated algorithms or machine learning strategies that enhance the glove's precision in interpreting intricate hand movements. Furthermore, it's critical to maximize the glove's comfort and ergonomics to make sure that wearers can wear it for extended periods of time without becoming tired or uncomfortable. Other crucial things to think about are user training and glove interface adaptation. Examining the glove's learning curve and how simple it is for users to incorporate it into their everyday routines will shed light on how practical and easy to use the device is. To sum up, the smart speaking glove has a lot of potential as a communication aid for people who have trouble communicating. With additional development and research, such as enhanced ergonomics, user training, and gesture detection, this technology could empower people with speech impairments by increasing their independence.

# 5. CONCLUSION AND FUTURE SCOPE

## 5.1 Conclusion

The technology bridges the communication barriers between deaf and normal persons by acting as a conduit for information between the two groups. With little weight and power, the gloves are autonomous and portable. The hand movements are translated by the system into text and then back into voice. There is a feature built into the text system that allows a person to read and comprehend what someone else is trying to say even in situations where they are unable to hear sounds. As of right now, cables are used to connect the gadget to the microcontroller. The device's early testing indicates that the cords may obstruct hand movements. To address this issue, a wireless connection between the device and microcontroller will be used in the future.

## 5.2 Future Scope

- It is possible to develop the other glove such that it can perform both hand gestures and phrase production.
- By employing a compact lipo battery, which can be charged and reused multiple times, the gadget can be made more portable.
- The usefulness and connectivity of the smart speaking glove can be improved by looking at integration with currently available smart devices, such as smartphones or tablets. Features like message writing, text-to-speech conversion, and communication app compatibility are examples of these.
- The speech output produced by the glove can have greater coherence and fluency because to developments in natural language processing (NLP). Improved sentence construction, tone, and context awareness can all contribute to more organic and successful communication.

# 6. REFERENCES


[1] J. Nagar, R. Gandhi Salai, C. -, D. Anu Me, and S. Vigneshwari, “SMART GLOVE FOR SIGN LANGUAGE TRANSLATION USING IoT,” SATHYABAMA INSTITUTE OF SCIENCE AND TECHNOLOGY (DEEMED TO BE UNIVERSITY), 2020

[2] J. B. Krishnaa, R. Haritha, G. D. Haritha, J. S. Lekha, and S. R. Malathi, “GLOVE BASED GESTURE RECOGNITION USING IR SENSOR,” *International Research Journal of Engineering and Technology*, 2023,

[3] K.Ravi Chandra, K.S.D.Charishma Patnaik, V.Suhruth, M.J.N.Sandeep “SMART GLOVE FOR SIGN LANGUAGE TRANSLATION USING ARDUINO,” ANIL NEERUKONDA INSTITUTE OF TECHNOLOGY AND SCIENCES, 2021

[4] R. Ambar, C. K. Fai, M. H. Abd Wahab, M. M. Abdul Jamil, and A. A. Ma’Radzi, “Development of a Wearable Device for Sign Language Recognition,” in *Journal of Physics: Conference Series*, Institute of Physics Publishing, Jun. 2018. doi: 10.1088/1742-6596/1019/1/012017.

[5] A. Z. Shukor, M. F. Miskon, M. H. Jamaluddin, F. Bin Ali Ibrahim, M. F. Asyraf, and M. B. Bin Bahar, “A New Data Glove Approach for Malaysian Sign Language Detection,” in *Procedia Computer Science*, Elsevier B.V., 2015, pp. 60–67. doi: 10.1016/j.procs.2015.12.276.

[6] J. Waykule, Y. Jhunjhunwala, P. Shah, P. Patil, and S. Sushila, “SIGN LANGUAGE TO SPEECH CONVERSION USING ARDUINO,” 2017.