"FLEX SENSOR BASED SIGN LANGUAGE TO SPEECH CONVERSION SYSTEM "

A MINI PROJECT REPORT

Submitted

In the partial fulfilment of the requirements for
the award of the degree of

BACHELOR OF TECHNOLOGY
IN
ELECTRONICS AND COMMUNICATION ENGINEERING

By

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WARANGAL – 506015
2022-2023

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WARANGAL – 506015
2022-2023

CERTIFICATE

This is to certify that Mini Project report entitled **“FLEX SENSOR BASED SIGN LANGUAGE TO SPEECH CONVERSION SYSTEM ”** embodies the original work done by **SK.MUDASSIR NAWAZ** bearing Roll Number **B22EC204L** studying **VI** Semester in partial fulfilment of the requirement for the award of degree of the **Bachelor of Technology** in **Electronics & Communication Engineering** from **KAKATIYA INSTITUTE OF TECHNOLOGY & SCIENCE, WARANGAL** during the academic year 2022-2023.

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I declare that the Mini Project report is original and has been carried out in the Department of Electronics & Communication Engineering, Kakatiya Institute of Technology and Science, Warangal, Telangana, and to the best of my knowledge it has been not submitted elsewhere for any degree.

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ABSTRACT

The Easiest way for Communication in the World is speech. Whereas it becomes difficult for speech impaired and hearing impaired people to communicate. Speech is the only medium by which we can share our thoughts or convey the message but for a person with disability (deaf and dumb) faces difficulty in communication with normal person. An innovative approach of Sign Language to Speech Conversion System that leverages flex sensor technology to facilitate seamless communication between individuals proficient in sign language and those relying on spoken language.

The proposed system employs strategically positioned flex sensors on the user's hand to capture and interpret intricate hand gestures associated with sign language.The system employs a real-time processing approach, allowing for instantaneous translation of sign language gestures into audible speech

This Sign Language to Speech Conversion System aims to bridge communication barriers, promoting inclusivity and understanding in various domains, including education, healthcare, and social interactions. By enabling real-time conversion, the technology contributes to a more inclusive society where individuals with hearing impairments can engage in spontaneous and meaningful conversations with their peers.

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1. INTRODUCTION

1.1 OVERVIEW

Flex sensor-based sign language to speech conversion works by using sensors that detect the movement of fingers when forming sign language gestures. These sensors are attached to a glove worn by the user. As the user makes different hand shapes and movements, the sensors measure the degree of bending in each finger. This information is then sent to a computer or a microcontroller, which translates it into spoken words or text. Essentially, it allows individuals who use sign language to communicate with others who may not understand sign language by converting their gestures into spoken language.

1.2 IMPORTANCE

In today's diverse world, effective communication is fundamental, yet barriers persist for those who communicate through sign language. Enter the flex sensor-based sign gesture to speech conversion system, a transformative technology bridge the space between the speech impaired and hearing communities. This innovative system operates by leveraging flexible sensors integrated into gloves or wearable devices, detecting the nuanced movements of the person's fingers and hands as they articulate sign language gestures.

Through sophisticated algorithms and signal processing techniques, these sensors translate these gestures into spoken words or text, enabling interaction between speech impaired people and those who does not understand sign language. This breakthrough technology not only enhances accessibility but also promotes inclusivity by facilitating meaningful interactions across linguistic barriers.

The implications of flex sensor-based sign language to speech conversion are far-reaching. It empowers individuals with hearing impairments to express themselves more fluently and participate fully in conversations, education, and professional settings. Moreover, it fosters greater understanding and empathy, breaking down communication barriers and fostering a more inclusive society.With ongoing advancements and refinement,.

This technology holds immense potential in various contexts, including educational settings, social interactions, and professional environments. It empowers individuals with hearing impairments to express themselves easily and enables seamless communication with a broader audience.

2. LITERATURE REVIEW

Flex sensor based sign language to speech conversion has emerged as a promising technology to facilitate communication in between speech impaired persons who use sign gestures and thosewho cannot understand it. Previous studies have explored various implementations and methodologies to achieve accurate translation. Researchers have investigated the mechanics of flex sensors, which are often integrated into gloves or wearable devices to detect hand movements and gestures. Signal processing techniques, including feature extraction and machine learning algorithms, have been utilized to interpret these movements and translate them into spoken words or text.

While flex sensor-based systems offer potential benefits for enhancing accessibility and inclusivity, challenges remain. These include ensuring accuracy in gesture recognition, addressing variability in sign language expressions, and achieving real-time processing capabilities. Ongoing research focuses on improving sensor accuracy, enhancing algorithm robustness, and optimizing system usability. Future directions include exploring applications in education, healthcare, and assistive technology, with the aim of further avoiding mis communication between deaf and hearing persons. Overall, flex sensor based sign gesture to speech conversion holds promise for advancing communication accessibility and fostering greater societal inclusion.

The system has two main parts. The first part takes video of Indian Sign gestures and matches them with spoken words. The second part takes regular spoken language and turns it into animated Indian Sign Language gestures. The process involves breaking down video into frames, identifying important areas, and connecting them to known signs using a correlation method. Then, it generates the appropriate spoken words using the Bluetooth Text-to-Speech app.

3. BLOCK DIAGRAM

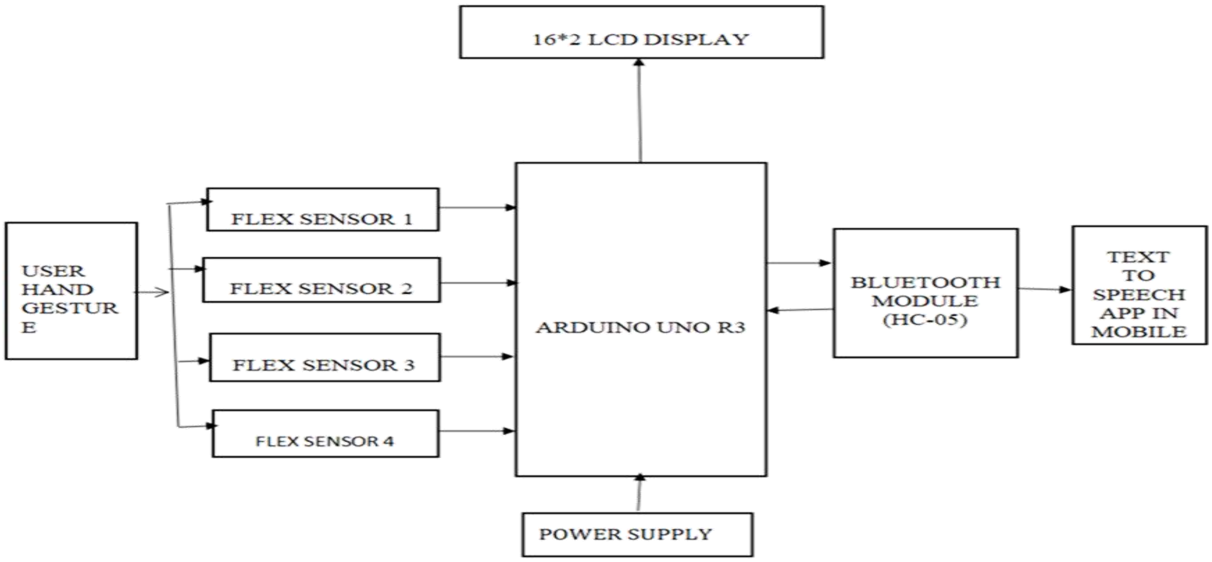


figure 3.a Block diagram of Sign gesture to speech conversion system

In above block diagram the input signal coming from a flex sensors which are attached to hand glove fingers each .when the flex sensors get bents to a certain degree due to voltage divider network a voltage variable signal is being applied to arduino microntroller for proccessing the data with pre-defined gestures given in the ide. finally the output of text is appeared on LCD display also the gesture data is sent to mobile application Text to speech through bluetooth HC-05 module which converts sign language gesture to Audible speech

3.1 CIRCUIT DIAGRAM

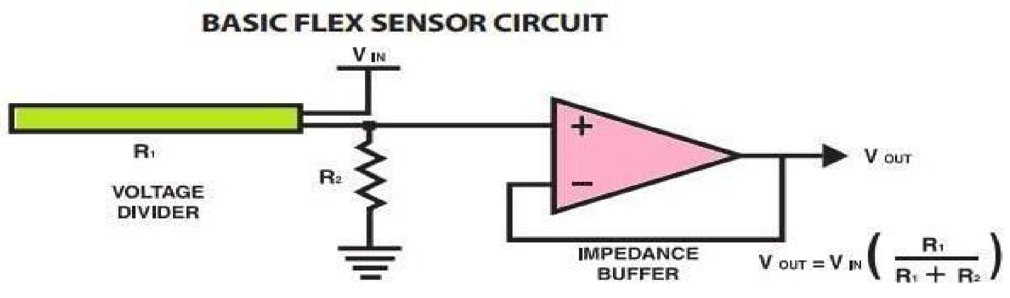


Figure 3.b depicts A voltage divider circuit using a flex sensor typically consists of the flex sensor connected in series with two resistors. The output voltage across one of the resistors changes as the flex sensor bends, providing a variable voltage output proportional to the degree of bending.

4. COMPONENTS DESCRIPTION

4.1 Hardware Requirements :

4.1.1 Flex sensor:

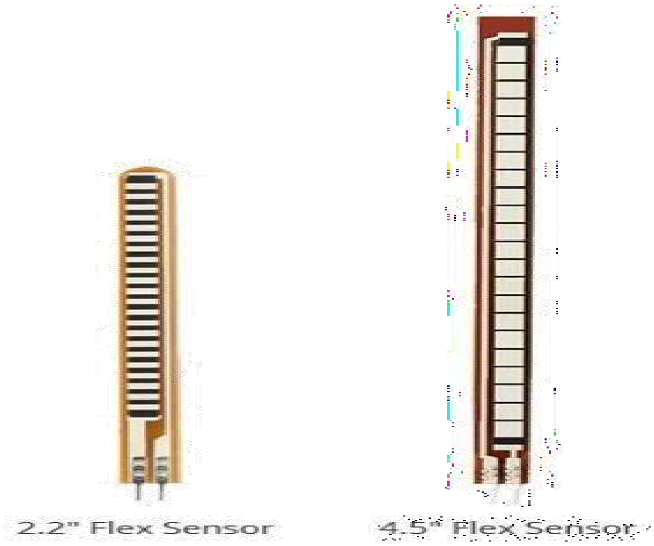


Figure 4.1.1 Flex sensors

A flex sensor is a variable resistor that changes its electrical resistance when it experiences bending or flexing. These sensors are typically constructed using a flexible substrate material such as plastic or rubber, with conductive materials like carbon or metal embedded within.

Features :

- Flat Resistance: The sensor has a default resistance of 25,000 ohms.
- Resistance Tolerance: It can vary by up to 30% from this default value.
- Bend Resistance Range: When you bend the sensor, its resistance can change, ranging from 45,000 to 125,000 ohms, depending on how much it's bent.
- Power Rating: It can handle a continuous power of 0.5 watts, but it can briefly handle up to 1 watt.
- Height: The sensor is very thin, only 0.43 millimeters thick.
- Operating Voltage: It works with voltages from 0 to 5 volts.
- Power Rating: Again, it can handle 1 watt at its peak and 0.5 watts continuously.
- Operating Temperature: It can function in temperatures ranging from -45°C to +80°C.

4.1.2 ARDUINO UNO

The Arduino Uno is like central processor of our project. It's a small computer board that can understand hand movements. It uses a tiny chip called Microchip ATmega328P. With its special pins, it can connect to other parts of the project. It has 6 pins for listening to how much things bend, and 14 pins for turning things on and off. Some of these pins can make things change smoothly instead of just turning on and off quickly. We can tell it what to do using a special program called Arduino IDE. To talk to our computer, it has a USB plug. It can run on batteries or be plugged into the computer.

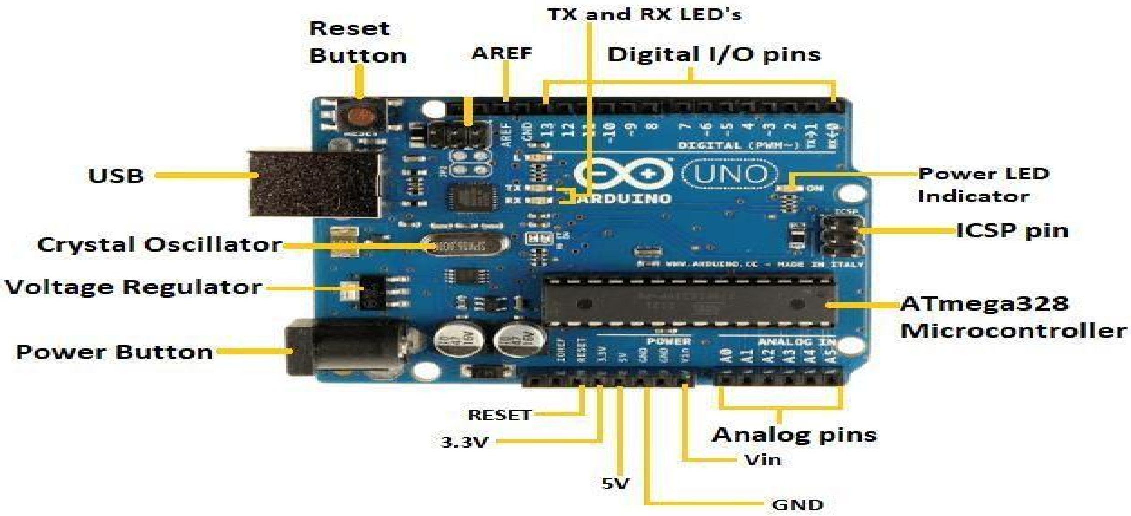


Figure 4.1.2 Arduino UNO with label function.

4.1.3 BLUETOOTH HC-05 MODULE

The Bluetooth HC-05 module is a tiny gadget that you can connect to your Arduino or other microcontroller. It lets your project talk to other devices like smartphones, tablets, or computers wirelessly using Bluetooth technology. With the HC-05 module, you can send and receive data, like text or sensor readings, without needing any wires. It's like adding a virtual wire between your project and another device, but without the actual wire! The HC-05 module is simple to use

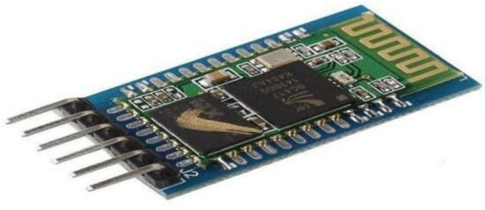


Figure 4.1.3 OF BLUETOOTH MODULE (HC-05)

4.1.4 Resistor (10k ohm)

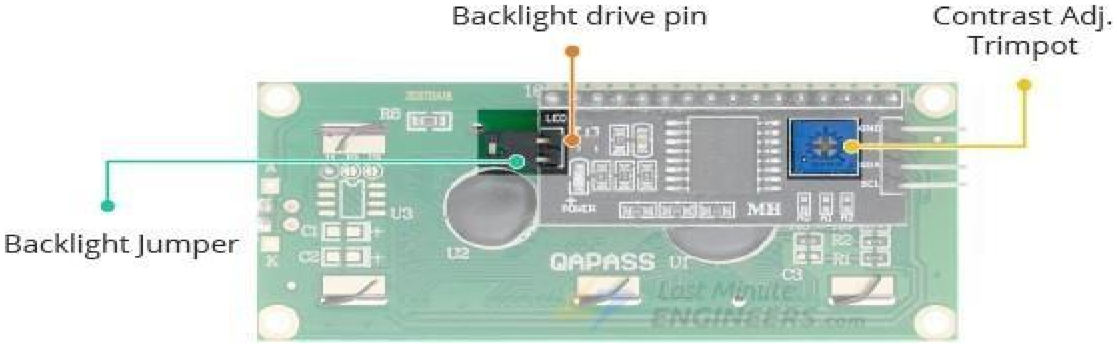
Figure 4.1.4 10k ohms Resistors.

A resistor is an electrical component it controls how much electricity can flow through it. You can also use resistors to give the right amount of electricity to other parts like transistors.

4.1.5 LCD with I2C module

The LCD 16x2 is a screen that can display up to 16 characters on each of its two rows. It uses LCD technology, which is known for using little power and providing clear contrast between the characters and the background. Usually, the display is managed by a tiny chip called an integrated circuit (IC) driver, such as the HD44780.

Figure 4.1.5 LCD display 16x2 with I2C Module



The following table lists the pin connections:

I2C LCD	Arduino
VCC	5V
GND	GND
SCL	SCL or A5
SDA	SDA or A4

I2C, or Inter-Integrated Circuit, is a communication method often used in systems controlled by microcontrollers. It operates using just two wires: one for sending data (SDA) and another for controlling the timing (SCL). This setup lets you connect multiple devices to the same line, and each device gets its own special address. An I2C module is a piece of hardware that helps handle this communication using the I2C method.

4.2 Software Requirements:

4.2.1 ARDUINO IDE SOFTWARE:

"The Arduino IDE is a special computer program that helps you write code for your Arduino projects. It's like a digital workshop where you can create instructions for your Arduino board to follow. With Arduino IDE, you The Arduino IDE comes with a Library Manager, which makes it easy for users to install and manage libraries. These libraries contain pre-written code that expands the capabilities of Arduino boards, allowing for tasks like interacting with sensors, displays, or communication modules.

The Board Manager in the Arduino IDE makes it easy to set up your project by letting you choose the type of Arduino board and microcontroller you're using. This helps whether you're using an official Arduino or a different brand. Plus, there's a tool called Serial Monitor that helps you find and fix problems and lets your computer talk to the Arduino board. You can quickly upload your code to the Arduino board with just one click, thanks to how well everything works together in the IDE.

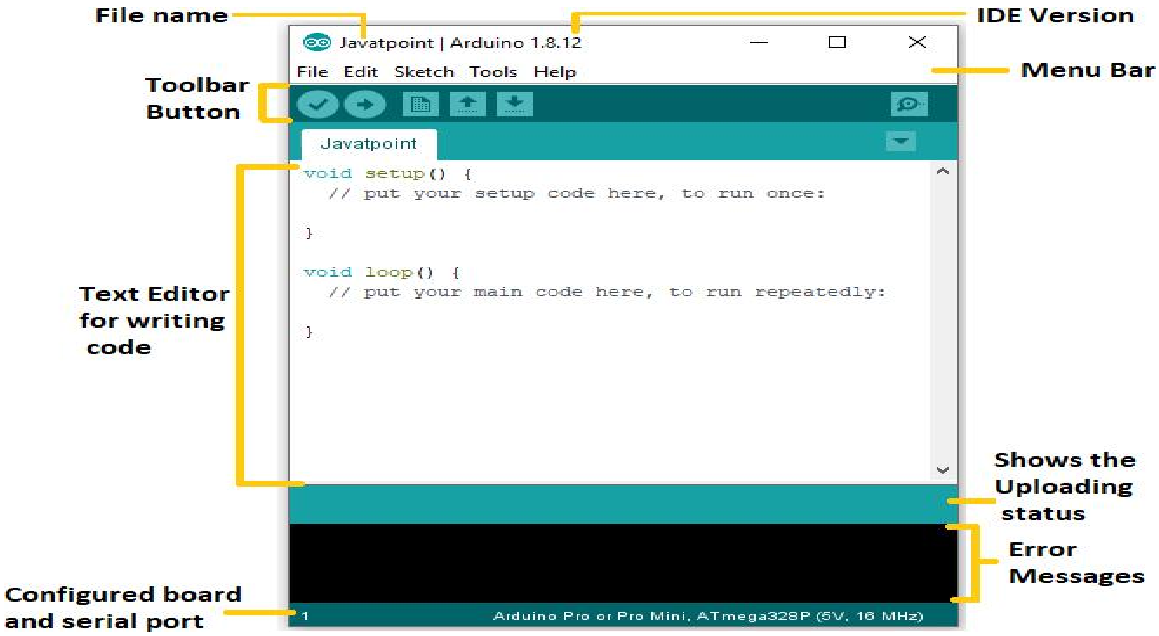


Figure 4.2.1 Arduino uno microcontroller

5. WORKING

The sign language to speech conversion system using three flex sensors, a Bluetooth HC05 module, and an LCD with an I2C module works by detecting hand gestures, interpreting them into corresponding sign language phrases or letters, converting them into text or speech, and then transmitting the output wirelessly via Bluetooth for communication.

working principle:

Flex Sensor Integration: The system begins with the integration of a flex sensor onto a wearable device such as a glove. The flex sensor is positioned in a way that it can detect the bending movements of fingers, which are crucial in sign language communication. As the user bends their fingers to form different sign language gestures, the flex sensor detects these movements and generates corresponding analog signals.

Microcontroller Processing: The analog signals from the flex sensors are then processed by a microcontroller such as an Arduino or similar board. The arduino reads the analog data from the flex sensor and converts it into digital information. Using programmed logic or algorithms, the microcontroller interprets these digital signals to recognize specific sign language gestures based on predefined patterns or thresholds.

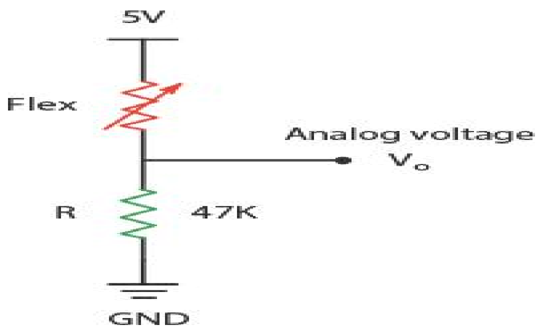
Bluetooth Communication: Once the sign language gestures are recognized, the microcontroller communicates this information wirelessly to a receiving device using a Bluetooth module, such as the HC-05. The Bluetooth hc-05 module is paired with the receiving device, which could be a smartphone, tablet, or computer. The microcontroller sends the recognized gestures as data packets over the Bluetooth connection, establishing a communication between the transmitting device and the receiving device.

Speech Synthesis on Receiving Device : On the receiving device, software is developed to receive and interpret the sign language gestures transmitted via Bluetooth. This software processes the received data packets, decodes the recognized gestures, and maps them to corresponding spoken language representations. Using speech synthesis technology, such as text-to-speech (TTS) libraries or APIs, the receiving device converts the recognized gestures into audible speech output.

Optional LCD Display Feedback : Additionally, the system may incorporate an LCD display connected to the microcontroller for providing visual feedback to the user. The LCD display can show real-time updates, such as the recognized sign language gestures or the translated speech output. This visual feedback can be helpful for the user to confirm that their gestures are accurately recognized and translated into speech.

User Interaction and Feedback Loop : Finally, the user interacts with the system by making sign language gestures, which are deflected by the flex sensor and processed into speech output. The system provides feedback to the person through both auditory (speech output) and visual (LCD display) channels, enabling seamless communication between persons using sign gestures and those who may not understand it directly.

Reading data from Flex Sensor : To easily measure the flex sensor, you pair it witha fixed resistor to make something called a voltage divider. This setup gives you a changing voltage that the microcontroller canunderstand, making it easy to read the sensor's data.



The equation to calculate the output voltage :

$$V_O = V_{CC}\frac{R}{R + R_{Flex}}$$

In this setup, when you bend the sensor more, the voltage it gives out goes down. For instance, if you have a 5V power supply and a 47K resistor, when the sensor is flat, the resistance is low, making the output voltage a certain value.

$$V_O = 5V\frac{47k\Omega}{47k\Omega + 25K\Omega}$$
$$= 3.26V$$

When the sensor is bent all the way (90°), its resistance goes up to about 100K. Because of this, the output voltage changes to a different value.

$$V_O = 5V\frac{47k\Omega}{47k\Omega + 100K\Omega}$$
$$= 1.59V$$

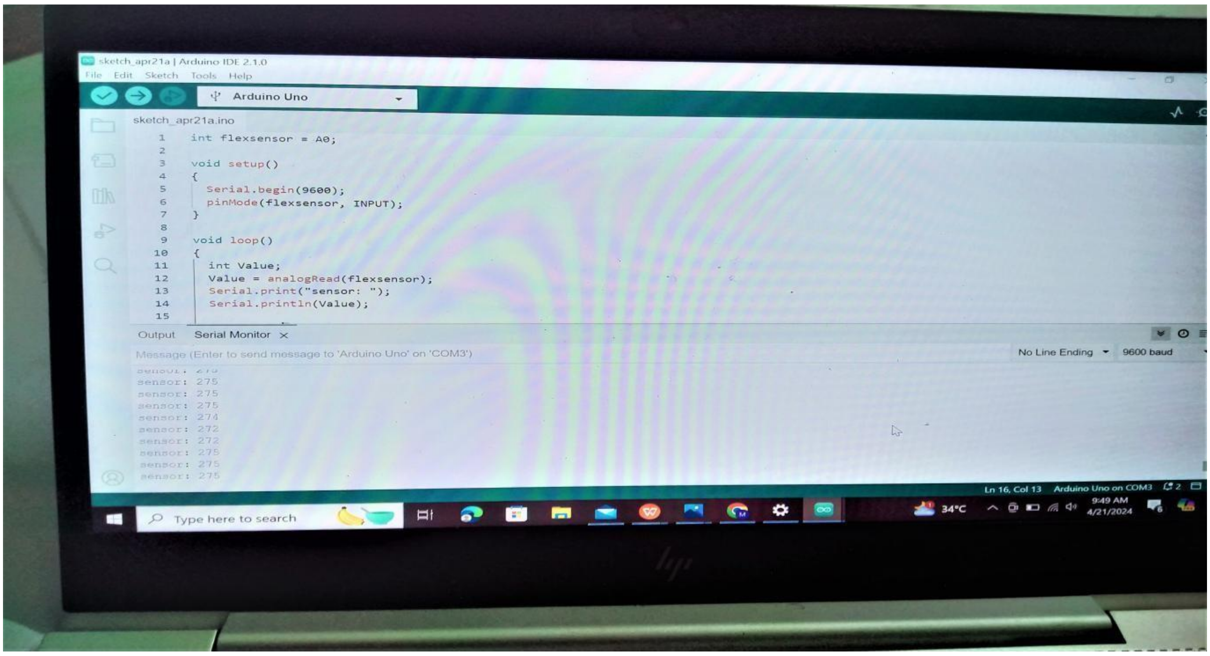
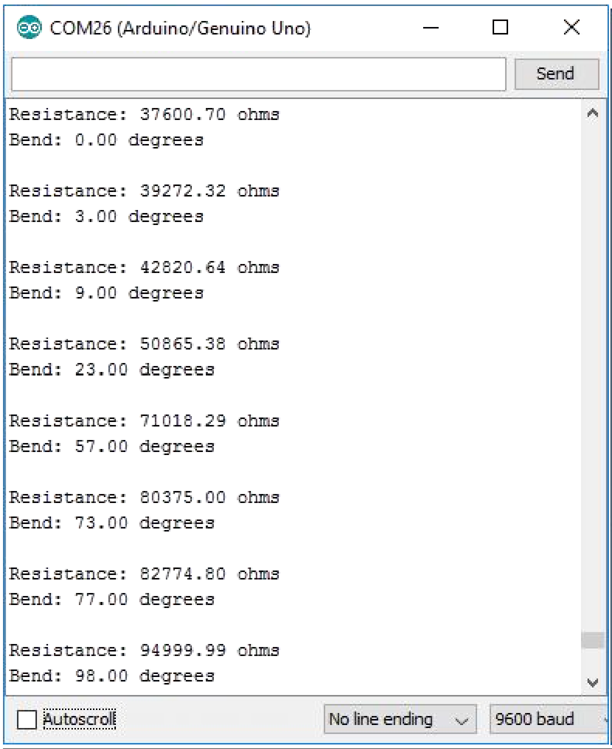


Figure 5.2.1 program for calibration of flex sensors



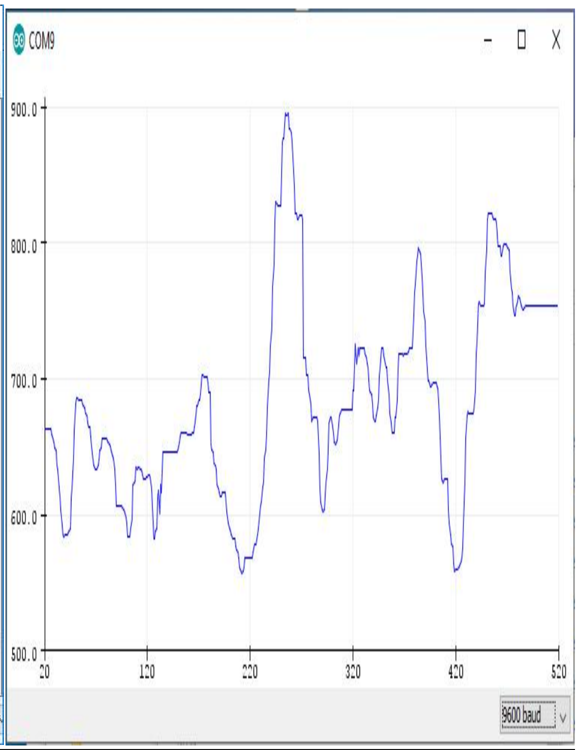


Figure 5.2.2 serial monitor calibration values

Figure 5.2.3 serial plotter graph

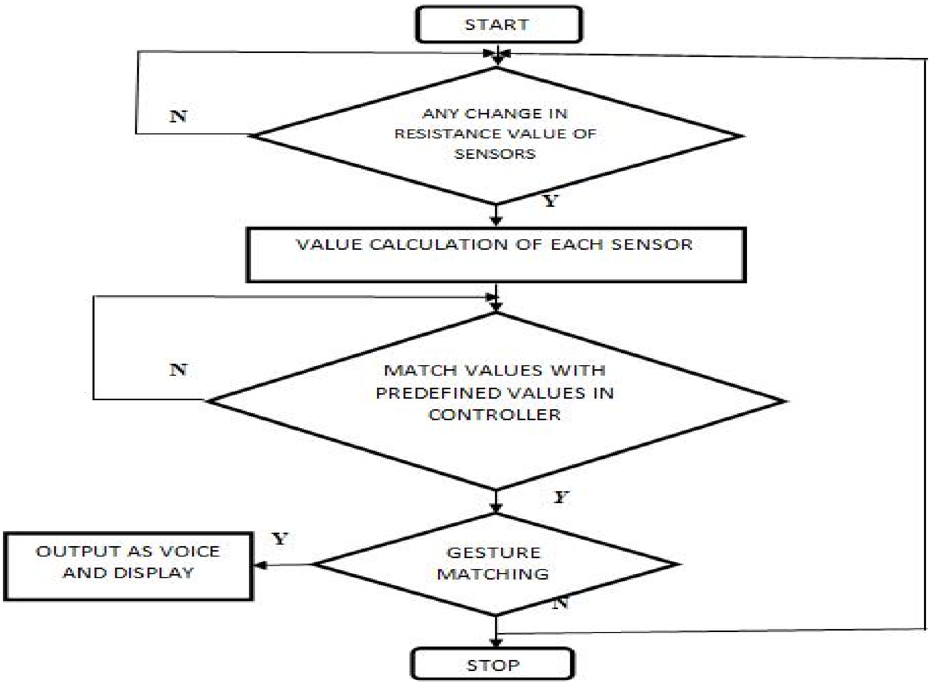


Figure 5.2.4 flowchart for Sign language to speech conversion

5.1 ADVANTAGES

i. Realtime sign language to speech conversion

ii. Compact and Portable

iii. Customization options

iv. Low power consumption

v. Privacy and security

vi. Easy to use

5.2 LIMITATIONS

i. Limited vocabulary

ii. Ambiguity in signs

iii. Sensor calibration

iv. Size and wearability

5.3 APPLICATIONS

i. Useful for physically challenged people

ii. Video relay services

iii. Education

iv. Emergency services

6. RESULTS AND ANALYSIS

When the flex sensors of each finger gets bent to certain degrees (i.e 90 deg) which provides variable voltage signal values as input which are compared with predefined gesture values given to an Arduino IDE. If the input data gets matched with the predefined values that particular gesture word will be displayed as text on Lcd display further it will convert it in to audible speech through Blueooth TTS Application

6.1. Case 1: If the person is hungry and wants food. For food, a particular sign gesture is set which is shown in figure 6.1. when the ring finger gets bent up to 90 degrees The gesture represents ”please give me some juice” on Lcd display as well as converted in to speech though Bluetooth TTS Application

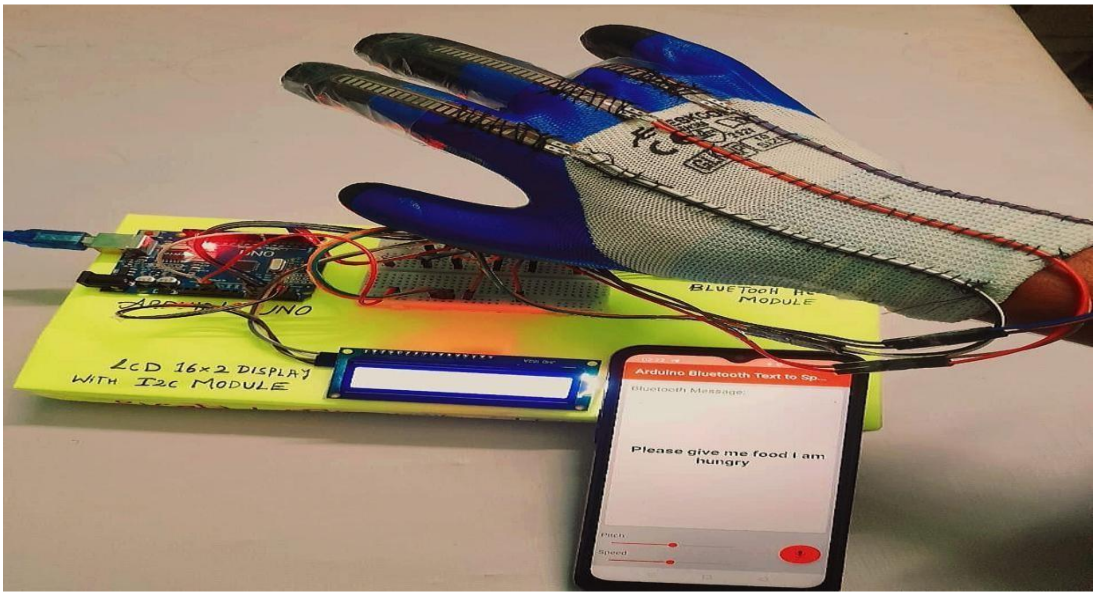


Figure 6.1. Sign gesture for “please give me food I am hungry”

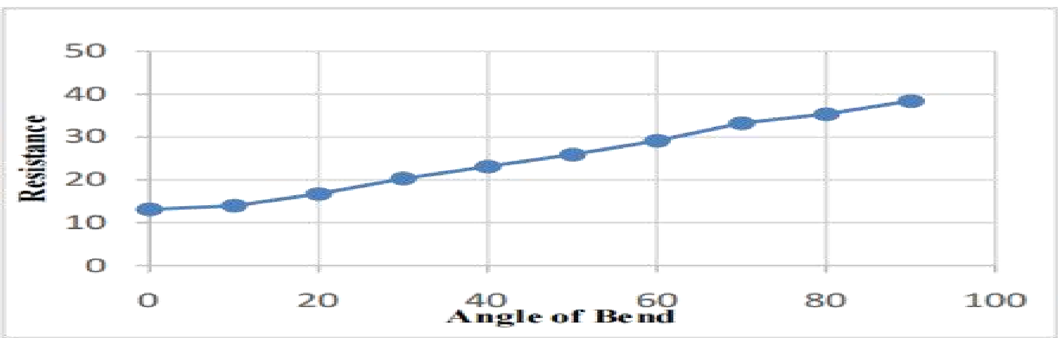


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Figure 6.2 Response of Flex sensor resistance to angle of bend of each finger

6.2. Case 2 : If the person needs medicine or tablets. For tablets, t a particular sign gesture is set which is shown in figure 6.2. when index finger and middle finger gets bent up-to 90 degrees at a time the gesture represents “please give me Tablets” on Lcd display as well as converted in to speech though Bluetooth TTS Application

Figure 6.3 Sign gesture for “please give me Tablets”

6.3. Case 3: If the person needs some juice. For juice, a particular sign gesture is set which is shown in figure 6.4 when middle finger and ring finger gets bent up-to 90 degrees at a time the gesture represents “please give me some juice” on Lcd display as well as converted in to speech though Bluetooth TTS Application

Figure 6.4 sign gesture represnting “please give me some juice”

6.4. Case 4 :

If the person wants to go washroom. For washroom, a particular sign gesture is set which is shown in figure 6.4 when middle finger and ring finger gets bent up-to 90 degrees at a time the gesture represents "I need to go washroom" on Lcd display as well as converted in to speech though Bluetooth TTS Application

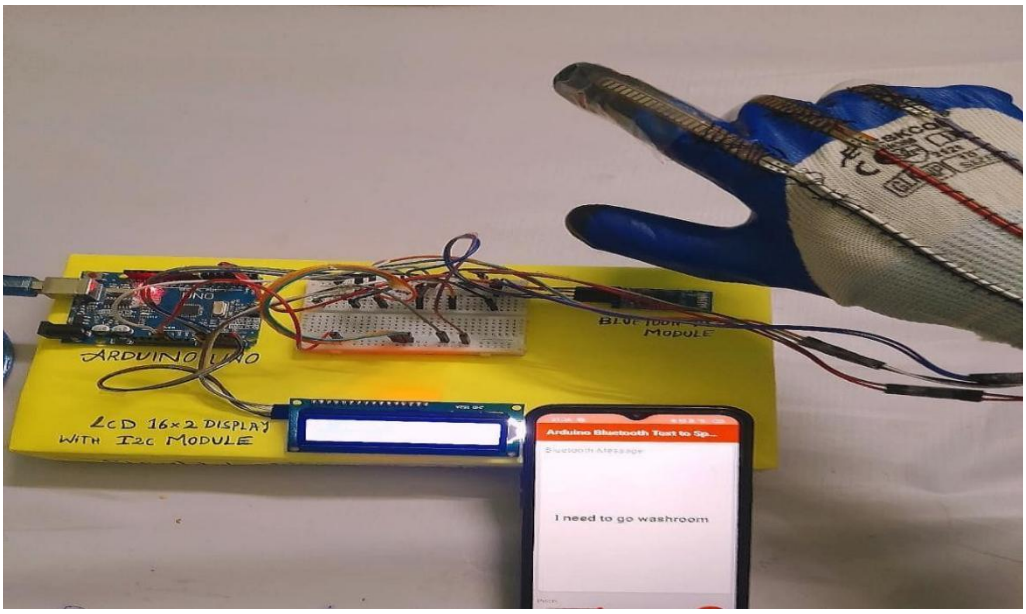

Figure 6.5 sign gesture represnting "I need to go washroom"

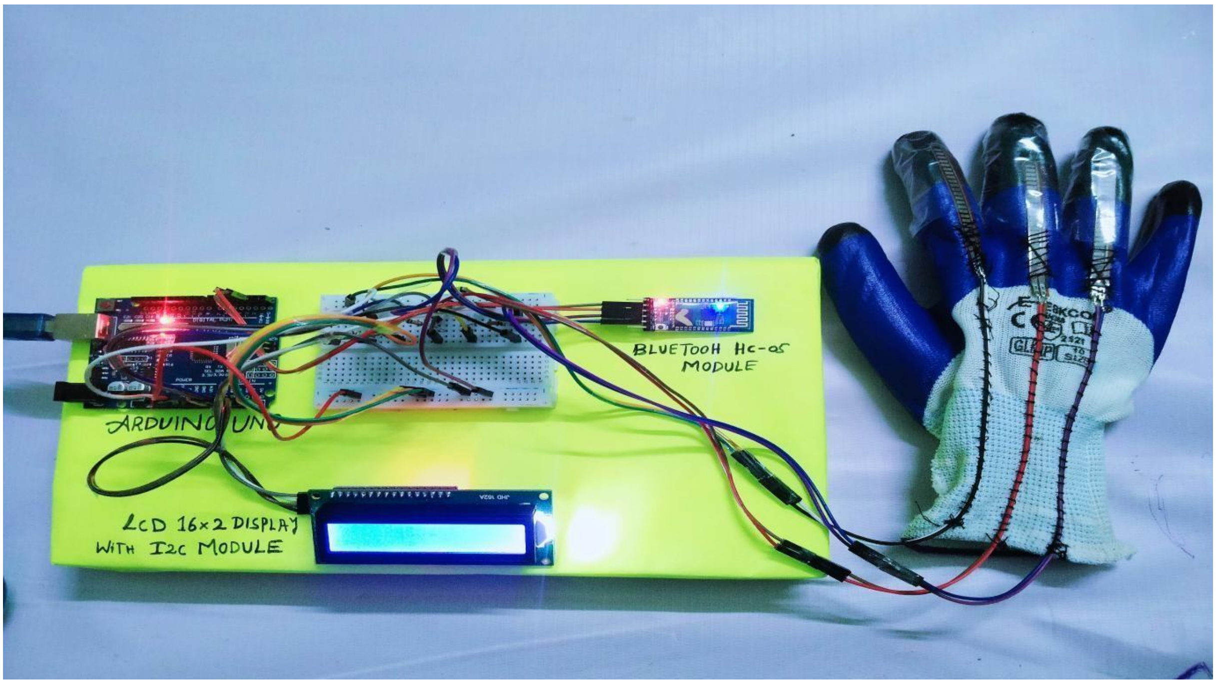

Figure 6.6 Final prototype

7.CONCLUSION

The flex sensor-based sign gesture to speech conversion system for speech impaired people, complemented by the Bluetooth HC-05 module, marks a advancement in accessibility technology. By leveraging the nuanced movements detected by the flex sensor and the seamless wireless communication facilitated by the HC-05 module, this system bridges communication barrier between people fluent in sign language and those who rely on spoken language.

Through the integration of a microcontroller for gesture recognition and a receiving device for speech synthesis, the system enables real-time translation of sign gestures into audible speech. This capability not only enables communication but also fosters inclusivity and understanding in various social and professional settings.

The optional inclusion of an LCD display further enriches the user experience by providing visual feedback, ensuring accurate gesture recognition, and reinforcing communication efficacy. Such features are crucial in empowering individuals with hearing impairments to engage more fully in conversations, interactions, and daily activities.

Beyond its immediate utility, this system embodies a commitment to accessibility and inclusivity, serving as a catalyst for social change and awareness. By breaking down communication barriers, it promotes empathy, understanding, and mutual respect among individuals with diverse linguistic abilities.

Looking ahead, continued refinement and development of such technologies hold promise for further enhancing accessibility and connectivity. By embracing innovation and technological advancements, we can strive towards building more inclusive societies where everyone has equal opportunities to participate, and thrive. In essence, the flex sensor based sign gesture to speech conversion system represents a pivotal step towards creating a more accessible and inclusive world for all.

8.FUTURE SCOPE

Enhanced Gesture Recognition: Future gesture recognition might get better by making algorithms more accurate and strong. They could use machine learning to learn and recognize more sign language gestures accurately..

Miniaturization and Wearable Integration: Efforts may be directed towards miniaturizing the hardware components, making them more lightweight and wearable. Integration into everyday accessories such as smartwatches or wristbands could offer discreet and convenient communication solutions for persons with hearing impairments.

Real-Time Feedback and Interaction: Future iterations of the system may explore real-time feedback mechanisms, such as haptic feedback or augmented reality overlays, to provide immediate guidance and assistance during sign language communication.

Multi-Modal Communication: Expanding the system to support multi-modal communication, including both sign language and text-based input/output, could further enhance its versatility and usability across different communication preferences and environments.

Localization and Customization: Tailoring the system to support different sign language dialects and regional variations could increase its relevance and accessibility in diverse linguistic communities worldwide. Additionally, allowing users to customize gesture recognition models based on individual preferences or unique signing styles could improve user satisfaction and adoption.

Integration with Smart Assistants and IoT Devices: Integrating the system with virtual assistants and IoT devices could enable seamless integration into smart homes and environments, empowering persons with hearing impairments to control and interact with their surroundings using sign language.

Accessibility in Education and Healthcare: The system's application in educational settings, such as classrooms and lecture halls, could facilitate communication between students, teachers, and peers. Similarly, in healthcare settings, it could improve communication between healthcare professionals and patients with hearing impairments, enhancing the quality of care and patient experience.

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ANNEXURE

```
#include "SoftwareSerial.h"
#include <LiquidCrystal_I2C.h>
#include <SoftwareSerial.h>
SoftwareSerial bluetooth(3, 2);
LiquidCrystal_I2C lcd(0x27, 16, 2);

#define blue 2
#define green 3
#define red 4

unsigned int f;
unsigned int g;
unsigned int h;

void setup() {

  pinMode(blue, OUTPUT);
  pinMode(green, OUTPUT);
  pinMode(red, OUTPUT);
  Serial.begin(9600);
  bluetooth.begin(9600);
  Serial.println();
  lcd.init();
  lcd.backlight();
  lcd.setCursor(0, 0);
  lcd.print("  Welcome To");
  lcd.setCursor(0, 1);
  lcd.print("My mini-project");
  lcd.clear();
  delay(3000);
}

void loop() {

  f = analogRead(1);
  g = analogRead(2);
  h = analogRead(3);

  if (f <= 260 && f>= 248 ) {
    digitalWrite(blue, HIGH);
    digitalWrite(green, LOW);
    digitalWrite(red, LOW);
    bluetooth.println(" Please give me food I am hungry");
    lcd.clear();
    lcd.setCursor(0, 0);
    lcd.print("Please give me");
    lcd.setCursor(0, 1);
    lcd.print("food Iam hungry");
    delay(3000);
    lcd.clear();
    lcd.setCursor(0, 0);
    lcd.print(" If Anything");
    lcd.setCursor(0, 1);
    lcd.print("  You Want ");
}

  else if (f <= 248 && f >= 235) {
    digitalWrite(blue, HIGH);
    digitalWrite(green, LOW);
    digitalWrite(red, LOW);
    bluetooth.println(" please give me water ");
    lcd.clear();
    lcd.setCursor(0, 0);
    lcd.print("please give me");
```

```
  lcd.setCursor(0, 1);
  lcd.print(" water ");
  delay(3000);
  lcd.clear();
  lcd.setCursor(0, 0);
  lcd.print(" If Anything");
  lcd.setCursor(0, 1);
  lcd.print("  You Want ");


}else if (g <= 275 && g >= 265) {
  digitalWrite(green, HIGH);
  digitalWrite(blue, LOW);
  digitalWrite(red, LOW);
  bluetooth.println(" please give me some fruits ");
  lcd.clear();
  lcd.setCursor(0, 0);
  lcd.print("please give me");
  lcd.setCursor(0, 1);
  lcd.print("some fruits");
  delay(3000);
  lcd.clear();
  lcd.setCursor(0, 0);
  lcd.print(" If Anything");
  lcd.setCursor(0, 1);
  lcd.print("  You Want ");


}else if (g <= 265 && g >= 245) {
  digitalWrite(green, HIGH);
  digitalWrite(blue, LOW);
  digitalWrite(red, LOW);
  bluetooth.println(" please give me some juice ");
  lcd.clear();
  lcd.setCursor(0, 0);
  lcd.print("please give me");
  lcd.setCursor(0, 1);
  lcd.print("some juice");
  delay(3000);
  lcd.clear();
  lcd.setCursor(0, 0);
  lcd.print(" If Anything");
  lcd.setCursor(0, 1);
  lcd.print("  You Want ");


}else if (h <= 270 && h >= 260) {
  digitalWrite(red, HIGH);
  digitalWrite(blue, LOW);
  digitalWrite(green, LOW);
  bluetooth.println("  I need help ");
  lcd.clear();
  lcd.setCursor(0, 0);
  lcd.print("I need help");
  lcd.setCursor(0, 1);
  lcd.print(" ");
  delay(3000);
  lcd.clear();
  lcd.setCursor(0, 0);
  lcd.print(" If Anything");
  lcd.setCursor(0, 1);
  lcd.print("  You Want ");


}else if (h <= 260 && h >= 240) {
  digitalWrite(red, HIGH);
  digitalWrite(blue, LOW);
```

```
    digitalWrite(green, LOW);
    bluetooth.println(" please give me coffee ");
    lcd.clear();
    lcd.setCursor(0, 0);
    lcd.print("please give me");
    lcd.setCursor(0, 1);
    lcd.print("coffee ");
    delay(3000);
    lcd.clear();
    lcd.setCursor(0, 0);
    lcd.print(" If Anything");
    lcd.setCursor(0, 1);
    lcd.print("  You Want ");

}else if (f <= 270 && g <= 276) {
    digitalWrite(green, HIGH);
    digitalWrite(blue, LOW);
    digitalWrite(red, LOW);
    bluetooth.println("I need to go washroom ");
    lcd.clear();
    lcd.setCursor(0, 0);
    lcd.print("I need to go ");
    lcd.setCursor(0, 1);
    lcd.print(" washroom ");
    delay(3000);
    lcd.clear();
    lcd.setCursor(0, 0);
    lcd.print(" If Anything");
    lcd.setCursor(0, 1);
    lcd.print("  You Want ");

  }else if (g <= 284 && h <= 284) {
    digitalWrite(green, HIGH);
    digitalWrite(red, LOW);
    digitalWrite(blue, LOW);
    bluetooth.println(" please give me Tablets");
    lcd.clear();
    lcd.setCursor(0, 0);
    lcd.print(" please give me");
    lcd.setCursor(0, 1);
    lcd.print("Tablets");
    delay(3000);
    lcd.clear();
    lcd.setCursor(0, 0);
    lcd.print(" If Anything");
    lcd.setCursor(0, 1);
    lcd.print("  You Want ");

  }else {
  delay(200);
}
void sendMessage(String message) {
  lcd.clear();
  lcd.print("Sign: " + message);

  bluetooth.println(message);
  delay(3000);  // Adjust the delay based on your application
}
```