

EMBEDDED SYSTEMS PROJECT



**Department of Electronics and Communication Engineering Indian
Institute of Information Technology Design and Manufacturing
Kurnool-518008, Andhra Pradesh (India)**

PROJECT REPORT

Sign Language Glove

Submitted by:

- **KRISHNA TEJA REGINTALA (122EC0045)**

Overview:

This project focuses on developing a wearable glove that recognizes sign language gestures and translates them into text or speech using Arduino and Bluetooth. The goal is to create an accessible tool for individuals with hearing impairments, enabling easier communication through sign language.

Importance:

Sign language is the primary mode of communication for many individuals with hearing disabilities. However, not everyone is familiar with it. This project aims to bridge that communication gap by creating an automated system to translate sign language into readable text or audible speech.

Technology:

The system utilizes Arduino for hardware control, flex sensors to detect finger movements, and Bluetooth for wireless communication to send data to a receiving device (smartphone, PC, etc.). The gesture data is then translated into text or speech.

Objectives:

- Develop a Wearable Sign Language Recognition Glove
- Integrate Bluetooth for Wireless Communication
- Convert Gestures into Digital Text or Speech
- User-Friendly Interface

System Architecture:

- Arduino UNO/NANO
- Flex Sensors
- Bluetooth Module (HC-05)
- Accelerometer ADXL
- Jumper Wires, Glove
- Bread Board, 9V Battery
- Bluetooth Communication Protocol
- Arduino IDE and Gesture Recognition Algorithm.

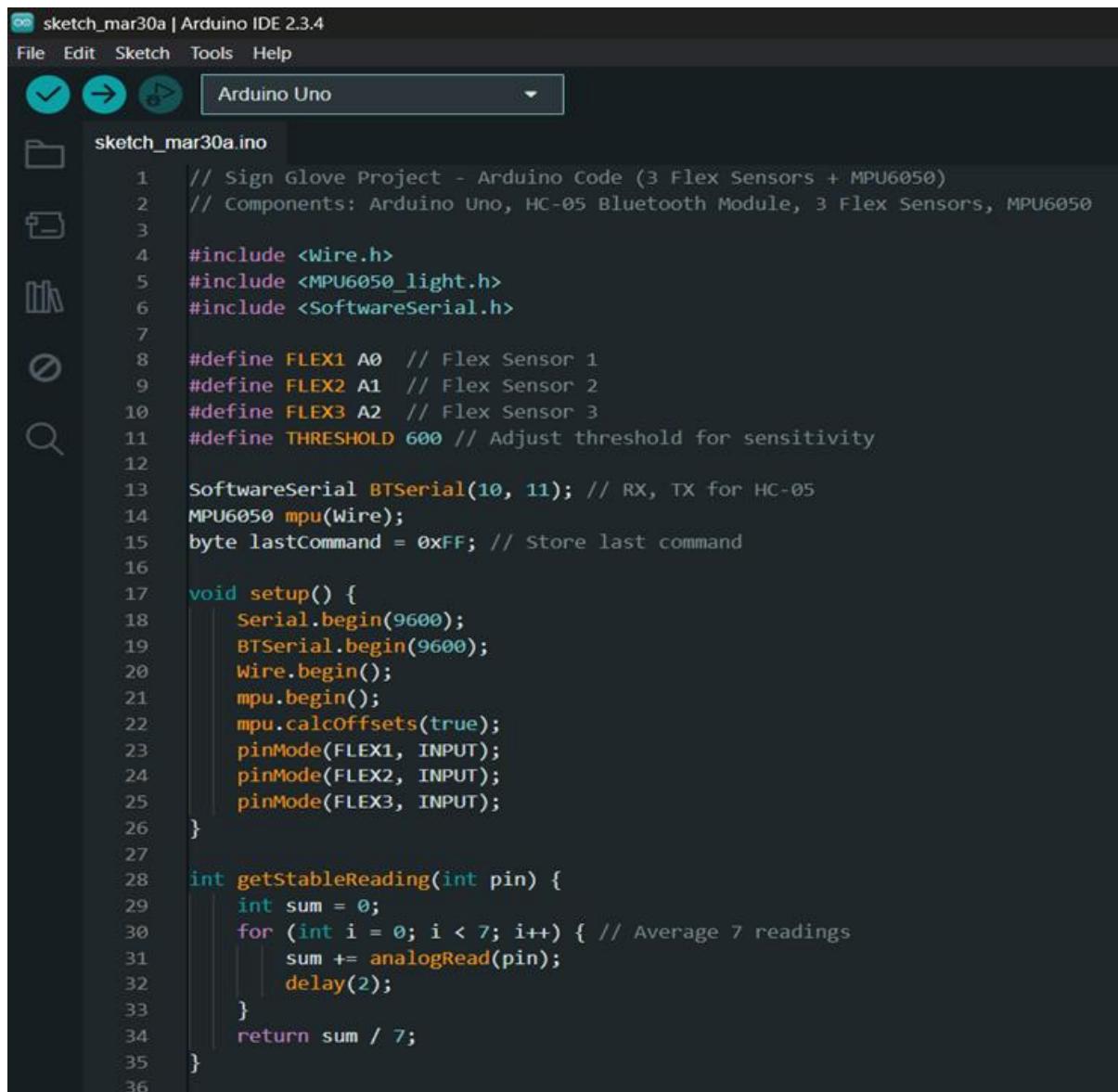
Working Mechanism:

- Step 1: The user wears the glove and makes a sign language gesture.
- Step 2: The flex sensors on the glove detect the bending of the fingers, generating corresponding data.
- Step 3: The Arduino processes the data and identifies the gesture based on predefined patterns.
- Step 4: The identified gesture is transmitted to a smartphone or computer via Bluetooth.
- Step 5: The receiving device translates the gesture into text or speech, providing real-time feedback to the user.

TRUTH TABLE FOR COMMANDS USING 3-BITS (8 variations):

Flex3 (A2)	Flex2 (A1)	Flex1 (A0)	Command Sent
0	0	0	Emergency
0	0	1	I need water
0	1	0	I need help
0	1	1	I am hungry
1	0	0	Call a doctor
1	0	1	I am in pain
1	1	0	I am okay
1	1	1	(No command defined)

CPP CODE FOR GESTURE RECOGNITION:



The screenshot shows the Arduino IDE interface with the following details:

- Title Bar:** sketch_mar30a | Arduino IDE 2.3.4
- Menu Bar:** File Edit Sketch Tools Help
- Tool Buttons:** Checkmark, Refresh, Upload, and a dropdown menu set to "Arduino Uno".
- Code Editor:** Displays the `sketch_mar30a.ino` file content.

```
// Sign Glove Project - Arduino Code (3 Flex Sensors + MPU6050)
// Components: Arduino Uno, HC-05 Bluetooth Module, 3 Flex Sensors, MPU6050
#include <Wire.h>
#include <MPU6050_light.h>
#include <SoftwareSerial.h>

#define FLEX1 A0 // Flex Sensor 1
#define FLEX2 A1 // Flex Sensor 2
#define FLEX3 A2 // Flex Sensor 3
#define THRESHOLD 600 // Adjust threshold for sensitivity

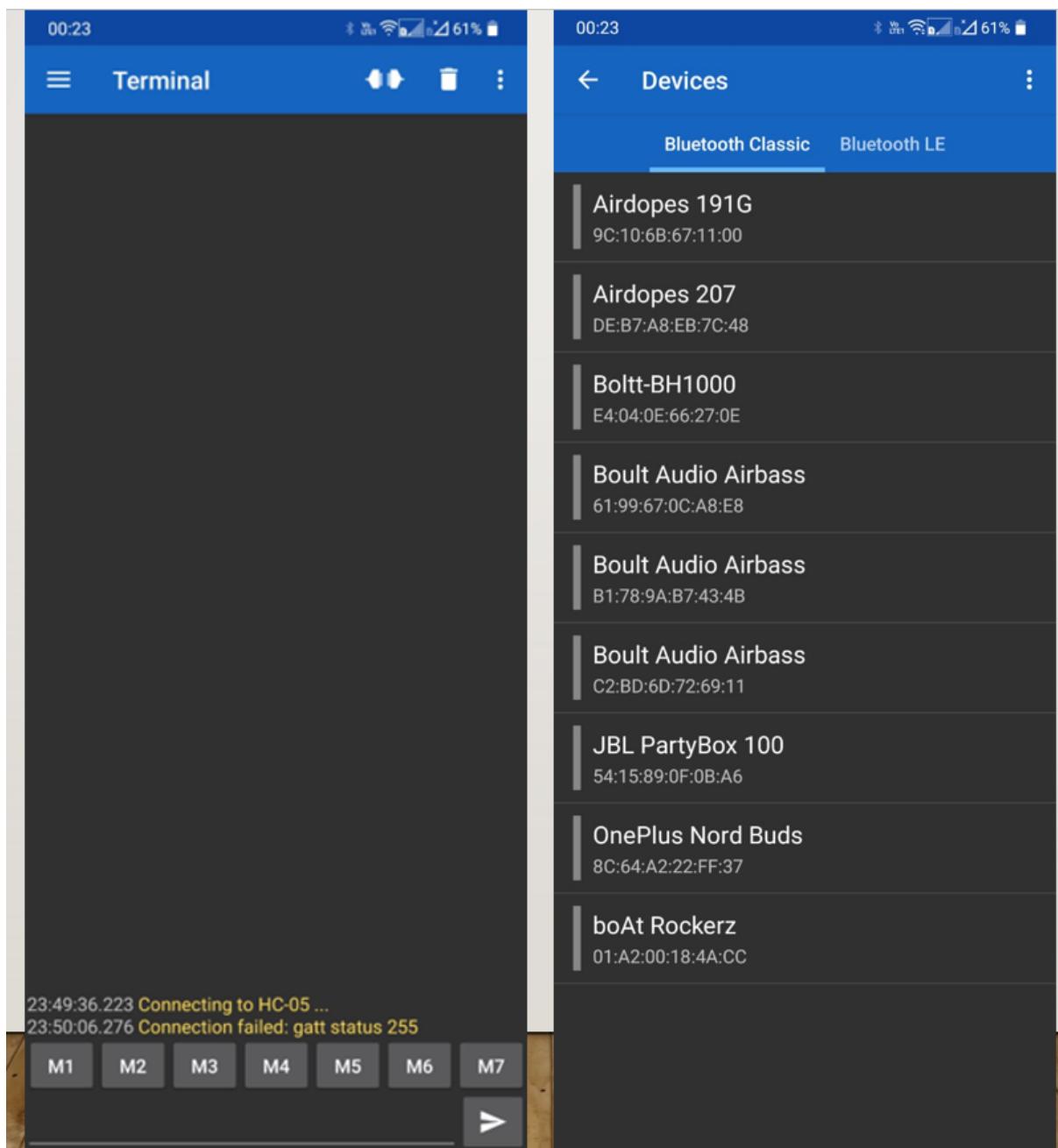
SoftwareSerial BTSerial(10, 11); // RX, TX for HC-05
MPU6050 mpu(Wire);
byte lastCommand = 0xFF; // Store last command

void setup() {
    Serial.begin(9600);
    BTSerial.begin(9600);
    Wire.begin();
    mpu.begin();
    mpu.calcoffsets(true);
    pinMode(FLEX1, INPUT);
    pinMode(FLEX2, INPUT);
    pinMode(FLEX3, INPUT);
}

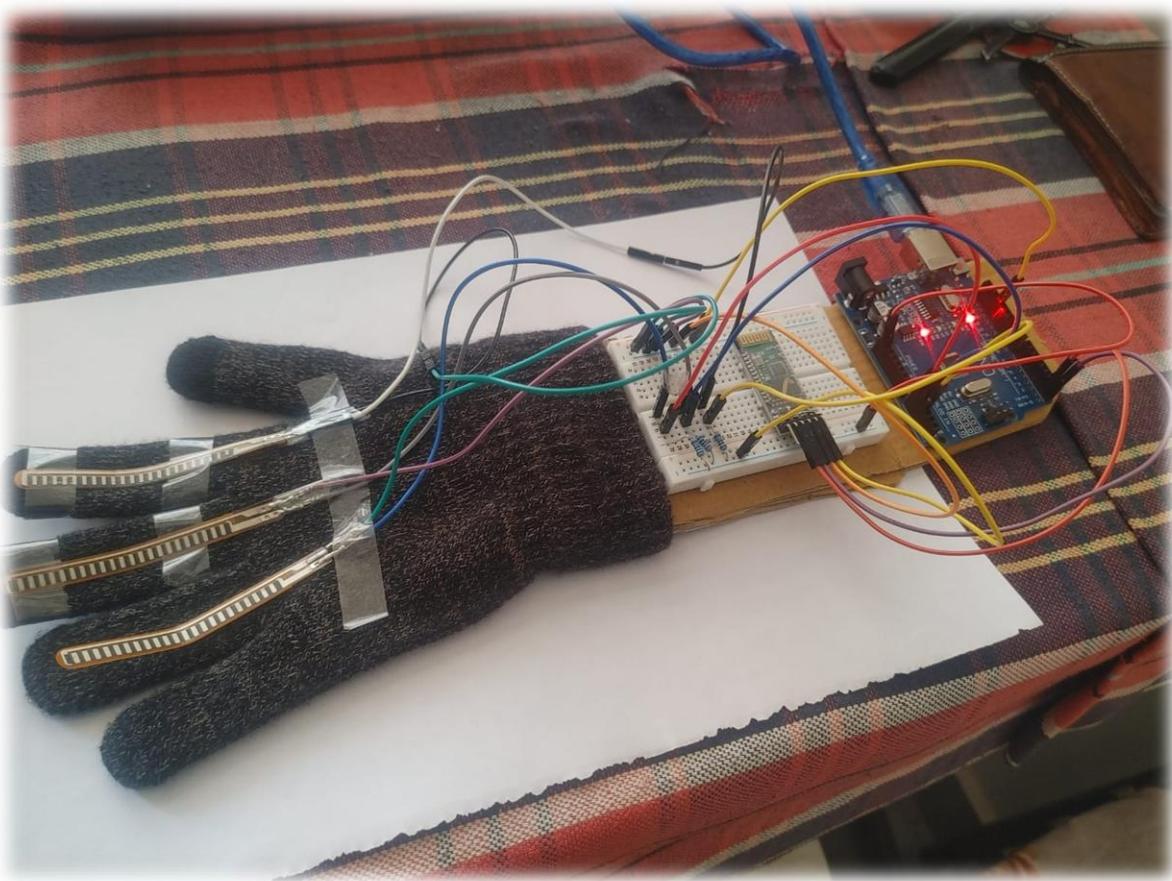
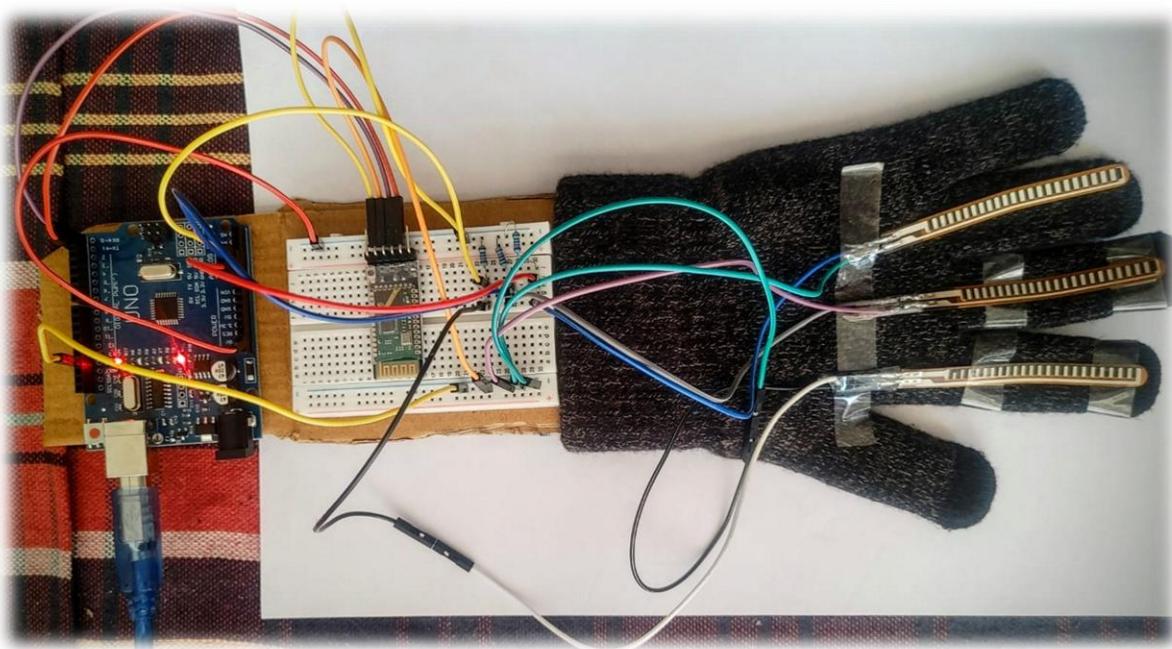
int getStableReading(int pin) {
    int sum = 0;
    for (int i = 0; i < 7; i++) { // Average 7 readings
        sum += analogRead(pin);
        delay(2);
    }
    return sum / 7;
}
```

```
37 void loop() {
38     int flex1 = getStableReading(FLEX1);
39     int flex2 = getStableReading(FLEX2);
40     int flex3 = getStableReading(FLEX3);
41
42     byte flex1State = (flex1 > THRESHOLD) ? 0b1 : 0b0;
43     byte flex2State = (flex2 > THRESHOLD) ? 0b1 : 0b0;
44     byte flex3State = (flex3 > THRESHOLD) ? 0b1 : 0b0;
45     byte command = (flex3State << 2) | (flex2State << 1) | flex1State;
46
47     String gesture = "";
48     switch (command) {
49         case 0b000: gesture = "Emergency"; break;
50         case 0b001: gesture = "I need water"; break;
51         case 0b010: gesture = "I need help"; break;
52         case 0b011: gesture = "I am hungry"; break;
53         case 0b100: gesture = "Call a doctor"; break;
54         case 0b101: gesture = "I am in pain"; break;
55         case 0b110: gesture = "I am okay"; break;
56     }
57
58     mpu.update();
59     float ax = mpu.getAccX();
60     float ay = mpu.getAccY();
61     float az = mpu.getAccZ();
62
63     if (ax > 1.5) gesture = "Call a nurse";
64     else if (ax < -1.5) gesture = "I feel dizzy";
65     else if (ay > 1.5) gesture = "Increase room temperature";
66     else if (ay < -1.5) gesture = "Decrease room temperature";
67     else if (az > 1.5) gesture = "Turn on lights";
68     else if (az < -1.5) gesture = "Turn off lights";
69
70     if (gesture != "") {
71         Serial.print("COMMAND SENT -> ");
72         Serial.println(gesture);
73         BTSerial.println(gesture);
74     }
75
76     delay(200);
77 }
```

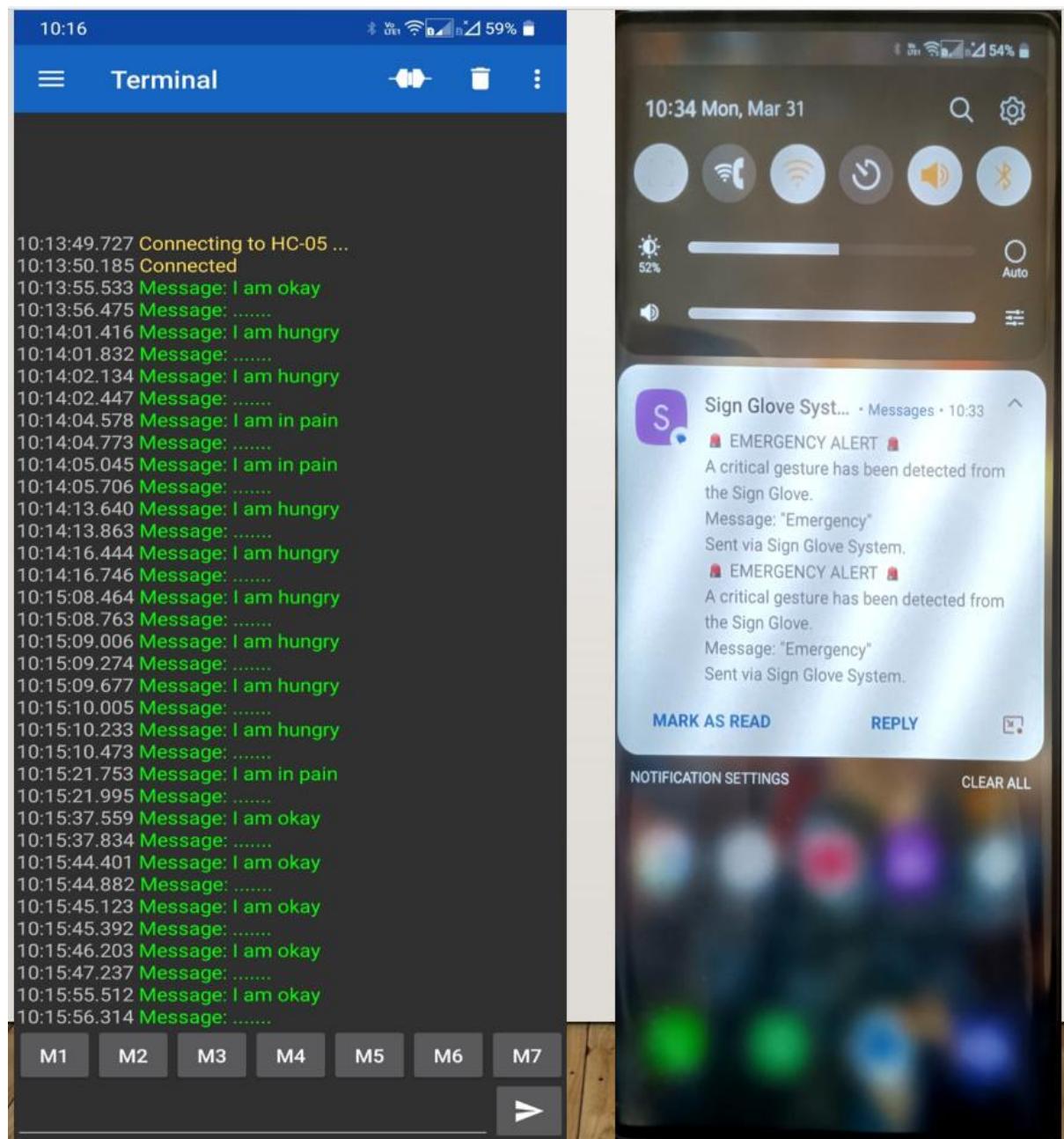
Designed Bluetooth Terminal Application:



PROTOTYPE:



Results:



Uses of the Sign Glove for Patients :

The Sign Glove project using flex sensors + MPU6050 accelerometer provides an innovative way for patients to communicate effectively, especially for those with limited speech or mobility.

Key Benefits for Patients:

1. Non-Verbal Communication
2. Quick Emergency Alerts
3. Motion-Based Assistance
4. Reduced Caregiver Workload
5. Improved Patient Comfort
6. Usable for Multiple Medical Conditions

BILL OF MATERIALS:

Component	Approx. Cost (INR)
Arduino Uno Clone	₹350
HC-05 Bluetooth Module	₹150
3 Flex Sensors	₹300 (₹100 each)
MPU6050 IMU Sensor	₹100
Glove (base material)	₹100
Wires, connectors, misc	₹100
Assembly labor	₹100
Total BOM Cost	~₹1,200

IDEAL SELLING PRICE:

Strategy	Price Range (INR)	Target Group	Notes
Social Impact / NGO	₹1,500 – ₹2,000	Needy patients, hospitals	Break-even or slight profit
Retail / Market Rate	₹2,500 – ₹3,500	Mass market	Includes packaging, profit, support
Premium Smart Version	₹4,000 – ₹5,000	Hospitals, accessibility startups	Add mobile app, SMS alerts, battery

Conclusion:

The **Sign Glove** successfully bridges the communication gap for **patients with speech or mobility impairments**, allowing them to convey their needs effortlessly. By integrating **flex sensors** and an **MPU6050 accelerometer**, the glove translates hand gestures into predefined commands, which are then transmitted via **Bluetooth** to a connected device.

This project has significant **applications in healthcare**, especially for **bedridden patients, individuals with paralysis, and elderly patients** who face difficulty in verbal communication. The system ensures **quick response times** from caregivers, enhancing patient care and comfort.