

SMART GLOVE FOR DEAF AND DUMB

Submitted in partial fulfillment of the requirements for the award of Bachelor of
Technology degree in Biotechnology
Interdisciplinary Project

By

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DEPARTMENT OF BIOTECHNOLOGY

SCHOOL OF BIO AND CHEMICAL ENGINEERING

SATHYABAMA

INSTITUTE OF SCIENCE AND TECHNOLOGY

(DEEMED TO BE UNIVERSITY)

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BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of **VISHAKA. K. S (41230074)** and **ABIRAMI. S (41240002)** who carried out the Interdisciplinary Project entitled "**SMART GLOVE FOR DEAF AND DUMB**" under our supervision from **JANUARY 2024** to **APRIL 2024**.

Internal Guide

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DECLARATION

We, **VISHAKA. K. S (41230074)** and **ABIRAMI. S (41240002)** hereby declare that the Interdisciplinary Project Report entitled “**SMART GLOVE FOR DEAF AND DUMB**” done by us under the guidance of **Dr. V. RAMESH KUMAR, M.Phil., Ph.D.**, is submitted in partial fulfilment of the requirements for the award of Bachelor of Technology degree in Biotechnology.

DATE: 06.05.2024

PLACE: CHENNAI

A handwritten signature in black ink, appearing to read 'K.S. Vinita', with a stylized flourish at the end.

SIGNATURE OF THE CANDIDATE

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ABSTRACT

This project introduces a novel approach to fostering communication between the deaf and mute community and non-deaf and mute individuals through the development of a Smart Glove system. The system is designed to interpret hand gestures made by the wearer using flex sensors embedded within the glove. Each gesture corresponds to a predefined set of comments or messages, enabling the wearer to convey meaning without the need for traditional spoken or written language.

The project's implementation involves the design and calibration of the flex sensors to accurately detect a wide range of hand gestures. These gestures are then mapped to corresponding comments or messages, allowing for a diverse and expressive means of communication. The Arduino app plays a crucial role in translating these gestures into understandable communication for non-deaf and mute individuals, thereby promoting inclusivity and understanding in various social and professional settings.

Keywords: Assistive technology, Communication aid, Gesture recognition, Flex sensors, Accessibility, Non-verbal communication, Arduino, Wearable technology, Social integration.

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LIST OF ABBREVIATION

LED	Light Emitting Diode
LCD	Liquid crystal display
PWM	Pulse Width Modulation
UART	Universal Asynchronous Receiver-Transmitter
SPI	Serial Peripheral Interface
I2C	Inter-Integrated Circuit

CHAPTER 1

INTRODUCTION

The "Smart Glove" prototype system represents a groundbreaking innovation aimed at addressing the profound communication challenges encountered by deaf-mute individuals. In a world where communication is predominantly verbal, it's estimated that around 650 million people grapple with disabilities that impede their ability to hear or speak fluently. Within this population, 15% to 20% are classified as deaf and mute, facing significant barriers in effective interaction with others. Traditional methods of communication, such as sign language, though effective, necessitate extensive training for both the deaf-mute individuals and those they wish to communicate with, presenting formidable obstacles to seamless communication. (Abhinandan Das *et al.*, 2016).

The Smart Glove system harnesses cutting-edge gesture recognition technology to offer a transformative solution. Embedded sensors or cameras capture and interpret intricate hand movements and gestures made by the wearer. These signals undergo meticulous processing by a sophisticated microcontroller or computing device housed within the glove. Complex algorithms accurately decipher and interpret gestures in real-time, enabling the generation of instant text messages.

These text messages can be conveniently displayed on a screen integrated into the glove, providing instant visual feedback to the wearer. Alternatively, they can be wirelessly transmitted to a companion device such as a smartphone or tablet. Moreover, the system incorporates speech synthesis technology, allowing the text messages to be converted into spoken words simultaneously. This groundbreaking feature enables non-deaf and mute individuals to engage in two-way communication with their deaf-mute counterparts, bridging the communication gap that has long persisted.

At the heart of the Smart Glove system lies the integration of Arduino Nano technology, a versatile microcontroller platform known for its flexibility and efficiency. The Arduino Nano facilitates the real-time interpretation of hand

gestures, ensuring swift and accurate responses to the wearer's movements. Furthermore, the system leverages Bluetooth connectivity to establish seamless communication with a dedicated Arduino app installed on a mobile device. This app serves as a user-friendly interface through which non-deaf and mute individuals can effortlessly receive communication in both voice and text formats, enhancing accessibility and inclusivity. (Suri *et al.*, 2020).

The impact of the Smart Glove extends beyond practical utility, holding the potential to foster greater connectivity and understanding within diverse communities. In educational settings, it facilitates more effective communication between students and educators, ensuring equal access to learning opportunities. In healthcare, it empowers deaf-mute individuals to articulate their needs and concerns to medical professionals, enhancing the quality of care they receive.

By providing a seamless and intuitive means of communication, the Smart Glove system aspires to transcend the limitations faced by deaf-mute individuals, thereby enhancing their social inclusion and improving their overall quality of life. Beyond its practical utility, this innovative solution holds the potential to foster greater connectivity and understanding within diverse communities, paving the way for a more inclusive and empathetic society.

The Smart Glove represents a remarkable advancement in assistive technology, offering hope for individuals facing communication barriers due to hearing impairments. Its innovative design and functionality promise to enhance social inclusion and improve the overall quality of life for deaf-mute individuals. As society embraces the potential of technologies like the Smart Glove, we move closer to building a more inclusive and empathetic world where communication knows no boundaries.

CHAPTER 2

LITERATURE SURVEY

In the pursuit of overcoming communication barriers for the disabled community, numerous researchers have explored innovative solutions, each contributing uniquely to the advancement of inclusive communication technologies.

Angelin Jael *et al.*, embarked on a mission to address the communication challenges faced by disabled individuals in the year 2016, particularly those who are dumb, deaf, or partially paralyzed. Their study introduced a novel device aimed at facilitating communication without necessitating the learning of sign language. By employing flex sensors stitched onto gloves, the team enabled gesture-based communication, emphasizing the paramount importance of ensuring device accessibility for users at all times. Similarly, Abdulla *et al.* recognized the limitations of sign language, especially in non-English speaking regions. Their research focused on developing a solution to enable deaf and mute individuals to communicate effectively in Arabic. Through the creation of a smart glove capable of translating sign language gestures into Arabic text, the team aimed to enhance communication accessibility for Arabic speakers with hearing impairments.

The publication by Sandeep *et al.*, (2021) , "Hand Glove for Deaf and Dumb Impaired," introduces an inclusive communication device tailored for individuals with limited text-based abilities in professional settings. This innovative glove transcends traditional aids by translating alphabets and common words into both text and Indian Sign Language, prioritizing user-friendliness and eliminating the need for extensive sign language learning. By converting sign language gestures into text and audio formats, the Hand Glove overcomes communication barriers in the workplace. Enhanced by dynamic Flex Sensor technology, it promises improved communication efficiency. Sandeep's creation signifies a significant advancement in promoting inclusivity and accessibility, empowering individuals with limited text-based communication abilities to engage confidently and effectively in professional environments.

In the year 2021 Yadav Punarvit *et al.*, developed an innovative project titled "Arduino-based Smart Gloves for Deaf and Dumb," aimed at addressing communication challenges faced by individuals with speech impairments. These intelligent hand-mittens serve as a powerful tool, seamlessly translating hand signals into spoken words and voice, thereby enhancing communication clarity for users. Additionally, the gloves feature an integrated IoT-based system that enables control over home automation, promoting daily independence and convenience. Through continuous testing and user feedback, this system shows promise in minimizing obstacles for individuals with disabilities, empowering them to navigate their daily lives more effectively. This project represents a convergence of IoT and Android technologies, incorporating advancements such as GPS tracking for accident prevention. The gloves utilize finger gestures to control various home applications, showcasing the seamless potential of technology to enhance the lives of individuals with communication challenges.

Kumuda and Preethi Mame in 2020 developed a cost-effective system for translating American Sign Language (ASL) using smart gloves equipped with flexible resistive sensors (FLIX) and LabVIEW software. This innovative approach captures biosignals from finger movements, allowing LabVIEW to interpret gestures and concatenate letters into words for both visual and audio output. The system underwent rigorous calibration and testing with ASL users, with continuous refinement aimed at enhancing accessibility. This project represents a significant advancement in assistive technology, offering a practical solution for individuals with speech and hearing impairments to communicate effectively through ASL.

Anupama *et al.*, (2021) developed an automated sign language interpreter using data gloves. The system incorporates five flex sensors placed securely underneath the gloves, each connected to an Arduino UNO board via jumper wires. Aluminium foil acts as a contact sensor between fingers, enabling communication with a PC display screen through USB connection. The system efficiently identifies English alphabet letters and phrases, providing an

affordable communication solution for the deaf and mute communities. Further enhancements could involve recognizing facial variations during signing to enhance accuracy. This project represents a significant advancement in assistive technology, offering a practical solution for communication barriers faced by individuals with speech and hearing impairments.

Sathya *et al.*, (2022) introduces Raspberry Pi processor-based i-gloves tailored for the mute community and home automation. These smart gloves translate sign language into both text and speech, with the Raspberry Pi serving as the central controller. Converted text is displayed on an LCD, while speech is transmitted through Bluetooth-connected or regular speakers. This technology aims to enhance communication for individuals facing challenges in verbal expression or understanding spoken language. By translating gesture-based communication into text and speech, the glove prototype empowers individuals with hearing impairments for fuller engagement. With its efficient design and predictive features, it enhances accessibility and enriches lives. This project contributes significantly to assistive technology, providing practical solutions for communication barriers in the mute community.

The publication in the year 2022 by Santosh Kumar *et al.*, developed a glove-based sign language interpreter for individuals who are deaf or mute. This microprocessor-based system utilizes components like the MPU6050 for hand tilt detection and a flex sensor model interfaced with an MCP3008 analog-to-digital converter. By processing sensor data through signal processing and a decision-making algorithm, the system interprets sign language symbols effectively after training. Evaluation of the system demonstrates high precision and recall for sign language symbol recognition, surpassing existing methods despite encountering environmental factors and sensor noise limitations. User feedback emphasizes its effectiveness in bridging communication gaps, with case studies illustrating its potential to enhance inclusivity and accessibility for individuals with hearing impairments. This project represents a significant advancement in assistive technology, offering a promising solution for communication barriers faced by the deaf and mute community.

CHAPTER 3

AIM AND SCOPE OF PRESENT INVESTIGATION

3.1. AIM

The aim of this project is to design and develop a prototype system, known as the 'Smart Glove,' aimed at bridging communication barriers for deaf and mute individuals. Utilizing Arduino Nano microcontrollers and flex sensors, the Smart Glove aims to recognize and translate hand gestures into real-time text and voice output. By enhancing communication accessibility and integration, the Smart Glove seeks to empower deaf and mute individuals, fostering greater social inclusion and interaction opportunities.

3.2. SCOPE

- **Communication Enhancement:** Smart gloves can significantly improve communication for individuals who are deaf and mute by translating sign language gestures into text or speech. This technology can facilitate seamless interactions in various settings, including workplaces, educational institutions, and social gatherings.
- **Accessibility in Technology:** Smart gloves can be integrated with various technological devices and platforms to enhance accessibility for the deaf and mute community. For example, they can enable individuals to control smartphones, computers, and home automation systems using sign language gestures.
- **Education and Learning:** Smart gloves have the potential to revolutionize education and learning for individuals who are deaf and mute. They can be used to develop interactive learning tools and applications that teach sign language, facilitate communication skills development, and provide access to educational content.
- **Healthcare and Rehabilitation:** In healthcare settings, smart gloves can be used for communication between healthcare professionals and patients who are deaf and mute. They can also aid in rehabilitation programs for individuals with speech and hearing impairments by providing real-time feedback on sign language.

- **Innovation and Research:** The development of smart gloves for the deaf and mute community presents opportunities for innovation and research in fields such as sensor technology, machine learning, human-computer interaction, and assistive technology. Researchers can explore new algorithms and techniques to improve gesture recognition accuracy, reduce latency, and enhance user experience.
- **Global Impact:** Smart gloves have the potential to make a significant impact on a global scale by promoting inclusivity, accessibility, and equality for individuals who are deaf and mute. They can help bridge communication barriers, foster understanding and empathy, and empower individuals to participate fully in society.

CHAPTER 4

MATERIALS AND METHODS

4.1. MATERIALS

4.1.1. *Arduino NANO*

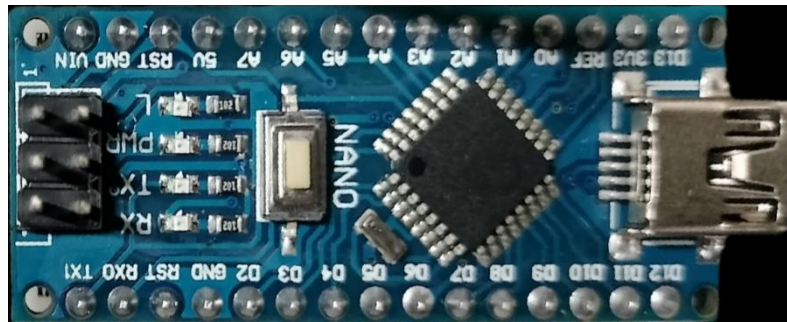


Fig 4.1 : Arduino NANO ATmega328

The Arduino Nano is a compact and versatile microcontroller board that is part of the Arduino family. It is based on the ATmega328P microcontroller, which is the same chip used in the Arduino Uno. However, the Nano is smaller in size and offers a more streamlined form factor compared to the Uno.

Key features of the Arduino Nano include

- **ATmega328P Microcontroller:** The heart of the Arduino Nano is the ATmega328P microcontroller, which runs at a clock speed of 16 MHz and has 32 KB of flash memory for storing program code.
- **Digital and Analog I/O Pins:** The Nano has 14 digital I/O pins, which can be used for interfacing with digital sensors, actuators, LEDs, and other components. Additionally, it has 8 analog input pins, allowing for the connection of analog sensors such as temperature sensors, light sensors, and potentiometers.
- **PWM (Pulse Width Modulation) Pins:** The Nano features 6 PWM pins, which can be used for controlling the brightness of LEDs, the speed of motors, or generating analog-like outputs.
- **UART, SPI, and I2C Interfaces:** The Nano supports serial communication through UART (Universal Asynchronous Receiver-Transmitter), SPI (Serial Peripheral

Interface), and I2C (Inter-Integrated Circuit) interfaces, enabling communication with other microcontrollers, sensors, and modules.

- USB Interface: The Nano can be powered and programmed via its USB interface, allowing for easy connection to a computer for programming and debugging purposes.

4.1.2. LCD display



Fig 4.2 : LCD Display

An LCD (Liquid Crystal Display) is a type of flat-panel display commonly used in electronic devices to visually convey information. LCD displays consist of a grid of tiny liquid crystal elements sandwiched between two transparent electrodes and two polarizing filters. These liquid crystals can change their orientation when subjected to an electric field, allowing them to control the passage of light through the display.

4.1.3. Bluetooth module



Fig 4.3 : Bluetooth module

A Bluetooth module is a small electronic device that enables wireless communication between electronic devices over short distances. It allows devices to establish a Bluetooth connection, enabling them to exchange data and communicate with each other without the need for physical cables.

Key features of the Bluetooth module include

- **Bluetooth Chip:** The core component of a Bluetooth module is the Bluetooth chip, which contains the hardware necessary for establishing and maintaining Bluetooth connections. The chip includes a radio transceiver, a microcontroller, and firmware that implement the Bluetooth protocol stack.
- **Antenna:** Bluetooth modules typically include an integrated antenna or a connector for an external antenna. The antenna is responsible for transmitting and receiving Bluetooth signals, allowing devices to communicate with each other wirelessly.
- **Interface:** Bluetooth modules feature one or more communication interfaces for connecting to host devices, such as microcontrollers or computers. Common interfaces include UART (Universal Asynchronous Receiver-Transmitter), SPI (Serial Peripheral Interface), and I2C (Inter-Integrated Circuit).
- **Power Supply:** Bluetooth modules require a power supply to operate. They are often designed to operate from a wide range of voltage levels and may include voltage regulation circuitry to ensure stable operation.
- **Protocols Supported:** Bluetooth modules support various Bluetooth protocols and profiles, including the Serial Port Profile (SPP) for serial communication, the Advanced Audio Distribution Profile (A2DP) for streaming audio, and the Human Interface Device (HID) profile for keyboard and mouse emulation, among others.
- **Pairing and Security:** Bluetooth modules support pairing and encryption to establish secure connections between devices. Pairing involves exchanging security keys between devices to authenticate their identities and encrypt data transmissions, ensuring privacy and security.

4.1.4. Flex sensor

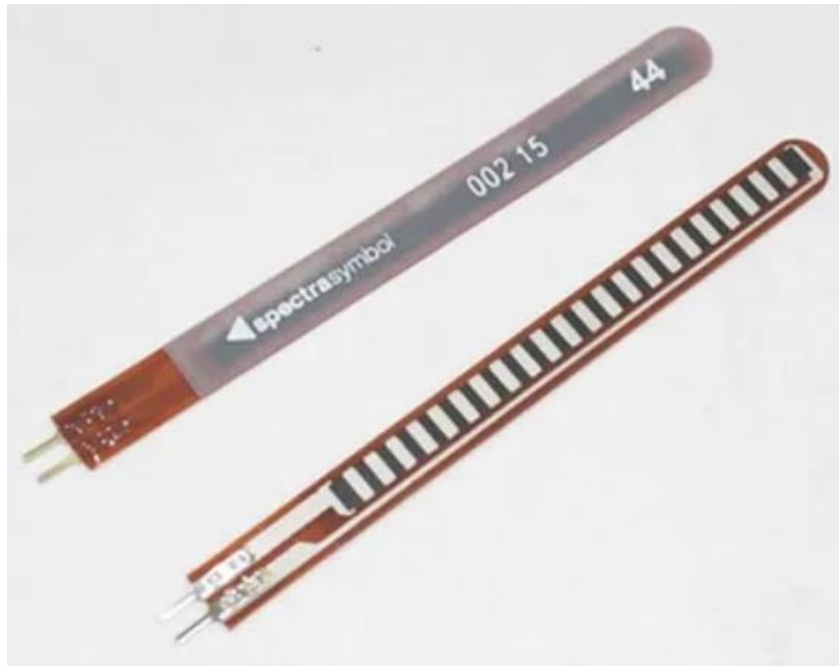


Fig 4.4 : Flex sensor(source: <https://m.indiamart.com/flex-sensor>)

A flex sensor is a type of sensor that detects bending or flexing of a physical object, such as a human finger or joint. It consists of a flexible substrate or strip made of a conductive material, typically carbon or conductive polymer, which changes resistance when bent. The resistance of the flex sensor varies in proportion to the amount of bending or flexing it experiences.

Key features of the Flex sensor include

- **Flexible Substrate:** The main component of a flex sensor is a flexible substrate or strip that undergoes bending or flexing when subjected to mechanical stress. The substrate is typically made of a flexible material such as plastic or rubber, allowing it to bend without breaking.
- **Conductive Material:** The flexible substrate is coated with a conductive material, such as carbon or conductive polymer, which forms a resistive element. When the substrate bends, the spacing between the conductive particles changes, altering the resistance of the sensor.

- **Linear Response:** Flex sensors exhibit a linear response to bending, meaning that the change in resistance is directly proportional to the amount of bending or flexing experienced by the sensor. This linear relationship allows for accurate measurement of bending angles or degrees of flexion.
- **Range and Sensitivity:** Flex sensors are available in various lengths and configurations, with different ranges and sensitivities to suit specific applications. Some sensors are highly sensitive and can detect subtle changes in bending, while others are designed for larger ranges of motion.

4.1.5. Resistor

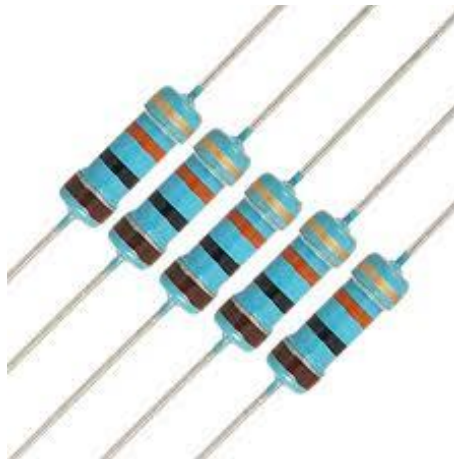


Fig 4.5 : 10k ohm resistor(Source : www.amazon.in)

A 10k ohm resistor is a type of fixed resistor with a resistance value of 10,000 ohms, often represented as 10k Ω . It is one of the most commonly used resistor values in electronic circuits due to its versatility and availability.

Key features of the Resistor include

- **Resistance Value:** The resistance value of a 10k ohm resistor is 10,000 ohms, which means it restricts the flow of electric current in a circuit. It is used to limit current, divide voltage, set bias conditions, and perform other functions in electronic circuits.
- **Color Code:** 10k ohm resistors are typically color-coded with a pattern of colored

bands that indicate their resistance value and tolerance. The color code for a 10k ohm resistor is brown-black-orange-gold, where:

- i) Brown represents the digit 1.
- ii) Black represents the digit 0.
- iii) Orange represents the multiplier 10^3 (or 1,000).
- iv) Gold represents the tolerance of $\pm 5\%$.

4.1.6. Breadboard

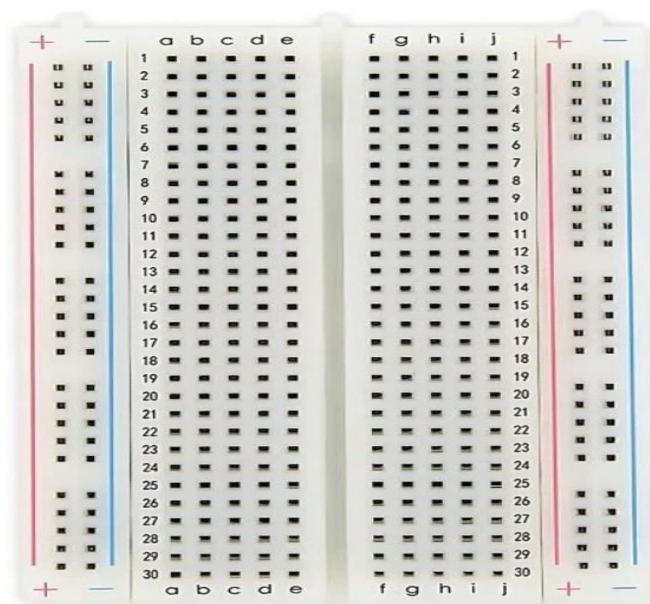


Fig 4.6 : Breadboard

The function of a breadboard is to provide a platform for prototyping electronic circuits quickly and without the need for soldering. It allows electronic components such as resistors, capacitors, integrated circuits, and wires to be easily inserted and connected, facilitating the construction and testing of circuits. The interconnected holes on the breadboard enable components to be arranged and connected in various configurations, making it versatile for experimenting with different circuit designs.

- Grid of Holes: Breadboards have a grid of holes for inserting electronic components and connecting wires.
- Power Rails: They typically have rows of interconnected metal strips for distributing power (+5V and GND).

4.1.7. Jumper wires



Fig 4.7 : Jumper wires(Source : in.rsdelivers.com)

Jumper wires are essential components in electronics prototyping, used to create electrical connections between various points on a breadboard or between components on a circuit board. They consist of insulated wires with connectors at each end, typically male pins (for insertion into breadboard holes) or female sockets (for connection to header pins or other male connectors).

4.1.8. Arduino cable



Fig 4.8 : Arduino Nano cable (Source : www.amazon.in)

- **Compact Design:** The Arduino Nano cable is known for its small and compact design, making it ideal for projects with limited space.
- **Versatile Connectivity:** Despite its size, the Arduino Nano cable offers a range of connectivity options, including digital and analog I/O pins, PWM pins, UART, SPI, and I2C interfaces.
- **Ease of Programming:** It can be easily programmed using the Arduino IDE, making it accessible for both beginners and experienced users.
- **USB Interface:** The Arduino Nano cable can be powered and programmed via its USB interface, simplifying the connection to a computer for programming and debugging.
- **Compatibility:** Despite its compact size, the Arduino Nano cable remains compatible with a wide range of shields and accessories designed for other Arduino boards, enhancing its versatility.

4.1.9. Arduino IDE

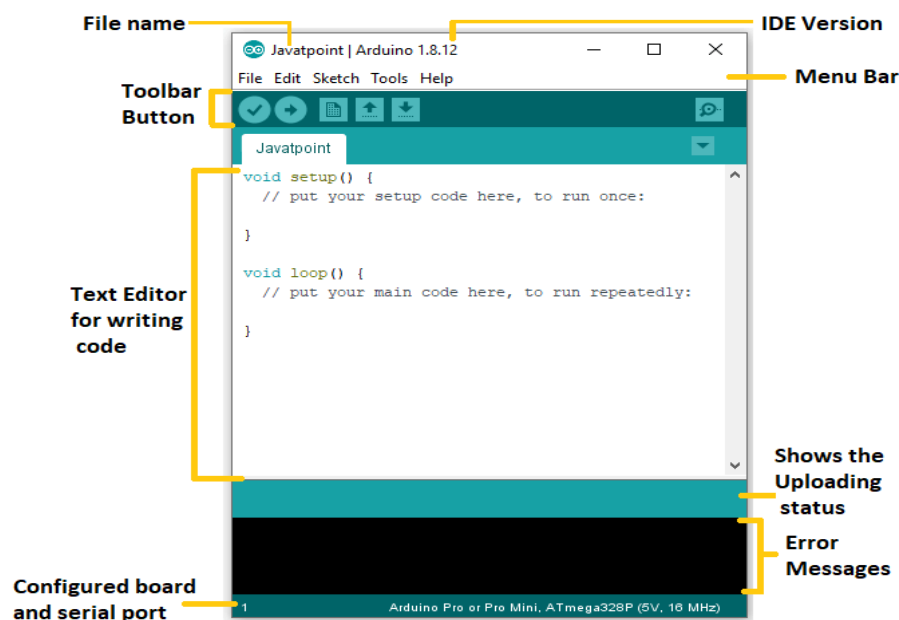


Fig 4.9 : Arduino IDE(WWW.Javatpoint.in)

- **USB Connectivity:** The Arduino Nano cable allows easy connection to a computer via USB for programming using the Arduino IDE.

- IDE Compatibility: It seamlessly integrates with the Arduino IDE, enabling smooth code upload and debugging.
- Driver Installation: Users may need to install USB drivers initially for proper connection with the Arduino IDE.
- Board Selection: In the IDE, users can select the Arduino Nano board from the "Tools" menu for correct compilation and uploading of code.
- Serial Monitor: The Arduino IDE's Serial Monitor aids in monitoring and debugging serial communication between the Nano and the computer.

4.2. METHODS

4.2.1. *Experiment*

- Setup Components

The initial step entails assembling the necessary hardware components on a breadboard. This includes connecting the Arduino Nano, Bluetooth module, 10k resistors, and an LCD display. The Arduino Nano serves as the central processing unit, while the Bluetooth module facilitates wireless communication with mobile devices. The 10k resistors are used for voltage division, and the LCD display provides a visual interface for displaying text messages.

- Connect to Laptop

Once the hardware components are set up on the breadboard, the Arduino Nano is connected to a laptop via a USB cable. This connection enables the transfer of code and facilitates the programming of the Arduino Nano using the Arduino Integrated Development Environment (IDE).

- Integrate Code

Using the Arduino IDE, the code for interpreting hand gestures and displaying text messages on the LCD display is integrated into the Arduino Nano. This code includes algorithms for gesture recognition, which analyze the sensor data from the smart gloves to identify specific hand movements and gestures.

- **Bluetooth Connection**

The Bluetooth module is configured to establish a wireless connection between the Arduino Nano and a mobile device. This connection enables the transmission of voice messages from the Arduino Nano to the mobile device, as well as the reception of commands or input from the mobile device.

- **Mobile App Installation**

To facilitate voice message reception, the Arduino app is installed on the mobile device. This app acts as a receiver for the voice messages transmitted by the Arduino Nano via Bluetooth. Users can install the app on their smartphones or tablets for convenient access to voice messages.

- **Gesture Recognition**

With the hardware components set up and the code integrated, the Arduino Nano is programmed to recognize hand gestures using sensors integrated into the smart gloves. The sensors capture the movement of the wearer's hands and convert them into digital signals, which are then processed by the Arduino Nano.

- **Voice Message Transmission**

During the testing phase, the system's ability to transmit voice messages via Bluetooth to a mobile device is evaluated. When a gesture is recognized, the system generates a corresponding voice message, providing auditory feedback to the recipient.

- **Text Message Display**

Concurrently, the system displays a text message on the LCD screen integrated into the gloves. This ensures that the communicated message is also visually presented to the wearer and any nearby individuals. By employing both voice and text message transmission methods, the system enhances accessibility and facilitates effective communication between individuals with speech and hearing impairments and those without, fostering inclusivity and understanding in various social contexts.

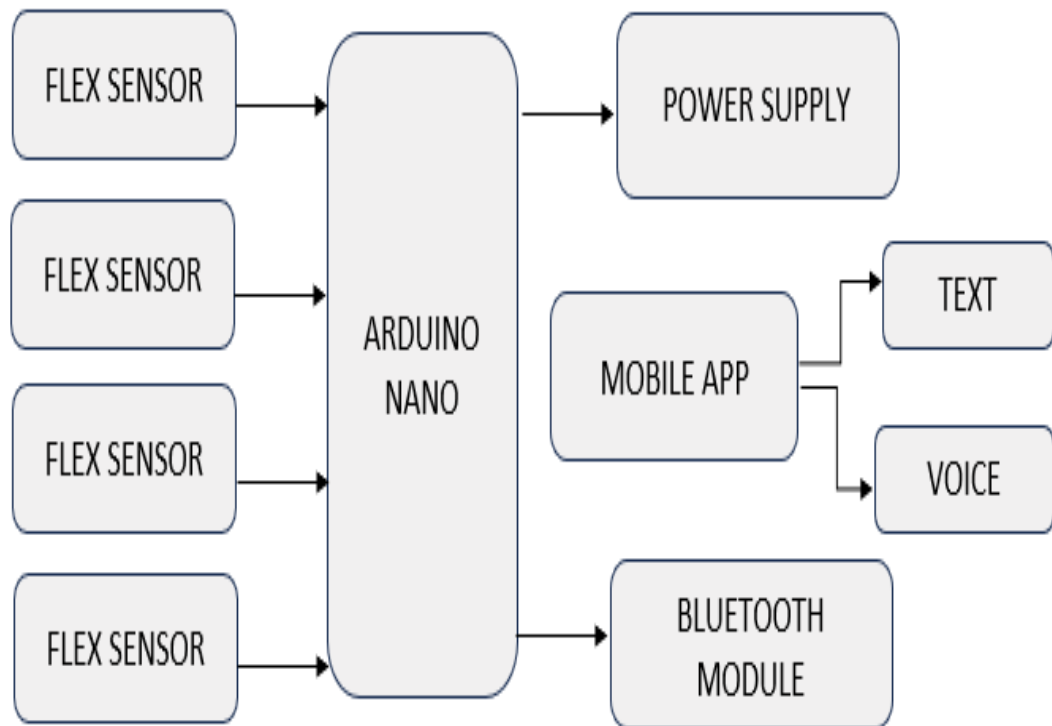


Fig 4.10 : Block diagram

4.2.2. Circuit connection

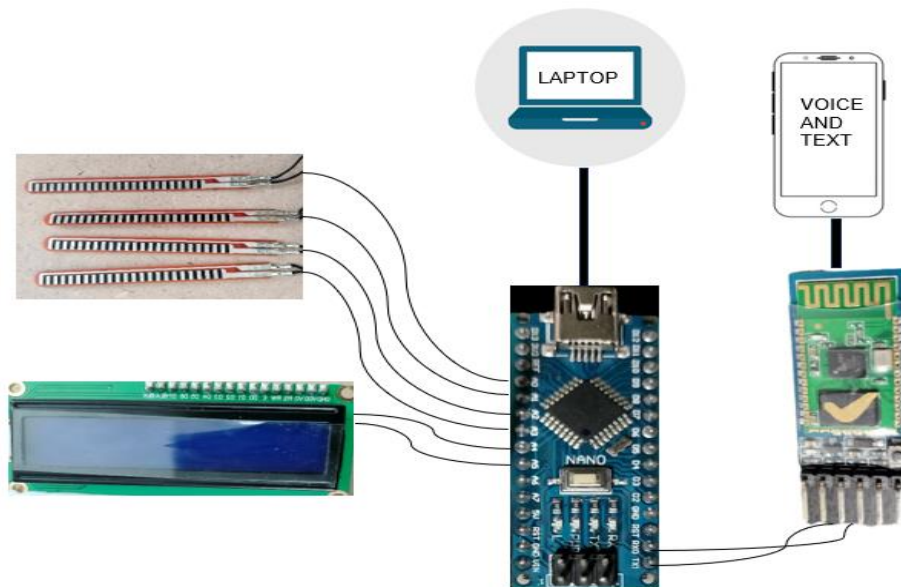


Fig 4.11 : Circuit diagram

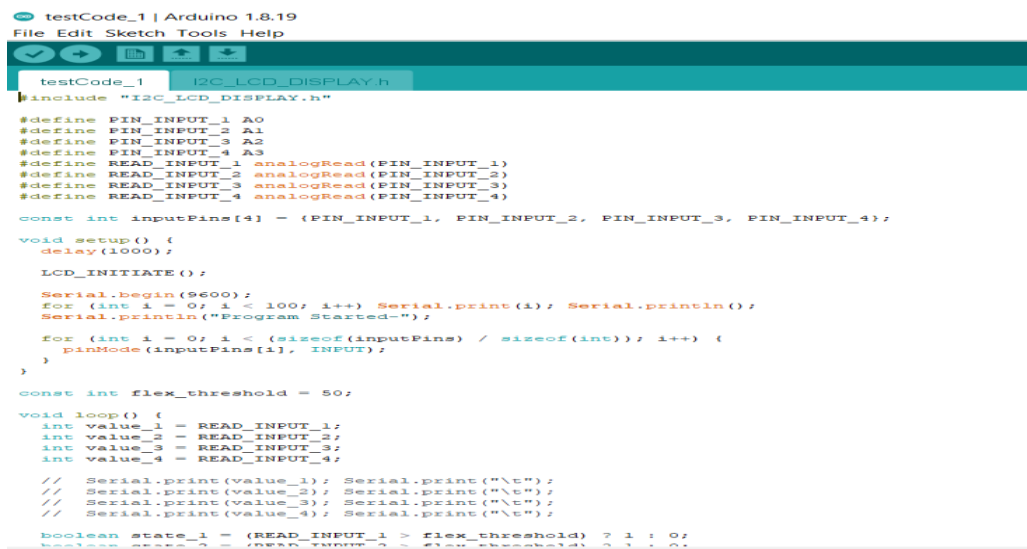
The circuit diagram for our smart glove project illustrates a straightforward yet crucial aspect of our design. Four flex sensors are connected to analog pins A0, A1, A2, and A3 of the Arduino Nano microcontroller. These sensors capture hand movements and gestures, providing input for our gesture recognition system.

The LCD display, serving as the visual interface for displaying text messages, is connected to the Arduino Nano via the analog pins A4 and A5. This setup allows for real-time feedback and interaction with the user.

For wireless communication, we integrate a Bluetooth module into the circuit. The RXD pin of the Bluetooth module is connected to the TXD pin of the Arduino Nano, facilitating the transmission of data from the Arduino to the Bluetooth module. Conversely, the TXD pin of the Bluetooth module is connected to the RXD pin of the Arduino, enabling data reception.

Finally, to establish a connection with a mobile device, such as a smartphone or tablet, the Bluetooth module is paired with the device. This connection allows for seamless communication between the smart glove system and the user's mobile device, enabling voice message transmission and other interactive features.

4.2.3. Prototype



```
testCode_1 | Arduino 1.8.19
File Edit Sketch Tools Help

testCode_1 I2C_LCD_DISPLAY.h
#include "I2C_LCD_DISPLAY.h"

#define PIN_INPUT_1 A0
#define PIN_INPUT_2 A1
#define PIN_INPUT_3 A2
#define PIN_INPUT_4 A3
#define READ_INPUT_1 analogRead(PIN_INPUT_1)
#define READ_INPUT_2 analogRead(PIN_INPUT_2)
#define READ_INPUT_3 analogRead(PIN_INPUT_3)
#define READ_INPUT_4 analogRead(PIN_INPUT_4)

const int inputPins[4] = {PIN_INPUT_1, PIN_INPUT_2, PIN_INPUT_3, PIN_INPUT_4};

void setup() {
  delay(1000);

  LCD_INITIATE();

  Serial.begin(9600);
  for (int i = 0; i < 100; i++) Serial.print(i); Serial.println();
  Serial.println("Program Started-");

  for (int i = 0; i < (sizeof(inputPins) / sizeof(int)); i++) {
    pinMode(inputPins[i], INPUT);
  }
}

const int flex_threshold = 50;

void loop() {
  int value_1 = READ_INPUT_1;
  int value_2 = READ_INPUT_2;
  int value_3 = READ_INPUT_3;
  int value_4 = READ_INPUT_4;

  // Serial.print(value_1); Serial.print("\t");
  // Serial.print(value_2); Serial.print("\t");
  // Serial.print(value_3); Serial.print("\t");
  // Serial.print(value_4); Serial.print("\t");

  boolean state_1 = (READ_INPUT_1 > flex_threshold) ? 1 : 0;
  boolean state_2 = (READ_INPUT_2 > flex_threshold) ? 1 : 0;
```

Fig 4.12 : Software

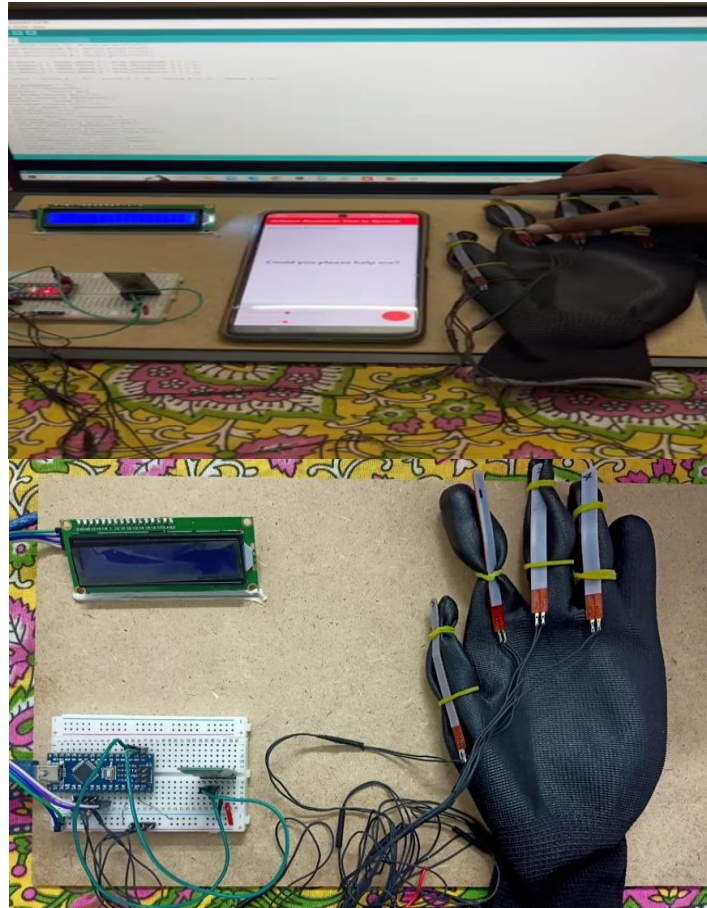


Fig 4.13 : Hardware model

4.2.4. Algorithm

```
#include "I2C_LCD_DISPLAY.h"
```

```
#define PIN_INPUT_1 A0
```

```
#define PIN_INPUT_2 A1
```

```
#define PIN_INPUT_3 A2
```

```
#define PIN_INPUT_4 A3
```

```
#define READ_INPUT_1 analogRead(PIN_INPUT_1)
```

```
#define READ_INPUT_2 analogRead(PIN_INPUT_2)
```

```
#define READ_INPUT_3 analogRead(PIN_INPUT_3)
```

```
#define READ_INPUT_4 analogRead(PIN_INPUT_4)
```

```
const int inputPins[4] = {PIN_INPUT_1, PIN_INPUT_2, PIN_INPUT_3,  
PIN_INPUT_4};
```

```

void setup() {
    delay(1000);
    LCD_INITIATE();
    Serial.begin(9600);
    for (int i = 0; i < 100; i++) Serial.print(i); Serial.println();
    Serial.println("Program Started-");
    for (int i = 0; i < (sizeof(inputPins) / sizeof(int)); i++) {
        pinMode(inputPins[i], INPUT);
    }
}

const int flex_threshold = 50;

void loop() {
    int value_1 = READ_INPUT_1;
    int value_2 = READ_INPUT_2;
    int value_3 = READ_INPUT_3;
    int value_4 = READ_INPUT_4;

    // Serial.print(value_1); Serial.print("\t");
    // Serial.print(value_2); Serial.print("\t");
    // Serial.print(value_3); Serial.print("\t");
    // Serial.print(value_4); Serial.print("\t");

    boolean state_1 = (READ_INPUT_1 > flex_threshold) ? 1 : 0;
    boolean state_2 = (READ_INPUT_2 > flex_threshold) ? 1 : 0;
    boolean state_3 = (READ_INPUT_3 > flex_threshold) ? 1 : 0;
    boolean state_4 = (READ_INPUT_4 > flex_threshold) ? 1 : 0;

    byte state = (state_4 << 3) | (state_3 << 2) | (state_2 << 1) | (state_1 << 0);

    String printText = "";
    if (state == 0b00000001) {
        printText = "Excuse Me";
        LCD_PRINT("Excuse Me", "");
    }
}

```

```

} else if (state == 0b00000010) {
    printText = "Thank You";
    LCD_PRINT("Thank You", "");
} else if (state == 0b00000100) {
    printText = "Sorry";
    LCD_PRINT("Sorry", "");
} else if (state == 0b00001000) {
    printText = "Where is this place?";
    LCD_PRINT("Where is this", "place?");
} else if (state == 0b00000011) {
    printText = "Could you please help me?";
    LCD_PRINT("Could you please", "help me?");
} else if (state == 0b00000110) {
    printText = "Could you repeat that?";
    LCD_PRINT("Could you repeat", "that?");
} else if (state == 0b00001100) {
    printText = "How much does this cost?";
    LCD_PRINT("How much does", "this cost?");
} else if (state == 0b00001001) {
    printText = "Could you write that down?";
    LCD_PRINT("Could you write", "that down?");
} else {
    LCD_PRINT("", "");
}
if (printText.length() != 0) {
    Serial.print(printText);
    Serial.println();
    delay(2500);
}
delay(500);
}

```

CHAPTER 5

RESULTS AND DISCUSSION

The successful assembly of the hardware components, including flex sensors, Arduino Nano, Bluetooth module, and LCD display, marks a significant achievement in the development of the smart glove prototype. This milestone sets the stage for advancing into the realm of software development, where the focus is on implementing algorithms, designing a user-friendly interface, and optimizing data processing capabilities. These efforts aim to enable real-time interaction and data analysis within the smart glove system, fostering seamless communication for deaf and mute individuals. As progress continues, rigorous testing and refinement will be conducted to ensure the reliability, accuracy, and usability of the prototype. Ultimately, the goal is to create a transformative solution that enhances communication accessibility and integration, empowering individuals with auditory and speech impairments to engage fully in social interactions and activities.

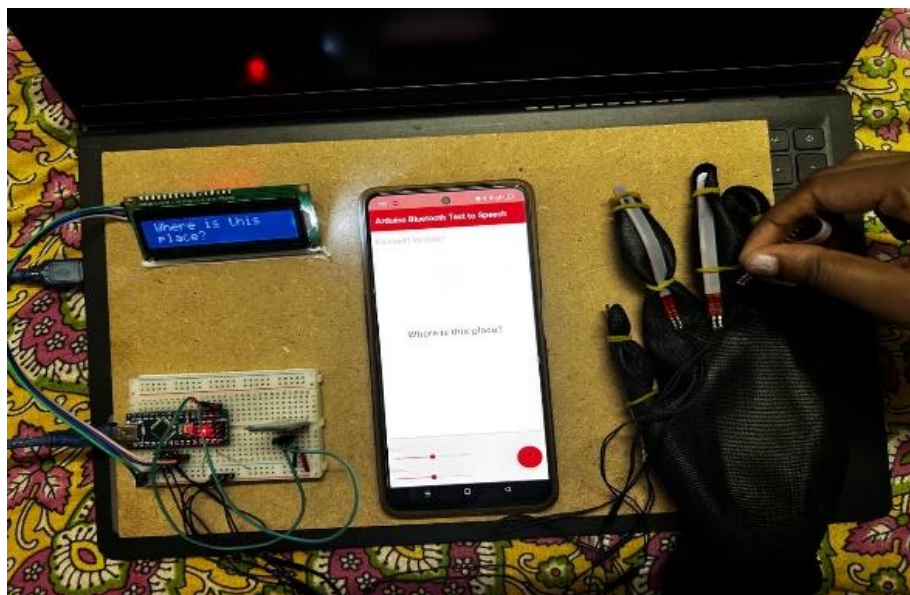


Fig 5.1 : Smart glove testing 1

- **Smart glove testing 1**

The uploaded image demonstrates the output of our smart glove system when the third flex sensor is bent in response to the command "where is this place." This gesture triggers the gesture recognition system, which accurately interprets the hand movement and translates it into text format. The recognized command, "where is this place," is prominently displayed on both the LCD screen of the smart glove and the synchronized mobile device. Additionally, the system provides voice output on the mobile device, vocalizing the text representation of the command. This integrated approach ensures accessibility and enhances the communication experience for users, allowing for seamless interaction with the environment.

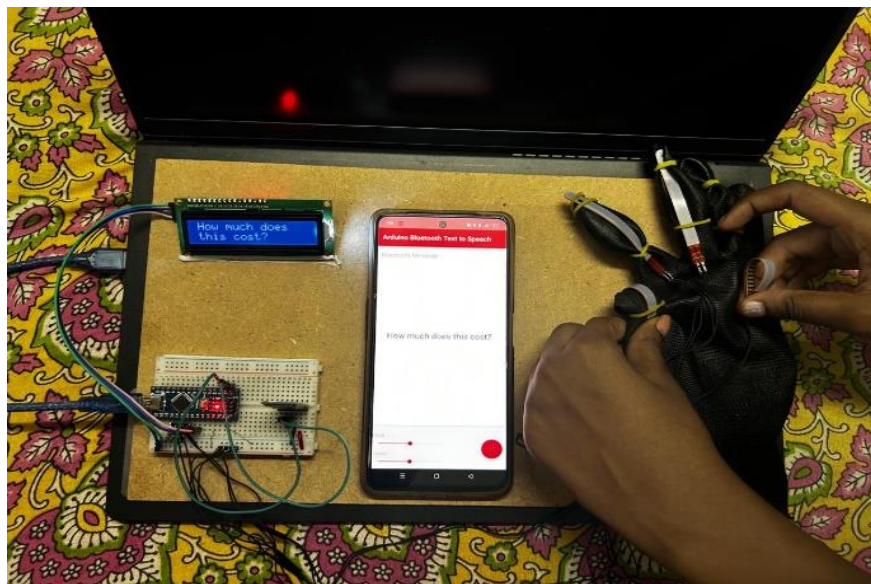


Fig 5.2 : Smart glove testing 2

- **Smart glove testing 2**

The uploaded image showcases the output of the smart glove's gesture recognition and text-to-speech conversion functionalities. In this particular instance, the gesture recognition system has detected the simultaneous bending of flex sensors 1 and 4. This gesture corresponds to the predefined command "how much does this cost." As a result, the system successfully converts this gesture into text format, displaying the command on both the LCD screen of the glove and the connected mobile device.

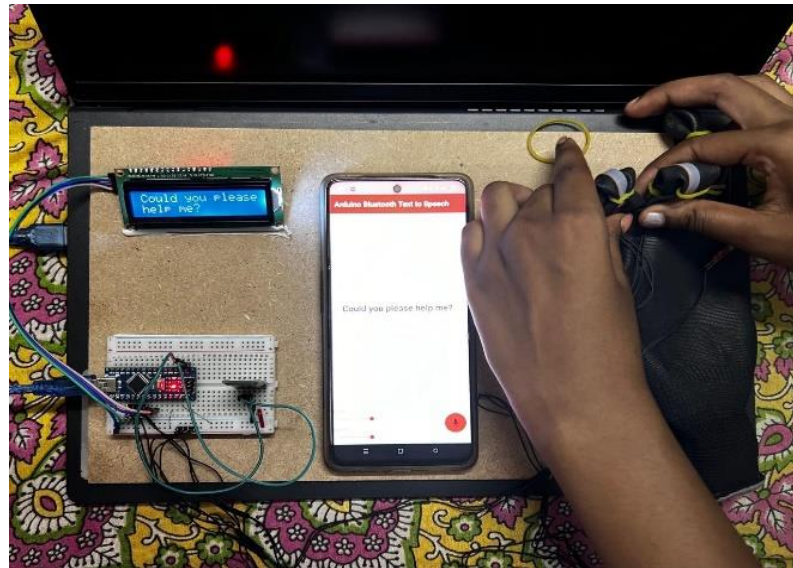


Fig 5.3 : Smart glove testing 3

- **Smart glove testing 3**

The uploaded image presents the output of the smart glove's gesture recognition system, specifically detecting the bending of flex sensors 1 and 2 simultaneously. This particular gesture corresponds to the predefined command "could you please help me." As a result, the smart glove accurately translates this gesture into text format, displaying the command on both the LCD screen of the glove and the synchronized mobile device.

CHAPTER 6

SUMMARY AND CONCLUSION

6.1. SUMMARY

The "Smart Glove" prototype pioneers global communication solutions for the deaf and mute, overcoming traditional sign language barriers with advanced gesture recognition and speech synthesis. Our project, focusing on Arduino Nano microcontrollers and flex sensors, aims for broad impact in communication, education, healthcare, and technology accessibility.

Methodology details code integration, Bluetooth setup, and gesture recognition testing, confirming accurate hand gesture interpretation for effective communication. Meticulous problem-solving and interdisciplinary collaboration embody our engineering education principles.

Our journey integrates diverse disciplines to address communication challenges, showcasing innovation and societal responsibility. Effective teamwork and communication, alongside lifelong learning, drive our commitment to engineering excellence and innovation.

In essence, our smart glove project embodies engineering values, transcending technical achievement to make a positive global impact.

6.2. CONCLUSION

In conclusion, our project has yielded a solution that addresses the fundamental challenge of communication barriers faced by deaf and mute individuals. Through the development of the "Smart Glove" prototype, we have provided an innovative tool that utilizes advanced technologies to interpret hand gestures and facilitate real-time communication. This solution not only enhances accessibility but also fosters inclusivity and understanding within diverse communities. Our achievement represents more than just a technical success; it signifies a significant step towards bridging communication gaps and empowering individuals worldwide.

REFERENCES

Abdulla, Dalal, Abdulla, Shahrazad, Manaf, Rameesa, Jarndal, Anwar H, Design and implementation of a sign-to-speech/text system for deaf and dumb people, International Conference on Electronic Devices, Systems and Applications (ICEDSA), 2016, pp. 1-4, doi: 10.1109/ICEDSA.2016.7818467.

Abhinandan Das, Lavish Yadav, Mayank Singhal, Raman Sachan, Hemang Goyal, Keshav Taparia, Raghav Gulati, Ankit Singh, Gaurav Trivedi, Smart glove for Sign Language communications, International Conference on Accessibility to Digital World (ICADW), 2016, pp. 27-31, doi: 10.1109/ICADW.2016.7942508.

Angelin Jael E, Lalith V S, Manju Basine M S, Sundar R, Implementation of LabVIEW based Smart Assistive Gloves for Deaf and Dumb People, International Conference on Applied Artificial Intelligence and Computing (ICAAIC),2023, pp. 966-971. doi: 10.1109/ICAAIC56838.2023.10140421.

Anupama H.S, Usha B A, Madhushankar S, Vivek V, Kulkarni Y, Automated Sign Language Interpreter Using Data Gloves, International Conference on Artificial Intelligence and Smart Systems (ICAIS),2021, pp.472-476 doi: 10.1109/ICAECA52838.2021.9675729.

Bhat, Krishnamurthy, Chayalakshmi C L, Advanced Glove for Deaf and Dumb with Speech and Text Message on Android Cell Phone, International Conference for Innovation in Technology (INOCON), 2020, pp. 1-7, doi: 10.1109/INOCON50539.2020.9298283.

Ganeshkumar D, Subasri T, Kaleeshwari R, Raksha R,Muthukumar D, An IoT Based Gesture Recognition System for Vocally and Hearing Impaired Individuals, International Conference on Advanced Computing and Communication Systems (ICACCS), 2023, pp. 685-689, doi: 10.1109/ICATME50232.2021.9732739.

Kakkoth, Sarang Suresh, Gharge, Saylee, Survey on Real Time Hand Gesture Recognition, International Conference on Current Trends in Computer, Electrical, Electronics and Communication (CTCEEC), 2017, pp. 948-954, doi:

10.1109/ICSSS54381.2022.9782194.

Kumuda S, Preethi Mame K, Smart Assistant for Deaf and Dumb Using Flexible Resistive Sensor : Implemented on LabVIEW Platform, International Conference on Inventive Computation Technologies (ICICT),2020,pp.994-1000,doi: 10.1109/ICCES51350.2021.9489184.

Nikhita Praveen, Naveen Karanthand Megha M S, Sign Language Interpreter Using A Smart Glove, International conference on Advances in Electronics, Computers and communications (ICAEECC), 2014, pp. 23-67, doi: 10.1109/ICICT48043.2020.9112553.

Patil, Sachin, Joshi, Sarang, Kulkarni, Hrushikesh B, Hagawane, Pradnesh, Shinde, Pradnya, Marathi Sign Language Hand Gesture Recognition Using Accelerometer and 3D Printed Gloves, International Conference on Computational Intelligence and Communication Networks (CICN), 2022, pp. 72-77, doi: 10.1109/ICACCS57279.2023.10112835.

Pravin Bhalghare, Vaibhav Chafle, Ameya Bhivgade, Vaibhav Deokar, Multipurpose Smart Glove for Deaf and Dumb People, International Research Journal of Engineering and Technology (IRJET), 2020, pp. 2373-2377, doi: 10.1109/ICSSS54381.2022.9782194.

Priiyadharshini M, Balaji V R, R Thrisha, R Suruthi, Sign Speaks-An IoT Based Smart Gloves for Dumb, International Conference on Communication and Electronics Systems (ICCES), 2021, pp. 470-475, doi: 10.1109/ICERECT56837.2022.10060135.

Raen, Reana and Islam, Sheikh Md. Rabiul and Islam, Redwanul, A Smart Hand Glove that Converts Gesture into Text & Speech to Assist the Handicapped-(Handtalk), International Conference on Advancement in Electrical and Electronic Engineering (ICAEEE), 2022, pp. 1-6, doi: 10.1109/ICAEEE54957.2022.9836392.

Sandeep, Snehaa A, Suryaprakash S, Monikapriya S, Mathankumar M, Thirumoorthi P, Smart Audio Glove for Deaf and Dumb Impaired, International Conference on Advancements in Electrical, Electronics, Communication, Computing and Automation (ICAECA) India, 2021, pp. 1-6, doi:

10.1109/ICOSEC49089.2020.9215392.

Santosh Kumar B, P Rachna, Hiremath, Ritika Basavaraj, Ramadurgam, Vanshika Sai, Shaw, Deepak Kumar, Survey on implementation of TinyML for real-time sign language recognition using smart gloves, Fourth International Conference on Emerging Research in Electronics, Computer Science and Technology (ICERECT), 2022, pp. 1-7, doi: 10.1109/ICAIS50930.2021.9395749.

Sathya, Priya M, Velraj Kumar P, Lavanya P, Ramesh L, Senthilpari, Raspberry Pi Processor-based i-Gloves for Mute Community and Home Automation System, International Conference on Smart Structures and Systems (ICSSS), 2022, pp. 01-05, doi: 10.1109/CICN56167.2022.10008290.

Suri, Ajay, Singh, Sanjay Kumar, Sharma, Rashi, Sharma, Pragati, Garg, Naman, Upadhyaya, Riya, Development of Sign Language using Flex Sensors, International Conference on Smart Electronics and Communication (ICOSEC), 2020, pp. 102-106, doi: 10.1109/CTCEEC.2017.8455041.

Yadav Punarvit, Shankar, Pujakumari Ravi K, Sawant, Er Khushboo Arduino Based Smart Gloves for Blind, Deaf and Dumb Using Sign and Home Automation Mode, International Conference on Advances in Technology, 2021, pp. 244-248, doi: 10.1109/ICAEE48663.2019.8975458.