

PROJECT REPORT

SMART GLOVE FOR DEAF AND DUMB PEOPLE

Gesture to Speech and Text Conversion System

1. INTRODUCTION

Communication is a fundamental requirement for human interaction. However, deaf-mute, paralyzed, and bedridden individuals face significant challenges in expressing their basic needs, leading to emotional distress and dependency on caregivers. Hand gestures are their primary mode of communication, but these gestures are not always understood by others.

This project presents a **Smart Gesture Recognition Glove**, a wearable assistive device that converts hand gestures into **text and voice output** using sensor-based detection and wireless communication. The glove integrates **flex sensors**, a **MEMS accelerometer**, an **Arduino microcontroller**, and an **HC-05 Bluetooth module** to detect finger movements and wrist orientation. These gestures are mapped to predefined messages such as *water, food, medicine, help*, etc., which are transmitted to a smartphone and announced through speech.

The system is **portable, low-cost, and user-friendly**, making it suitable for real-time use in healthcare and assistive environments.

2. LITERATURE REVIEW

Several gesture-based communication systems have been developed in the past to assist physically challenged individuals. Existing approaches include:

- **Flex sensor-based gloves** that detect finger bending through resistance changes
- **Accelerometer-based systems** that identify hand orientation and motion
- **Vision-based sign language recognition systems** using machine learning and cameras

Although vision-based and ML-driven systems offer high accuracy, they require large datasets, high processing power, and are expensive. Many commercial assistive devices are also costly and not customized for basic patient needs.

Research studies indicate that combining **finger bending (flex sensors)** with **wrist orientation (MEMS accelerometer)** significantly improves gesture recognition accuracy. Arduino-based embedded systems are widely used due to their simplicity, affordability, and reliability. Bluetooth modules such as HC-05 provide efficient low-power wireless communication.

This project adopts a **rule-based sensor fusion approach**, offering a cost-effective and practical alternative to complex ML systems.

3. AIM AND OBJECTIVES

Aim

To design and implement a **wearable smart glove** that detects hand gestures and converts them into **speech and text output** for deaf-mute and paralyzed individuals.

Objectives

1. Detect finger bending using flex sensors
 2. Detect wrist tilt using a MEMS accelerometer
 3. Convert sensor data into predefined digital commands
 4. Transmit commands wirelessly via Bluetooth
 5. Display text and generate speech on a smartphone
 6. Ensure low cost, portability, and ease of use
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4. MATERIALS AND METHODS

Hardware Components

- Arduino Nano / Arduino Uno
- Flex Sensors (3)
- MEMS Accelerometer (ADXL335 / ADXL345)
- HC-05 Bluetooth Module
- LED Indicator
- 9V Battery
- Breadboard / PCB and connecting wires
- Hand glove

Software Tools

- Arduino IDE (Embedded C programming)
- Proteus / TinkerCAD (Simulation)
- Android Bluetooth Text-to-Speech Application

Methodology

- Flex sensors are mounted on the index, middle, and ring fingers
- Accelerometer is mounted on the back of the hand
- Sensors are connected to Arduino analog inputs
- Threshold values are defined for gesture detection

- Arduino processes logic and sends messages via Bluetooth
 - Smartphone app converts received text into speech
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5. WORKING PRINCIPLE

- **Flex Sensors:**
Resistance increases when bent. Arduino converts analog readings (0–1023) into binary logic (0/1).
- **MEMS Accelerometer:**
Detects hand tilt and orientation using X, Y, and Z axes.
- **Gesture Mapping:**
Combination of flex sensor outputs corresponds to specific messages.
- **Bluetooth Communication:**
Messages are transmitted wirelessly using HC-05 module.
- **Speech Output:**
Smartphone application announces the received message.

The Arduino acts as the central controller coordinating sensor input, decision logic, and communication.

6. CIRCUIT DESCRIPTION

The circuit consists of:

- Flex sensors connected to Arduino pins A0, A1, A2
- MEMS accelerometer connected to A3, A4, A5
- HC-05 Bluetooth module connected via TX–RX pins
- LED indicator on digital pin 13
- 9V battery supply via VIN pin

Flex sensors operate as voltage dividers, while the accelerometer provides analog tilt signals. All components are mounted on a glove for wearable operation.

7. PROGRAMMING

The system is programmed using **Arduino IDE** in Embedded C.

Key features of the code include:

- SoftwareSerial communication for Bluetooth
- Analog sensor reading and thresholding
- Gesture combination logic

- Serial and Bluetooth message transmission
- LED indication for gesture detection

The program continuously monitors sensor values and sends the corresponding message when a valid gesture is detected.

8. SIMULATION AND TESTING

- Individual sensor calibration performed
- Proteus used to simulate Arduino and Bluetooth communication
- Real-time testing conducted by wearing the glove
- Successful message transmission and speech output observed

Testing Parameters:

- Flex sensor sensitivity
 - MEMS tilt accuracy
 - Bluetooth range (~10 meters)
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9. RESULTS

- All eight predefined gestures recognized accurately
 - Text displayed clearly on smartphone
 - Voice output generated for each command
 - Low power consumption
 - Fast response time
 - Fully portable and wearable system
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10. DISCUSSION

The Smart Glove demonstrates a practical assistive communication system using simple sensor-based logic. While the rule-based approach limits gesture flexibility, it ensures reliability, low cost, and ease of implementation. External factors such as sensor calibration and hand placement can affect accuracy but can be improved with refinement.

11. ADVANTAGES AND LIMITATIONS

Advantages

- Low cost and lightweight
- Easy to operate
- Real-time translation
- Portable wearable design
- Suitable for physically challenged users

Limitations

- Flex sensors are highly sensitive
 - Limited to predefined gestures
 - No adaptive learning
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12. FUTURE SCOPE

- Machine learning-based gesture classification
 - Full sign language translation
 - GSM/GPS integration for emergency alerts
 - Smartwatch-style wearable design
 - Vibration feedback for hearing-impaired users
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13. CONCLUSION

The Smart Gesture Recognition Glove successfully converts hand gestures into speech and text, enabling effective communication for deaf, dumb, paralyzed, and bedridden individuals. The system is low-cost, portable, and efficient, demonstrating the potential of wearable biomedical engineering solutions in assistive healthcare technology.

14. REFERENCES

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