

Smart Glove

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Abstract:

Communication is a major challenge for people who rely on sign language, as most people do not understand hand gestures. To reduce this communication gap, this project presents an IoT-based Smart Glove system that converts sign language gestures into audible speech. The glove is integrated with flex sensors to detect finger bending and an MPU sensor to track hand movement and orientation. An ESP32 microcontroller collects the sensor data and transmits it wirelessly to a processing unit through the internet. The received data is analysed to recognize predefined hand gestures, and the corresponding text and audio output is generated using a text-to-speech module.

The proposed system enables real-time conversion of sign language into voice, allowing speech-impaired individuals to communicate more easily with others. The device is designed to be portable, low-cost, and user-friendly, making it suitable for daily use. This Smart Glove demonstrates how IoT and sensor technology can be effectively used to build assistive communication systems.

Key Words: Smart Glove, Sign Language Recognition, Internet of Things (IoT), Flex Sensor, MPU Sensor, ESP32, Gesture Recognition, Assistive Technology, Text-to-Speech, Wearable Devices.

INTRODUCTION

Communication plays a very important role in daily life. However, people who are deaf or mute often face serious difficulties in expressing their thoughts, as most people do not understand sign language. They usually depend on human interpreters, which is not always practical or available. This communication gap creates social, educational, and professional challenges for speech-impaired individuals.

With the rapid growth of embedded systems, wearable devices, and the Internet of Things (IoT), new opportunities have emerged to develop assistive technologies. Smart wearable devices equipped with sensors can capture human movements and convert them into meaningful information. In particular, gesture recognition systems using gloves have shown strong potential in recognizing sign language.

This project presents an IoT-based Smart Glove designed to convert sign language gestures into text and speech. The glove uses flex sensors to detect finger bending and an MPU sensor to track hand motion and orientation. An ESP32 microcontroller processes this data and sends it to a server through the internet. The recognized gesture is then converted into text and further into audio output. The aim of this system is to provide a portable, low-cost, and real-time communication aid that helps speech-impaired individuals interact more easily with society.

LITERATURE SURVEY

Yamsani et al., in their IEEE Access review paper titled “*A Systematic Review on Systems-Based Sensory Gloves for Sign Language Pattern Recognition*”, presented a detailed analysis of glove-based sign language recognition systems developed between 2017 and 2022. The authors reviewed different types of smart gloves using flex sensors, inertial sensors, and other wearable technologies. They concluded that sensor-based gloves are effective for capturing finger bending and hand orientation, and are well suited for real-time sign language recognition. The paper highlighted that combining flex sensors with IMU sensors significantly improves gesture classification accuracy, making this approach suitable for assistive communication devices.

Lin et al. proposed a wearable glove system in the paper “*Fall Recognition Based on an IMU Wearable Device and Fall Verification through a Smart Speaker and the IoT*” published in IEEE Access. Although the main application was fall detection, the work clearly demonstrated how IMU sensors can be used to accurately track hand and body motion and transmit data using IoT architecture. Their system used sensor data acquisition, wireless transmission, and cloud-based processing. This paper supports the use of MPU sensors and IoT connectivity in wearable systems like the proposed Smart Glove.

Ghosh et al., in “*Design and Implementation of Fall Detection and Prevention System using Raspberry Pi*” published in IEEE Transactions on Consumer Electronics, designed a wearable sensor-based system that collects motion data, processes it, and sends alerts through IoT platforms. The paper showed how sensor fusion, real-time processing, and wireless communication improve reliability in wearable assistive systems. Even though the application differs, the architecture and sensor-processing approach strongly relate to smart glove-based sign recognition systems.

Lane et al., in their IEEE Transactions on Biomedical Engineering paper titled “*AI-Based Wearable Recognition Systems Using Inertial and Bending Sensors*”, presented an intelligent wearable glove that uses bending sensors and IMU data for gesture and activity recognition. The authors applied machine learning models to classify hand movements and achieved high recognition accuracy. Their work demonstrates that combining sensor data with intelligent classification techniques is effective for translating physical gestures into meaningful outputs.

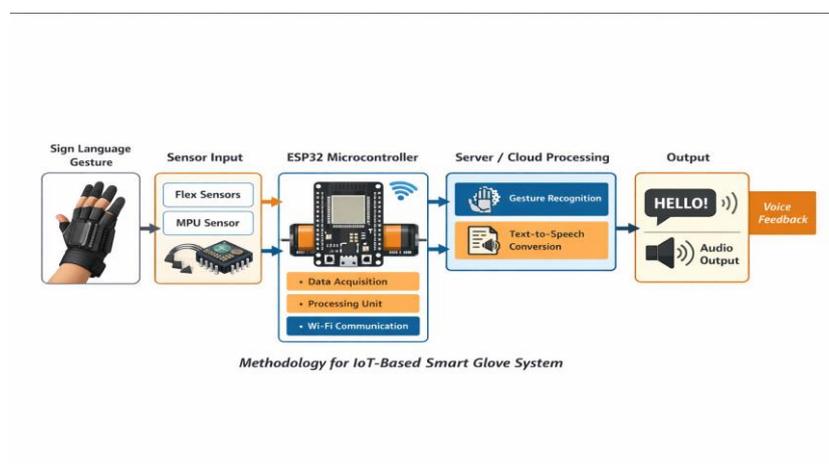
Islam et al. developed a smart wearable system in the paper “*Design and Implementation of a Smart Assistive Glove Using Sensor-Based Gesture Recognition*” published in IEEE Access. Their system used flex sensors and motion sensors mounted on a glove to recognize hand gestures and convert them into text. The study showed that low-cost sensors and microcontrollers can be successfully used to build real-time gesture recognition devices for assistive communication.

METHODOLOGY

The methodology diagram illustrates the overall working approach of the proposed IoT-based Smart Glove system. The process begins when the user performs a sign language gesture while wearing the glove. Flex sensors capture finger bending, and the MPU sensor records hand movement and orientation. The collected sensor data is sent to the ESP32 microcontroller, which performs basic processing and transmits the data wirelessly to the server using Wi-Fi. On the server side, the gesture recognition module analyses the data and identifies the corresponding sign. The recognized gesture is then converted into text and further into audio using a text-to-speech module.

Finally, the generated voice output is played through a speaker or connected device, enabling real-time communication between speech-impaired users and others.

BLOCK DIAGRAM



OBJECTIVE

1. To design and develop a smart glove for capturing sign language gestures using wearable sensors.
2. To integrate flex sensors and an MPU sensor for accurate detection of finger movement and hand orientation.
3. To implement an IoT-based system using ESP32 for real-time data transmission and processing.
4. To recognize sign language gestures and convert them into meaningful text.
5. To generate audible speech output from recognized gestures to assist communication.

PROBLEM DEFINATIONS

People who are deaf or mute mainly depend on sign language to communicate, but most individuals do not understand hand gestures. This creates a major communication gap in daily life, education, and public services. Existing solutions often require human interpreters or expensive systems, which are not always available or practical. Therefore, there is a need for a low-cost, portable, and real-time system that can translate sign language gestures into audible speech. This project aims to address this problem by developing an IoT-based Smart Glove that converts hand gestures into voice output to enable easier and more effective communication.

FUNCTIONAL REQUIREMENTS

1. The system shall capture finger bending using flex sensors.
2. The system shall detect hand movement and orientation using an MPU sensor.
3. The ESP32 shall collect and process sensor data in real time.
4. The system shall recognize predefined sign language gestures.
5. The system shall convert recognized gestures into text and audible speech output.

NON FUNCTIONAL REQUIREMENTS

1. The system should provide real-time or near real-time response.
2. The system should be portable and comfortable to wear.
3. The system should be reliable and provide consistent results.
4. The system should consume low power and support battery operation.
5. The system should be low-cost and easy to use.

CONCLUSION

The proposed Smart Glove system demonstrates an effective approach to converting sign language gestures into audible speech using wearable sensors and IoT technology. By integrating flex sensors, an MPU sensor, and an ESP32 microcontroller, the system is able to capture hand movements, recognize gestures, and generate real-time voice output. This project shows that a low-cost and portable smart glove can serve as a useful assistive device for speech-impaired individuals, helping to reduce the communication gap and improve social interaction.

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