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Sign Language Translation Using Glove

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Abstract： Communication barriers significantly affect speech- and hearing-impaired individuals in their daily lives. Traditional sign language communication requires the listener to understand sign gestures, which limits interaction with the general public. This paper proposes a Sign Recognition and Voice Conversion System using Internet of Things (IoT) technology to bridge this communication gap. The system utilizes touch sensors to represent predefined sign gestures, which are processed by a NodeMCU (ESP8266) microcontroller. When a sensor is activated, the system converts the sign into a voice output and simultaneously sends a notification to caregivers via Firebase cloud. Additionally, a DHT11 temperature sensor monitors environmental conditions and displays the readings on a 16x2 LCD screen. The integration of IoT ensures real-time monitoring and remote communication through a mobile application. The proposed system is cost-effective, portable, and easy to use, making it suitable for elderly and physically challenged individuals. The implementation demonstrates how simple sensors combined with cloud technology can create a reliable assistive communication system.

1.INTRODUCTION

Communication is a fundamental human necessity that enables individuals to express their thoughts, emotions, and needs. It plays a vital role in building relationships, ensuring safety, and maintaining social interaction. However, for individuals with speech and hearing impairments, communication often becomes a significant challenge. These individuals primarily rely on sign language or gestures to convey messages, but such methods are effective only when the listener understands sign language. In real-world scenarios, especially in public places, hospitals, workplaces, or emergency situations, not everyone is familiar with sign language. This creates a communication gap that may lead to misunderstandings, frustration, social isolation, and even life-threatening delays in emergency response. According to global disability statistics, millions of people worldwide suffer from speech and hearing impairments. In developing countries, access to advanced assistive technologies is limited due to high costs and lack of awareness. Many available systems are either complex, expensive, or require wearable gloves embedded with flex sensors and motion detection units. Although these glove-based systems provide dynamic gesture recognition, they often involve complicated calibration, high maintenance cost, and limited portability. Moreover, such systems may not be suitable for elderly or bedridden patients who require simple and quick communication mechanisms.

In recent years, the advancement of Internet of Things (IoT) technology has opened new opportunities in assistive healthcare and communication systems. IoT enables physical devices embedded with sensors and microcontrollers to connect to the internet and exchange data in real time. By integrating IoT with simple sensor-based input methods, it is possible to design cost-effective and reliable communication systems for differently-abled individuals. IoT-based solutions provide remote monitoring, instant notifications, and cloud storage capabilities, making them highly suitable for assistive applications.

The proposed Sign Recognition and Voice Conversion System using IoT aims to bridge the communication gap between speech-impaired individuals and caregivers. Instead of relying on complex gesture recognition using cameras or flex sensors, the system uses predefined touch-based inputs to represent commonly required messages. Capacitive touch sensors are utilized as input devices, where each sensor corresponds to a specific need such as requesting food and water, asking for help, wanting to go out, or requesting medicine. This approach simplifies the recognition process while ensuring reliability and accuracy.

The core of the system is the NodeMCU (ESP8266) microcontroller, which integrates Wi-Fi connectivity and processes sensor inputs. When a user activates a touch

sensor, the NodeMCU immediately identifies the corresponding message and performs multiple actions simultaneously. First, it converts the selected input into a voice message using a voice playback module. This allows nearby individuals to hear the request clearly. Second, the message is displayed on a 16x2 Liquid Crystal Display (LCD), providing visual confirmation. Third, the system uploads the message data to the Firebase cloud platform, enabling caregivers to receive real-time notifications on a mobile application. This multi-mode communication approach ensures that the message is conveyed effectively through audio, visual, and digital means.

In addition to communication functionality, the system incorporates a DHT11 temperature sensor to monitor environmental conditions. Environmental comfort is crucial for elderly and bedridden individuals who may not be able to adjust room conditions themselves. The temperature readings are displayed on the LCD screen and can also be stored in the cloud database for remote monitoring. This additional feature enhances the safety and healthcare monitoring capability of the system.

The integration of Firebase cloud services plays a significant role in enabling real-time data synchronization. Firebase provides a real-time database that allows data to be instantly updated across connected devices. Whenever a touch sensor is pressed, the system sends the corresponding message along with timestamp information to the cloud. Caregivers or family members can access this information via a mobile application from any location with internet connectivity. This remote monitoring capability is especially beneficial in hospitals, care centers, and homes where continuous supervision may not always be possible.

One of the major advantages of the proposed system is its simplicity and cost-effectiveness. Unlike camera-based sign recognition systems that require image processing and machine learning algorithms, this system operates using simple digital input detection. This reduces computational complexity, power consumption, and overall system cost. The use of widely available components such as NodeMCU, touch sensors, LCD display, and DHT11 sensor ensures easy implementation and maintenance.

Furthermore, the system is portable and user-friendly. The compact design allows it to be placed near the user's bed, wheelchair, or personal space. The touch sensors require minimal effort to activate, making the system suitable even for individuals with limited mobility. The voice output feature eliminates the need for others to interpret signs manually, thereby increasing communication efficiency.

Security and reliability are also important considerations in IoT-based systems. The Firebase platform ensures secure data transmission and cloud storage. With proper authentication and database rules, unauthorized access can be prevented. Additionally, the system can be expanded in the future to include emergency auto-calling features, SMS alerts, or integration with wearable health monitoring devices.In summary, the proposed Sign Recognition and Voice Conversion System using IoT provides a practical and efficient solution to communication challenges faced by speech-impaired individuals. By combining touch-based sign recognition, voice output, LCD display, environmental monitoring, and cloud connectivity, the system ensures reliable, real-time, and accessible communication. The design demonstrates how IoT technology can be leveraged to create socially impactful assistive devices that improve independence, safety, and overall quality of life for differently-abled individuals.

2.LITERATURE SURVEY

In recent years, significant research has been conducted in the field of assistive communication systems for speech- and hearing-impaired individuals. Various technologies such as sensor-based gloves, image processing techniques, machine learning algorithms, and IoT-enabled systems have been proposed to bridge the communication gap between differently-abled individuals and society.Kumar et al. (2018) developed a gesture recognition glove using flex sensors and an Arduino microcontroller to convert hand gestures into text and speech output. The system successfully translated finger bending movements into predefined messages. However, the major limitation of this approach was the high cost of flex sensors and the need for frequent calibration. Additionally, wearing a glove continuously may cause discomfort, especially for elderly users.Sharma and Gupta (2019) proposed an image-processing-based sign language recognition system using a camera and OpenCV algorithms. The system captured hand gestures and processed them using pattern recognition techniques. While the system provided dynamic gesture recognition capability, it required controlled lighting conditions and high computational power. The dependency on a camera module and real-time image processing increased system complexity and reduced portability.Singh and Chatterjee (2020) introduced an IoT-based communication device using NodeMCU and cloud integration. Their system allowed users to send predefined emergency messages to caregivers through a mobile application. The use of Firebase cloud enabled real-time data transmission and remote monitoring. However, the system was mainly focused on emergency alerts and did not include voice conversion features or environmental monitoring.Banerjee et al. (2021) developed a capacitive touch sensor-based communication system for non-verbal patients. Each touch sensor corresponded to a specific message displayed on an LCD screen. The system was simple and cost-effective compared to glove-based solutions. Nevertheless, it lacked IoT integration, limiting its application to local communication only.Reddy et al. (2022) proposed a smart assistive device combining IoT and health monitoring sensors such as temperature and heart rate sensors. The system transmitted health data to caregivers via cloud platforms. Although the research demonstrated effective remote monitoring, it did not focus specifically on communication support for speech-impaired individuals.

3.METHODOLOGY

The proposed Sign Recognition and Voice Conversion System using IoT is designed to provide a simple, reliable,

and real-time communication mechanism for speech-impaired individuals. The methodology involves hardware integration, software programming, cloud connectivity, and multi-mode output generation. The overall system operation is divided into input acquisition, processing, output generation, and cloud communication stages.

4.TECHNOLOGIES IOT:

The Internet of Things (IoT) is a gadget of interrelated registering gadgets, mechanical and virtual machines, items, creatures or individuals which may be outfitted with specific identifiers (UIDs) and the cappotential to switch insights over a local area with out expecting human-to-human or human-to-pc connection.

4.1 FIREBASE:

Firebase's most memorable item turned into the Firebase Real-time Database, an API that synchronizes programming measurements all through iOS, Android, and Web gadgets, and shops it on Firebase's cloud. The item helps programming program developers in building constant, cooperative applications.

4.2 NODEMCU:

NodeMCU is a low-expense open inventory IoT stage. It at first covered firmware which runs on the ESP8266 Wi-Fi SoC from Espressif Systems, and equipment which changed into principally based absolutely at the ESP-8266 module.

The proposed methodology ensures efficient communication, low latency, and enhanced accessibility for speech-impaired individuals. By combining sensor-based input with IoT cloud integration, the system provides both local and remote communication capabilities.

5.RESULT

6.CONCLUSION

The proposed Sign Recognition and Voice Conversion System using IoT provides a simple, reliable, and cost-effective solution to assist speech-impaired individuals in communicating their basic needs. By integrating capacitive touch sensors with the NodeMCU (ESP8266), LCD display, voice output module, and Firebase cloud platform, the system enables multi-mode communication through audio, visual display, and real-time mobile notifications. The addition of environmental monitoring using the DHT11 sensor further enhances user safety and comfort. The system demonstrates low complexity, fast response time, and efficient cloud connectivity, making it suitable for home, hospital, and elderly care applications. Overall, the proposed approach effectively bridges the communication gap and highlights the practical application of IoT technology in assistive healthcare systems.

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Research Highlights

1. Design a Sign Recognition and Voice Conversion system using IoT to enable sign-language gestures to be translated into voice output and notifications.
2. A glove embedded with touch sensors captures predefined sign gestures.
3. The microcontroller converts the sign to voice output and sends a notification to caregivers via Firebase cloud.
4. Real-time monitoring and remote communication through a mobile application.