Message Conveyor for People with Hearing and Speech Impairment

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Abstract – Sign language is the only way of communication for speech-impaired people. It will become difficult for the normal people because they do not understand the sign language. To deal with the problem we implement a model that will help in reducing the communication gap between dumb-deaf people in society. Therefore, we suggest a speech device that will make it possible for mute people to convey their messages to normal people through hand gestures. A speaking system is incorporated with flex sensors whose resistance value changes according to the gestures specified by the user. This gesture information is processed by the NODE MCU microcontroller and corresponding voice output is given through the speaker in the desired language. In case of an emergency, the message is sent through GSM.

Keywords – NODE MCU, Flex Sensor, Accelerometer, GSM, LCD Display, Power Supply, Emergency, Beeps.

1. INTRODUCTION

“A person deemed dumb" may be someone who refrains from verbal communication either due to an inability to speak or a reluctance to engage in verbal interaction [1]. This term is particularly associated with individuals experiencing profound congenital deafness, rendering them incapable of utilizing conventional language [1]. The global population affected by this condition is estimated to be around 700,000 to 900,000 [2], with only a small fraction proficient in sign language [3]. However, comprehending sign language poses a challenge for those not familiar with it [4]. Sign language is intricate, serving as a complete, sophisticated, and naturally evolving language with its grammar, vocabulary, and over 300 dialects. Communicating through sign language demands consistent practice, adding to its complexity.

Efforts have been directed toward developing automatic sign language generation systems for the deaf and mute community, as outlined in recent research papers. In one example [5], B. G. Lee and team introduced an intelligent sign language translation system using portable handheld devices. The authors utilized an embedded SVM model to collect and analyze sensor data, employing a custom handheld system constructed with a 3D printer. An Android application was then created to assess the functionality of the proposed wearable framework, featuring built-in text-to-speech conversion capabilities.

In another study [6], F. N. H. Al Nuaimy designed a glove to aid semi-paralyzed, deaf-mute patients capable of finger movement but unable to speak. This innovative communication method facilitates easier interaction for deaf individuals. While the paper presented data on the internal flexi-force circuit and sensor behavioral characteristics, it lacked real-time results and word collection rates with the utilized hardware components. The work highlighted the equipment's scope, cost, performance specifications, and portable design utilizing a 9V mini radio battery for audible and visual output. Three flex force sensors for three fingers, each with two voltage ranges, translated applied loads into voltages received by the Node MCU microcontroller. The system then commanded the LCD and speaker to display and vocalize the detected words.

In [7], P. Dhepekar and Y. G. Adhav utilized a finger motion capture device incorporating a flex sensor as a high-sensitivity input component. This flex sensor, known for its precision, facilitated superior results. The Zigbee framework was employed for wireless signal transmission, establishing a seamless connection between the human hand and the robotic mechanical device. The robotic system, equipped with multiple flex sensors, was adept at recognizing human finger behavior, particularly suited for wireless media due to its excellent identifying capabilities with quick movements.

Moving on to [8], the proposed architecture for an automatic sign language generator system integrated both software and hardware components. The hardware comprised flex sensing devices for each finger, an accelerometer, a Node MCU controller, a Bluetooth module, and a glove. Flex sensors measured and inputted bend values subsequently transformed into resistance values corresponding to gestures. The gyroscope input signaled angular bend or rotation, determining finger positions. The Node MCU verified resistance values, transmitting the text via Bluetooth to a Smartphone application. The sensor played a vital role in determining bend, location, rotation, and hand motion.

In [9], Y. Tao et al. employed face recognition image processing and feature extraction technology to create a Smartphone framework for mute and hard-of-hearing individuals. Facial expression recognition images were treated as vectors, and subjected to various calculations for different facial patterns. The authors demonstrated a framework for analyzing and collecting user data, incorporating a glove with multiple sensors for finger movements and emotion detection. Real-time data, including finger curving and palm adjustment, were processed by a built-in microprocessor and transmitted to a cell phone via Bluetooth.

In the comprehensive development of an intelligent sign language recognition system, the proposed system in this work is founded on a smart, cost-effective glove incorporating flex sensors, Node MCU Uno, and a GSM 800L module. Flex sensors detected and measured finger movements, with the system presenting sign languages on an LCD screen and through a speaker. The GSM 800L module provided a signal in emergencies when patients moved their fingers, alerting the nearest person. This system is both economical and beneficial for individuals with disabilities.

Looking ahead to Part II, the discussion will delve into the introduction and functionality of the project. The components, including additional ones for testing, have been outlined in this section. The subsequent section will showcase the project's output with sample code and diagrams. Finally, in Part IV, the conclusion and future extensions of this work will be explored.

2. PROPOSED SYSTEM

This segment outlines the essential software and hardware elements, elucidating the overall operational framework of the intelligent sign language recognition system. The envisioned device incorporates flexi pressure sensors positioned within the palm. Each sensor corresponds to a specific coordinate level, and each variation in coordinates signifies a distinct sentence. The identified sentences are then showcased on the LCD screen and notified through a buzzer. The sensor performs the crucial task of translating the detected execution load into a signal. The Node MCU microcontroller interprets this coordinate, directing the LCD and speaker to present and audibly relay the associated sentence. Refer to Fig. 1 for a visual representation of the proposed system's block diagram.

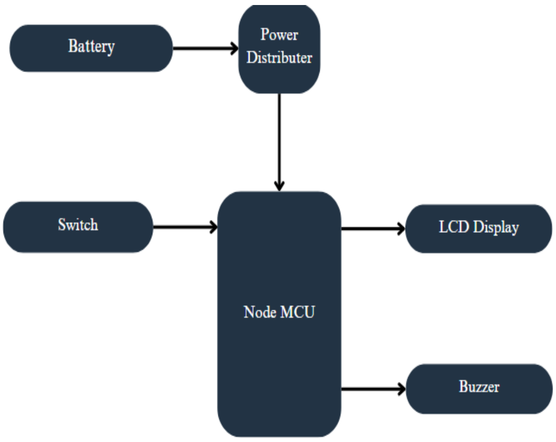

Fig.1 – Block Diagram of Receiver side

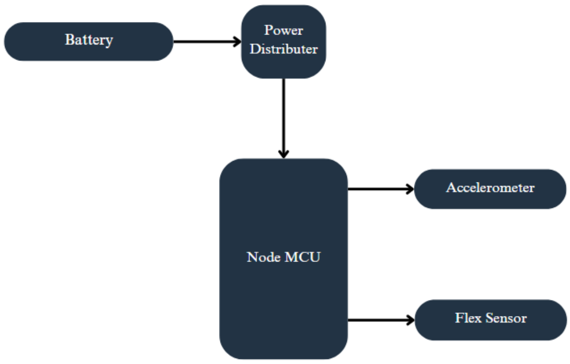

Fig.2 – Block Diagram of Transmitter side

In conclusion, the operational sequence of the proposed system is elucidated in Fig. 1 and Fig. 2. Initially, the user executes a gesture with the hand on which the glove is present, and the glove acts as a transmitter part that will transmit the information based on the gesture. The flex sensor captures the gesture, verifying the gesture is stored in the NODE MCU. Once registered, the outcome of the gesture is presented through the integrated auditory and visual system. Graphical output using coordinates is facilitated through the LCD screen, while the speaker is employed for auditory output.

Working of Accelerometer

An accelerometer operates based on the principles of Newtonian physics, particularly Newton's second law of motion, which states that the force acting on an object is directly proportional to its acceleration. Inside the accelerometer, there is typically a small mass suspended by springs. When the accelerometer experiences acceleration, the mass attempts to remain stationary due to inertia, causing the springs to compress or stretch. This movement generates a change in voltage through either piezoelectric materials or capacitive plates, which are sensitive to mechanical deformation. This voltage change is then measured and interpreted to determine the acceleration forces acting on the accelerometer. Applications of accelerometers span various fields, including consumer electronics, industrial monitoring, navigation systems, and automotive safety, where precise measurement and analysis of acceleration are essential for functionality, control, and safety.

Working of Flex Sensor

A flex sensor, also known as a bend sensor or a flexible potentiometer, operates on the principle of changes in resistance in response to bending or flexing. Typically constructed using a flexible substrate coated with a conductive material, such as carbon or a conductive polymer, the flex sensor exhibits an increase or decrease in resistance when bent. This change in resistance occurs due to the alteration in the spacing and alignment of conductive particles within the substrate as it bends. When subjected to bending, the distance between conductive particles changes, affecting the overall conductivity of the sensor. This alteration in resistance is directly proportional to the degree of bending or flexing experienced by the sensor. By measuring the resistance changes, typically through voltage or current measurement techniques, the degree of bending can be accurately determined. Flex sensors find applications in a variety of fields, including robotics, wearable technology, medical devices, and industrial automation, where precise monitoring and control of bending or flexing motions are required for sensing and actuation purposes.

Working of the system

This system integrates flex sensors into gloves to enable gesture recognition, responding to the user's hand movements. Each flex sensor's resistance changes with finger bending, yielding analog voltage signals. These signals are processed by a Node MCU microcontroller, which stores predefined threshold values for various gestures in its database. Each gesture corresponds to specific messages or actions. Upon surpassing thresholds, the microcontroller triggers actions like displaying messages on an LCD or generating speech signals. Flex sensor outputs are digitized for accurate analysis. The microcontroller matches detected gestures with its database, ensuring precise responses. Additionally, a GSM module facilitates message transmission. In summary, this system enables intuitive gesture-based control and interaction, enhancing user experience and functionality.

When a user executes a gesture, the microcontroller assesses the voltage signals against preset thresholds. Should the voltage exceed the threshold designated for a specific gesture, the microcontroller triggers a corresponding action. This action might entail presenting a predetermined message on a connected LCD screen and producing a speech signal via a built-in speaker, thereby offering auditory feedback to the user. Through this process, the system swiftly translates hand gestures into actionable responses, enriching user interaction. By leveraging these functionalities, users can seamlessly control and communicate with the system, enhancing their overall experience. The integration of gesture recognition with feedback mechanisms like visual display and auditory cues fosters intuitive interaction, facilitating user engagement. This iterative feedback loop between gesture input and system response ensures a seamless and efficient user experience.

To streamline signal processing, the analog output generated by the flex sensors undergoes conversion into digital format, ensuring accuracy in analysis by the microcontroller. With this digitized data, the microcontroller can efficiently reference its database, enabling precise identification of the executed gesture. Subsequently, based on this recognition, the microcontroller promptly triggers the appropriate response, aligning with the user's intended action. Through this systematic approach, the system maintains reliability and consistency in gesture interpretation, enhancing overall performance. By leveraging digital signal processing techniques, the system optimizes efficiency in gesture recognition and response generation, promoting seamless interaction. This conversion process enhances the system's capability to accurately discern subtle variations in gestures, ensuring robust and reliable performance. Consequently, users can expect a responsive and intuitive experience, with gestures seamlessly translated into actionable commands.

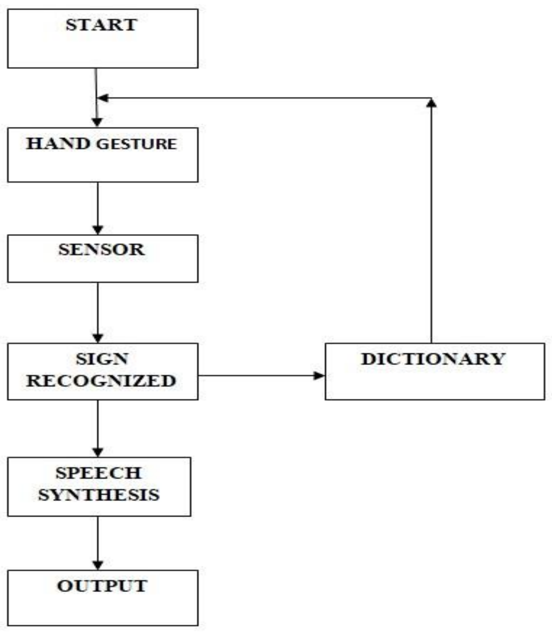

Fig.3 – Proposed model's flow of working

Moreover, including a GSM module extends the system's capabilities by enabling message transmission. This feature allows additional functionalities, such as sending alerts or notifications based on detected gestures.

Overall, this system offers a user-friendly interface for intuitive interaction, utilizing hand gestures to control and communicate with external devices or systems effectively.

Literature Review

S.No.	Year	Author's Name	Key Points	Scope of Improvement
1.	2022	Suvarna Kadam	Discusses precision for the hand movement and the coordinates they work on.	To improve the precision, a lot of hardware was added which made the receiver contain more electronics which could result in less accuracy.
2.	2020	Pritesh Ambavane	Used sign languages which is used for recognizing by using two different methods that is vision and non-vision approaches.	The key limitation of the proposed work is lots of miss interpretation of data.
3.	2019	Masrur Sobhan	Multimodal communication - it made a system which had 2 interfaces, one with international sign language and another one that could be modified according to the disabled person.	It may require advanced sensor hardware, increasing the cost of proposed system.
4.	2018	Vijaybhasker Reddy	This was a compact system that had a lesser number of electronics which made it easier for disabled persons to keep the glove wearing as the weight was reduced.	A module named Raspberry Pi was used in the system which made it expensive.
5.	2016	Nikita P.Nagori	Authors used their own sign language in place of generalized sign language for example (American Sign Language (ASL) and Germany Sign Language (GSL)).	Using their own language made it difficult for people with disability to learn a new language.
6.	2013	Pallavi Verma	Had a microcontroller-based cost-effective system to recognize gesture and convert into coded form so that it can be displayed if code matches with predefined codes.	• In designing gloves, the identification of the purpose for which it has to be built along with specifying requirements. • In this case, a system needs to be developed for deaf people which enables them to communicate with normal persons. Also helps to bridge the gap between a person with a disability and a normal person.

Future Scope

The future scope of this project lies in further enhancing the accessibility and functionality of communication systems for individuals with speech and hearing disabilities. As technology continues to advance, there is potential for integrating more sophisticated sensors and machine learning algorithms to improve gesture recognition accuracy and response time. Additionally, the development of mobile applications and cloud-based platforms could expand the reach of these communication tools, allowing for remote access and collaborative communication. Furthermore, future iterations could focus on increasing the system's adaptability to diverse user needs and preferences, such as multilingual support and personalized gesture mapping. Collaborations with healthcare professionals and user communities would be invaluable in refining and validating the effectiveness of these systems in real-world settings. Overall, ongoing research and innovation in this field hold promise for empowering individuals with disabilities to communicate more effectively and participate more fully in society.

Conclusion

In conclusion, this project represents a significant milestone in addressing the communication barriers experienced by individuals with speech and hearing disabilities. Through the integration of cutting-edge technologies and meticulous design considerations, a robust and user-friendly communication system has been developed. By utilizing flex sensors, Node MCU controllers, and GSM modules, the system achieves a high degree of precision and reliability in gesture recognition and message conveyance. Additionally, the incorporation of real-time feedback mechanisms ensures immediate confirmation of user input, enhancing the overall user experience. Moreover, the inclusion of emergency alert features adds an extra layer of safety and security for users, providing peace of mind in critical situations. The project's success not only demonstrates the transformative potential of technology in improving the quality of life for individuals with disabilities but also underscores the importance of inclusivity and accessibility in modern society. Moving forward, ongoing research and development efforts will be vital to further refine and optimize the system, ultimately enabling more seamless and effective communication for individuals of all abilities.

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