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Empowering Sign Language Communication with the Revolutionary Glove

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Abstract: This paper presents a novel approach to bridging communication barriers for the Deaf and Hard-of-Hearing (DHH) community through a revolutionary glove system that translates sign language into written words and audio. Traditional sign language interpreters and static translation systems often face challenges in portability, accessibility, and affordability. The proposed system leverages sensor-enabled gloves, integrated with machine learning algorithms, to capture hand gestures, convert them into standardized sign language, and generate text output in real time. The system utilizes Bluetooth connectivity for real-time data transmission between wearable sensor gloves equipped with flex sensors, gyro sensors, and the mobile application. These gloves detect hand movements and gestures, utilizing flex sensors to measure finger bends and gyro sensors to track hand orientation. The data is then interpreted by an embedded processing unit and translated into readable text and audible speech by the app. The Bluetooth connectivity ensures seamless and uninterrupted communication, allowing users to interact easily in different environments. By providing a reliable and accessible means of communication, this project aims to enhance the inclusivity of deaf and mute individuals, leading to improved social interactions, increased independence, and more opportunities for education and employment

Keywords: sign language,flex sensor, and patterns variation

INTRODUCTION

Many mute people choose sign language as their primary mode of communication because it is a beautiful and expressive medium. others who use sign language to communicate may find it difficult to communicate with others who do not understand sign language, which could create a communication barrier between these two communities. This proposal seeks to close this gap by outlining a project that would create a glove that will empower sign language communication. In order to translate sign language into text and voice, this project will develop and construct a glove with sensors. The process makes use of an Arduino Nano, on which the uploaded code is checked for signs that are consistent.When the predictive indications and the coding match, data transfer in the form of text and voice is carried out via a Bluetooth module to an application. As a result, this approach fosters more inclusivily by improving communication between the normal and mute population.

LITERATURE REVIEW AND HYPOTHESIS DEVELOPMENT

This paper introduces a smart glove system designed to address these challenges through innovative sensor integration and machine learning capabilities. Individuals with congenital deafness experience hearing impairment from birth, and this condition can arise from various factors, including genetic influences, prenatal infections, or complications during childbirth. Communication for those with congenital deafness often involves diverse methods such as sign language, written communication, lip reading, and the use of hearing aids or cochlear implants. On the other hand, congenital muteness refers to the inability to speak from birth and can result from physical conditions affecting the vocal cords, neurological disorders, or genetic factors by Douglass E. and Richardson J. C., (1959). People with congenital muteness often develop alternative means of communication, relying on non-verbal methods such as gestures, facial expressions, and written communication. It is essential to use respectful and inclusive language, avoiding terms like "dumb," which are considered outdated and offensive. Instead, employing person-first language emphasizes the individual's humanity over their condition, fostering understanding and promoting dignity for those with congenital deafness and muteness.

Sign language serves as a vital communication medium for millions worldwide, yet many in the hearing community lack proficiency in creating significant barriers. Existing tools, such as manual interpreters and video-based systems, have limitations, including dependency on internet access, lack of portability, and high costs by Farooq U, Mohd Rahim M.S, Sabir N, Hussain A, Adnan Abid (2021). Therefore, the advent of wearable technology offers a promising solution, enabling real-time translation of sign language gestures into spoken or written forms.

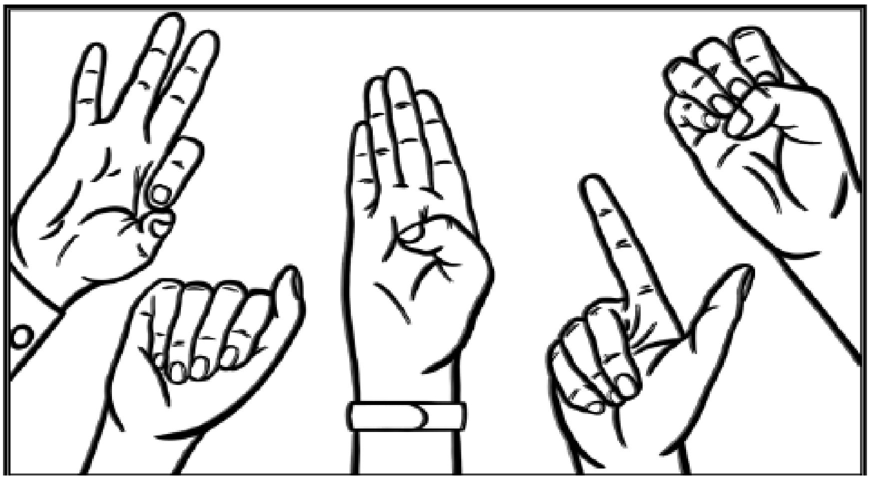

Figure 1. Sign Language Structure, Douglass E. and Richardson J. C., (1959)

Sign language structure selected is seen in Figure 1, had evaluated research that focuses mostly or exclusively on the sign languages used by deaf populations; so, in the following, these languages will be referred to as "sign languages." The structure of American Sign Language (ASL), the most researched sign language, as revealed by research, is the main topic of this review. Information about other sign languages is also examined; these include those from southern France, Japan, Denmark, Israel, Taiwan, China, Providence Island in the Caribbean, and the Enga tribe of New Guinea. Rennell Island is a Polynesian outlier in the Solomons. ASL and other sign languages are examples of distinct structures that are part of their visual-gestural modality said by AA Abdul hussein, Raheem FA (2020). Unlike spoken languages, sign languages utilize specific handshapes, movements, and locations to construct signs, forming the foundation of their manual components. Facial expressions play a pivotal role in conveying grammatical and emotional nuances, adding depth to the linguistic expression. Non-manual markers, including head movements and body postures complement facial expressions to convey grammatical information and emphasis. Spatial grammar involves using the space around the signer's body to denote various grammatical elements, such as subject and object, (Othman, A. ,2024).. Temporal aspects, including timing and rhythm, are essential, influencing the meaning of signs. Sign languages have their own syntax and grammatical structures, often diverging from the word order found in spoken languages. Iconicity is present, where signs may visually resemble their meanings.

While there are various ways for people to interact, one approach aims to improve translation by providing a practical, affordable framework that translates speech into sign language and sign language into text in real time. The first sensor of its kind, the Kinect is utilised in a large-scale depth camera. This device has 3D viewing capabilities. The device was initially developed by Microsoft as a gamecont roller, and it runs on the company's proprietary software for 3D data processing, which includes computations for gesture recognition, motion tracking, feature tracking, scene analysis, and bone tracking, Chai et al (2013). The work's efficacy is assessed using Kinect after being completed in Matlab. A good technique for translating sign language to spoken language is to use Kinect with Matlab. A method that would allow everyone to converse with the dumb and deaf. A webcam is positioned in front of the physically disabled person with this arrangement. The guy with physical impairment would have colourful rings on his fingers. The webcam will record the precise locations of the rings when he makes the letter gestures, and it will use colour recognition in image processing to ascertain the colour coordinates. The exact alphabet will be recorded in accordance with the matching of the captured coordinates with the previously stored one. By proceeding in this manner, a person with physical impairments will be able to finish the words they wish to say. Then it will able to change in speech, Dhake, D., Kamble, M. P., Kumbhar, S. S., & Patil, S. M. (2020).

METHODS

In the experiment section gives an outline of the revolutionary glove which can facilitate communication via sign language. approach will focus more on the development of software and hardware guided project development block diagram.

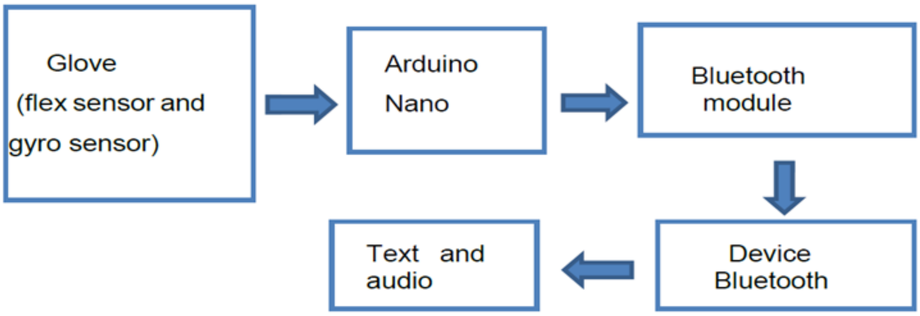

Figure 2. Block diagram of the project development

Figure 2 illustrates a block diagram of a glove that uses sensors to detectvarious sign language gestures. The sensory data is fed into an Arduino NANO,which then uses a Bluetooth module to transfer the data to an application where it is converted into text and audio.

The flowchart for the standard operating procedure is displayed in figure 3. First, the smart glove must be turned on. Next, the gyro sensor and five flex sensors, which are fastened to the glove's five fingers, read the motion and also position . It determines whether the gesture matches predefined coding in node MCU when the user positions the gesture at a specific angle based on predefined values. In the event that they don't match, it waits for the accurate data before sending the output to the Bluetooth module. The data is transmitted when the Bluetooth module is linked to the receiver; if not, it waits to connect to the Bluetooth receiver. After turning on the device's Bluetooth, the programme couples the smart glove with the glove's Bluetooth module. It waits for the module to supply data when the connection has been made. When data is received, it first converts to text and then uses the microphone on the device to convert it to audio. The outcome is presented as both text and audio.

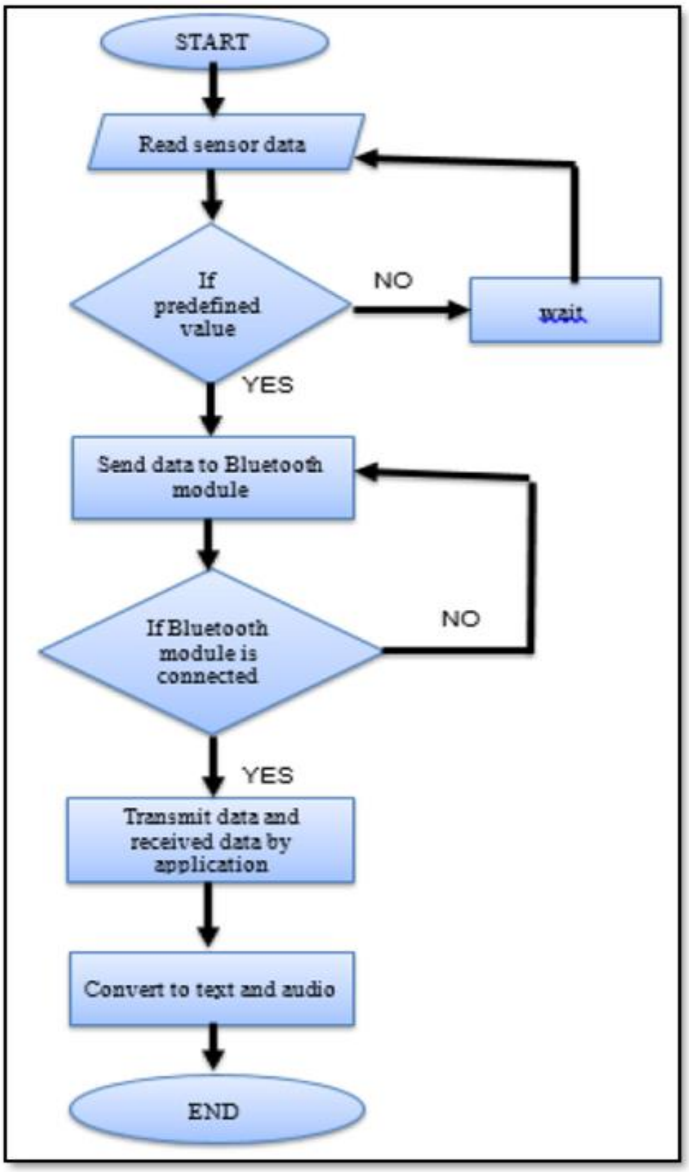

Figure 3. Block diagram of the project development

RESULT AND DISCUSSION

This section discusses the results based on hardware (sign using glove) and sofware (convert into text and audio by application) from experiment test to validate the mobile application which transleates into text and audio. Then, the display application illustrated for all the five (5) selected sign consist of : "Hi," "please help me," "please call me", "I need to drink water."and "I'm sorry," according the degress theresholds setting.

Figure 4. 'Hi' sign using glove and display in application [13]

Figure 4 illustrates the 'hi' sign detected by the glove, with all flex sensors at 0 degrees and the gyro sensor positioned to the left of the body at a 90-degree angle. The glove recognizes when fingers are straight and detects hand orientation precisely. For the 'hi' sign, the hand must be positioned 90 degrees away from the body to the left. Once correctly positioned, the Arduino NANO detects the gesture and sends the data to a mobile application, which translates it into text and audio. The successful output is displayed as a 'hi' picture, text, and audio, demonstrating the effective translation of the sign.

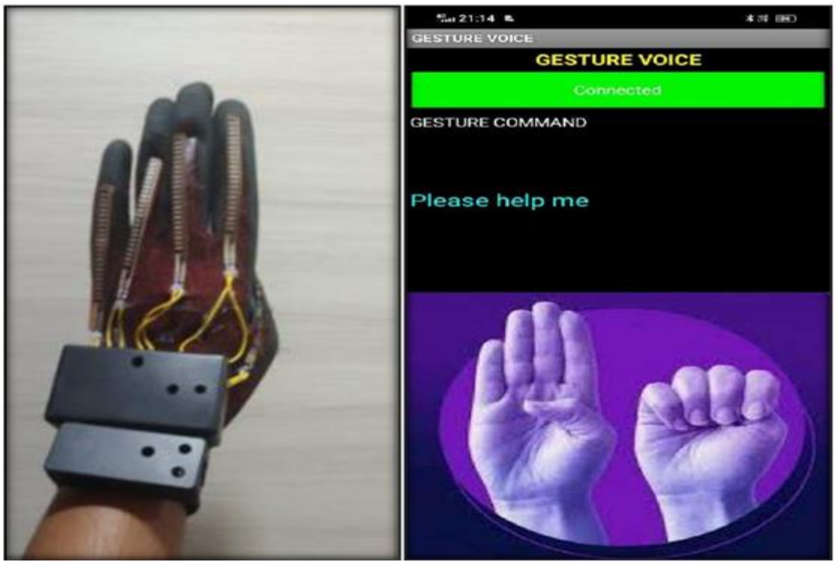

Figure 4. ‘please help me’ sign using glove and display in application (Claire Wolters 2021)

The "please help me" sign can be seen in Figure 4.The sign for ‘please help me position’ like bending of the thumb sensor to a 90 angle with the rest of the fingers staying straight. In order to maintain a 90-degree angle between the body and the hand position, the gyro sensor is placed opposite the body. When the Arduino Nano recognises the predefined values as written in the programming code, it allows the sign to be sent to an application that can interpret it into text and voice.

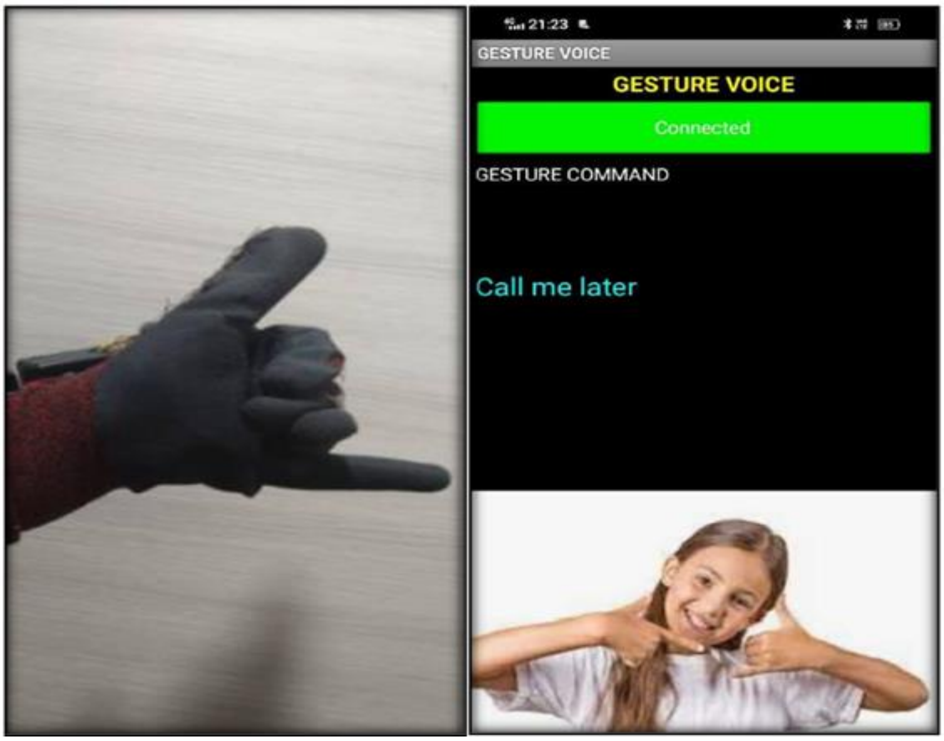

Figure 6. ‘Please call me’ sign using glove and display in application (closeup-portrait-teenager-girlmaking-call (2014)

Figure 6 displays the 'please call me' sign. The thumb and little finger must be straight to achieve this sign, but the rest of the fingers must be completely bent. The gyro sensor is 30 degrees angled towards the face and located to the left. For the Arduino Nano to recognise the established value and send it to the mobile application, the sign's positioning must be precise. Otherwise, the Arduino Nano will keep searching until it detects the gesture in the proper position. When the collected data match with predefined value the Arduino nano sends the data to application by Bluetooth connection.Then the application changed it into text and audio which is easy way to communicate between dumb people to normal people.

Figure 7 displayed I need to drink water sign by using glove.For this sign , the thumb finger in straight position meanwhile the rest of finger bending fully. The gyrosensor position front of the face.When the Arduino nano detect correct position as describe it will share it to application through Bluetooth module otherwise wait until get correct position detection. the result for ‘I need to drink water’ through mobile application.It will shown when Arduino nano sends the correct data to the application through Bluetooth module.Then,the collected data will display in the form of text and audio by application.

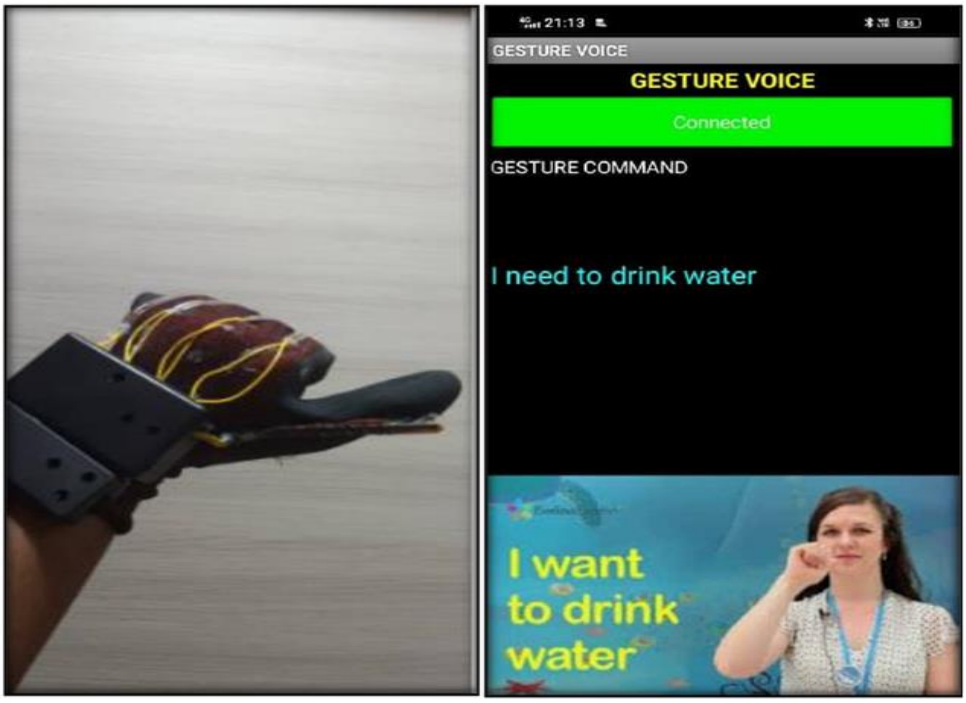

Figure 7. ‘I need to drink water’ sign by using glove and display in application (Guy's and Thomas St, 2016)

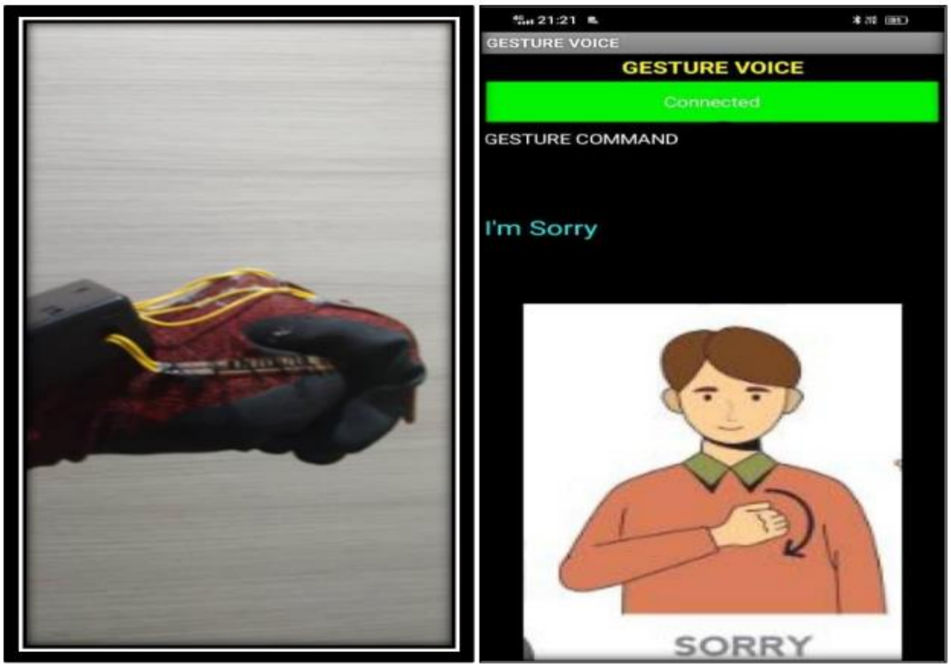

Figure 8 I m sorry sign by using glove and display in application (Getty Images, 2019)

The figure 8 shows that I m sorry sign.The position of the hand for I m sorry is bending all the fingers and gyro sensor position front of the body.The correct data is detect by Arduino nano and transfer that data to application by Bluetooth module. The sign's exact position is crucial because the Arduino Nano only identifies and delivers data to the android application when it matches predetermined settings. The Arduino Nano waits until it can obtains precise input in cases.when an appropriate position is not immediately detected it will wait until get correct input.

CONCLUSIONS

The development and implementation of the sign language glove project have shown a great deal of promise to overcome the communication issue between deaf or mute people and non-sign language learners. This project successfully recorded hand motions that correlate to five important signs: "hi," "please help me," "please call me," "I need to drink water." and "I'm sorry," These signs are collected and sent to a mobile application using Bluetooth, where they are immediately translated into text and audio form.This represents a meaningful way forward in accessibility and inclusion, offering practical solutions to facilitate communication between individuals with different communication abilities. By leveraging wearable technology and modern communication tools, had addressed critical needs in the deaf and mute community, empowering them to express themselves more freely and interact more seamlessly with the wider community furthermore can participate more inclusively in society. Therefore, this project would create a revolutionary glove that will empower sign language communication, in order to understand and translate sign language into text and voice.

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