A Gesture Vocalizer Translation System for Efficient Communication

Project Reference No.: *47S_BE_2035*

College **:** *Amrita School of Engineering, Bengaluru*
Branch **:** *Department of Electronics and Communication Engineering*
Guide(s) **:** *Ms. Priya B.K*
Student(S) **:** *Ms. Ananya Muralidharan*
Ms. C G Priya
Mr. Goutham P Keeryat

Keywords:

Rubber Gloves, Flex Sensors, Accelerometer, Connecting wires, MPU6050, Python Raspberry Pi

Introduction:

The Gesture Vocalizer Translation System for Peer-to-Peer Communication is designed to assist individuals with speech and hearing challenges, enabling them to communicate effectively by translating hand gestures into spoken words. This innovative system incorporates flex sensors and MPU 6050 sensors embedded in gloves that detect specific hand and finger movements. These sensors are connected to a Raspberry Pi via Bluetooth, using an ESP 32 Bluetooth module. Once the gestures are interpreted by the system, it reliably translates these hand gestures into speech. It supports five languages: English, Hindi, Tamil, Kannada, and Malayalam, allowing users to choose their preferred language. Subsequently, the system converts gestures into speech in the selected language. This conversion is crucial as it facilitates clear and effective communication between people with speech and hearing impairments and the wider community. This technology not only supports personal interaction but also enhances the ability of affected individuals to participate more fully in public and social life. This project combines advanced hardware, such as flex sensors and accelerometers, with sophisticated software algorithms to accurately interpret gestures. These components work together to capture the nuances of hand movements and translate them into digital signals that the Raspberry Pi can process.

Objectives:

The primary aim of the Gesture Vocalizer Translation System for Peer-to-Peer Communication project is to develop a dependable and effective communication tool that utilizes a smart glove to assist individuals with speech and hearing challenges. This system is equipped with sensors in gloves that precisely detect and translate hand gestures into spoken words, accommodating various hand sizes and gesture types. It uses cost-effective and readily accessible components like the ESP 32, Raspberry Pi, and flex sensors, and incorporates sophisticated software algorithms to enhance gesture recognition accuracy and efficiency. Rigorous testing in real-life settings will be conducted to verify the system's functionality and reliability. The system is designed to be flexible, easily adapting to different languages. This approach creates a dependable system that converts hand gestures into spoken words, offering translations in five languages: English, Hindi, Tamil, Kannada, and Malayalam. Users can select their desired language for conversion, and once a language is selected, all conversions will occur in that chosen language. The interface is intentionally simple and user-friendly to facilitate quick adoption by users. Moreover, the system is built to operate in real-time with minimal delay, supporting fluid and natural communication. Ultimately, this project aims to foster inclusivity and significantly improve the lives of those with speech and hearing impairments by removing communication barriers.

Methodology:

The methodology for developing the Gesture Vocalizer Translation System for Peer-to-Peer Communication includes a comprehensive approach involving materials selection, system design, and detailed implementation steps:

Materials Used: The project utilizes ten flex sensors, 2 accelerometers (MPU6050) embedded in a glove to detect gestures. These sensors are interfaced with two ESP32 microcontrollers each in left and right hand, that transmits the sensor data to a Raspberry Pi via Bluetooth. The Raspberry Pi processes this data to recognize gestures and produce vocalized speech in the selected desired language.

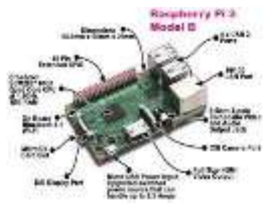


Fig.1 – Flex sensor Fig.2 – ESP32 microcontroller Fig.3 – MPU6050 Fig.4 – Raspberry Pi

SYSTEM DESIGN:

Sensor Integration: The ten flex sensors placed on each of the glove measure the degree of finger bending, while accelerometers track the orientation and movement of the hand. This data is crucial for accurately interpreting the user's gestures.

Data Transmission: The two ESP32 microcontroller mounted on the left and the right hand collects and sends sensor data to the Raspberry Pi using Bluetooth, ensuring real-time data exchange.

Gesture Recognition: On the Raspberry Pi, a CSV file data set processes the incoming data to identify specific gestures. This data set has been trained of hand gestures corresponding to the Indian Sign Language alphabet and numbers and words into five languages: English, Hindi, Tamil, Kannada, and Malayalam.

Fig.5 – Smart gloves (Transmitter)

Fig.6 – Raspberry Pi (Receiver)

Voice Output: Once a gesture is recognized, the corresponding text is converted into speech into the one of five desired languages using a Text-to-Speech (TTS) engine implemented on the Raspberry Pi. This method creates a reliable system that translates hand gestures into speech. It supports five languages: English, Hindi, Tamil, Kannada, and Malayalam. Users can choose their preferred language, and then the system will convert gestures into speech in that language.

Block Diagram: A comprehensive block diagram is provided to illustrate the flow of data from the gesture-detecting glove to the speech output. It highlights the key components such as the sensors, microcontroller, Raspberry Pi, and output devices.

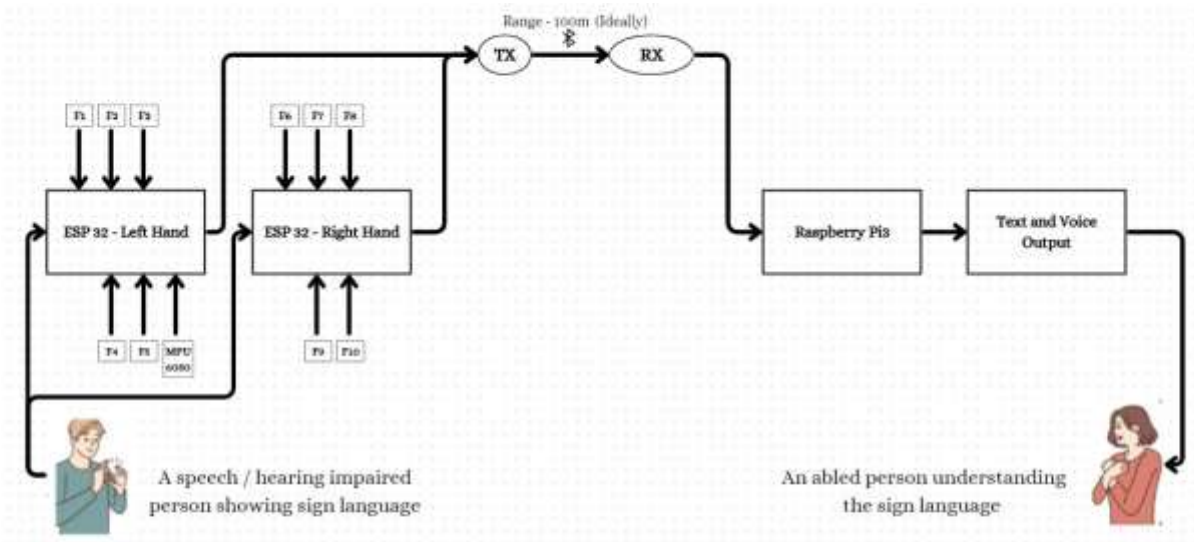


Fig.7 – Block Diagram

DIAGRAMS AND ILLUSTRATIONS:

Circuit Diagram: Shows the electrical connections between the sensors, ESP32, and other components.

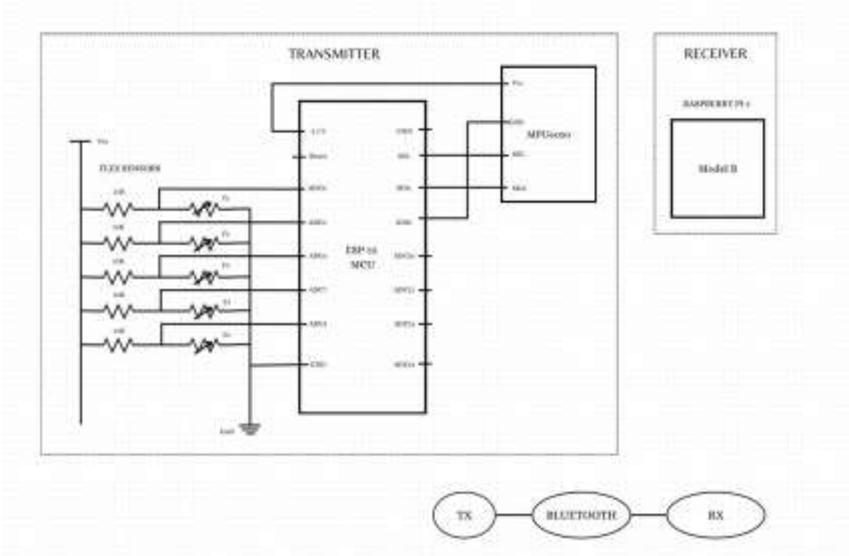
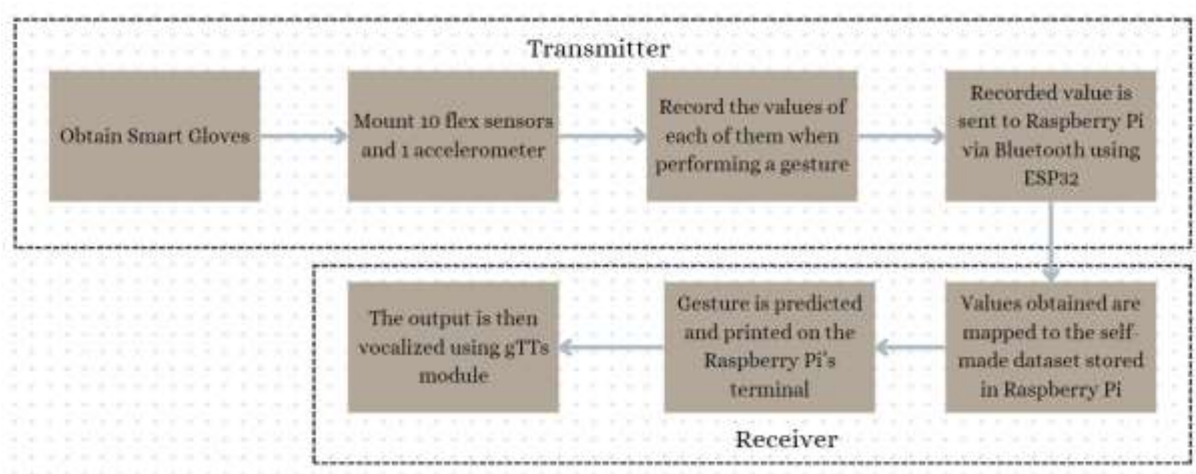


Fig.8 – Circuit Diagram

Workflow Diagram: The methodology details a step-by-step process that begins with gesture detection and culminates in speech output, effectively illustrating the operational flow of the system. This approach ensures a robust design capable of achieving the project's goals by efficiently translating gestures into the speech of the user's chosen language. The system supports five languages: English, Hindi, Tamil, Kannada, and Malayalam. Users are given the option to select their preferred language for translation. Once a language is selected, all gestures are translated into speech in that chosen language, thereby enhancing communication for individuals with speech and hearing impairments.



Fig

Conclusion:

The evaluation concluded that the gesture vocalizer translation system is technically viable, utilizing gesture recognition algorithms and multilingual text-to-speech engines effectively. It demonstrated scalability potential, indicating that it could accommodate more complex gestures and a broader array of languages as technological advancements are made. The system provides considerable benefits to individuals with speech or hearing impairments, significantly enhancing their communication capabilities. To facilitate wider adoption and practical application, the system requires further refinement, particularly in optimizing gesture recognition accuracy across varying environmental conditions and expanding its linguistic capabilities. This project highlights the profound potential for gesture-based communication tools to increase accessibility and foster inclusion across diverse linguistic communities.

Scope for future work:

To enable accurate and effective gesture detection, the smart glove's technology needs to be improved to be able to read even the slightest hand movements for voice conversion. Interaction between spoken language speakers and sign language users enables real-time communication across linguistic barriers. Enhancing the Raspberry Pi and ESP32's Bluetooth connection has also resulted in better connectivity. Accessibility is further enhanced by cloud integration, which makes large datasets and outcomes internationally available. We can increase the amount of the gesture dataset and the languages it supports in the future. Thanks to these developments, the smart glove can now be used as an effective tool for inclusive communication, enabling simple spoken and sign language interactions across national and cultural boundaries.