International Research Journal on Advanced Engineering Hub (IRJAEH)
e ISSN: 2584-2137
Vol. 03 Issue: 03 March 2025
Page No: 511 - 516
https://irjaeh.com
https://doi.org/10.47392/IRJAEH.2025.0071

Flex Sensor Based Communication Aid for Mute Communities

K Priya Dharshini[1], R Kayal Vizhi[2], M. Keerthana[3], P P Samsitha[4]
[1]Associate Professor, Department of CSE, Kamaraj College of Engg. & Tech., Virudhunagar, Tamil Nadu, India
[2,3,4]UG Scholar, Department of CSE, Kamaraj College of Engg. & Tech., Virudhunagar, Tamil Nadu, India
Emails: *priyadharshinicse@kamarajengg.edu.in[1], 21ucs011@kamarajengg.edu.in[2], 21ucs021@kamarajengg.edu.in[3], 21ucs110@kamarajengg.edu.in[4]*

Abstract
This project focuses on developing an electronic device that translates finger gestures into text or speech, facilitating communication for mute individuals. At its core is a data glove equipped with flex sensors that capture finger movements, converting resistance changes into digital data processed by a microcontroller. The output is displayed on a 16-bit LCD for real-time readability and integrated with an MP3 module f openor voice playback, ensuring accessibility for the blind. By translating hand gestures into text or speech, this device enables seamless social interaction without the need for sign language interpreters. Additionally, it holds potential in healthcare, allowing ICU or sedated patients to communicate effectively with medical staff through simple hand gestures. The device combines cutting-edge sensor technology, efficient data processing, and user-friendly design to address a critical societal need. It empowers mute individuals, promotes inclusivity, and provides transformative applications in daily life and specialized fields like medicine.

Keywords: *Cutting-Edge Sensor, IOT.*

1. Introduction

This project is focused on designing and developing an electronic device that translates finger gestures into text or speech, enabling effective communication between mute individuals and the general population. At the core of this device is a data glove, which acts as an interface for capturing hand and finger movements. The data glove is constructed from a regular rubber or cloth glove fitted with flex sensors, one along the length of each finger. These flex sensors are highly sensitive to bending and produce varying resistance values based on the degree of finger movement. When a mute person wears the glove and performs specific hand gestures, the sensors detect the changes in resistance caused by the bending of the fingers. The resistance data collected by the flex sensors is sent to a microcontroller, which processes the input and converts it into a recognizable format. The processed data is then displayed on a 16-bit LCD screen, allowing the person on the other side to read the message in real-time. For individuals who are blind, the device also includes a voice recording and playback system, integrated with an MP3 module, that converts the text into audible speech. This ensures that the device is accessible to a broader range of users, making it a versatile communication tool. This system provides a seamless way for mute individuals to express their emotions, thoughts, and needs through simple hand gestures, which are instantly translated into text or speech for others to understand. It is particularly useful in everyday social interactions, allowing mute individuals to communicate effectively without relying on sign language interpreters or written notes. Beyond its primary function as a communication aid, this device also has potential applications in the medical field.

In critical settings like intensive care units (ICUs) or operation theatres, where patients may be unable to speak due to intubation, sedation, or other medical conditions, the device can act as a biomedical instrument for facilitating communication. Patients can use the glove to convey basic messages or needs through hand gestures, which can then be understood

International Research Journal on Advanced Engineering Hub (IRJAEH)
e ISSN: 2584-2137
Vol. 03 Issue: 03 March 2025
Page No: 511 - 516
https://irjaeh.com
https://doi.org/10.47392/IRJAEH.2025.0071

by medical staff, improving patient care and reducing misunderstandings. By combining cutting-edge sensor technology, efficient data processing, and user-friendly output methods, this project offers an innovative solution to a critical societal need. It empowers mute individuals, enhances inclusivity, and provides practical applications in both everyday life and specialized fields such as healthcare, making it a truly transformative device.

2. Related Work

A low-cost smart glove prototype for gesture recognition, achieving 90% accuracy using a convolutional neural network (CNN). The glove uses flex sensors to capture finger movements, with resistance data processed by a CNN trained on diverse gestures. The system offers affordable, efficient gesture recognition tailored for gaming and educational applications. In gaming, the glove enhances interactivity by enabling gesture-based controls, creating an immersive and intuitive experience. Beyond gaming, the device is explored as a communication tool for individuals with hearing disabilities, mapping gestures to words or phrases to improve inclusivity in educational settings. Designed with cost-effective materials, the glove's modular architecture allows for easy upgrades and integration with technologies like haptic feedback. Testing validated its performance across varied hand sizes and movement speeds, although challenges such as sensor calibration and gesture complexity were noted. The study highlights the glove's potential to empower individuals with disabilities, providing affordable, inclusive solutions for communication and interaction in both entertainment and educational contexts [1]. A gesture recognition system utilizing accelerometers embedded in gloves, combined with machine learning algorithms to enable accurate and real-time translation of hand movements. The system captures motion data from accelerometers, which is processed using classification models to recognize specific gestures effectively [2]. The study emphasizes the system's ability to deliver fast and reliable gesture recognition, making it suitable for applications like communication aids and human-computer interaction. The integration of machine learning ensures high adaptability to diverse user movements and improves gesture recognition accuracy. To enhance the system's performance, the authors propose the incorporation of AI-based optimization techniques, which aim to reduce processing latency and increase response speed. These advancements are particularly beneficial for real-time applications where immediate feedback is crucial. The authors also highlight the scalability of their approach, suggesting that the system could be adapted for use in various fields, such as gaming, virtual reality, and assistive technologies for individuals with disabilities. Future work focuses on refining the algorithms and exploring the use of more advanced sensors to further improve system accuracy and efficiency [3-6]. a cutting-edge technology developed at UCLA that translates American Sign Language (ASL) into speech using a wearable glove integrated with a smartphone app. The glove is embedded with flexible sensors that capture hand and finger movements corresponding to ASL gestures. These movements are transmitted wirelessly to the smartphone app, which processes the data and converts it into audible speech in real-time. This innovation aims to bridge the communication gap for individuals relying on ASL, offering a practical and portable solution. The glove’s user-friendly design and smartphone integration ensure accessibility and ease of use in everyday interactions. The study also addresses key challenges for long-term usability, such as improving battery life to extend operational hours and enhancing the durability of the glove to withstand regular wear and tear. The authors suggest integrating energy-efficient components and robust materials as part of future development. This technology represents a significant advancement in assistive devices, with potential applications in education, workplaces, and public settings, empowering individuals who use ASL to communicate seamlessly with non-signers [7-12]. An insightful review of sensor-equipped gloves designed for translating sign language gestures into text, which can significantly enhance accessibility for the hearing-impaired. The study highlights the importance of such technology in bridging communication gaps between hearing-impaired individuals and the broader community. These gloves use various sensors, such as flex sensors, inertial measurement units (IMUs), and accelerometers, to capture hand movements and gestures. The data is then processed using machine learning algorithms to translate gestures into text accurately. The authors discuss the key challenges, including the high cost of sensors, complexity in gesture recognition, and the need for lightweight and ergonomic designs. They emphasize the importance of affordability and ease of use for broader real-world adoption. The review also explores advancements in materials and sensor technology, which have the potential to make such devices more practical and reliable. Additionally, it addresses the integration of wireless communication to improve mobility. Overall, the paper underscores the need for interdisciplinary collaboration to overcome technical and economic barriers for developing accessible sign language recognition devices. A novel approach to Arabic sign language recognition using deep learning models integrated into wearable gloves. Their system utilizes advanced sensors to capture hand movements and gestures, which are then processed by convolutional neural networks (CNNs) to achieve high accuracy in gesture recognition. The research highlights the system's 90% accuracy rate in recognizing a variety of Arabic sign language gestures, demonstrating its effectiveness. The authors emphasize the scalability of their model, aiming to expand its capacity to recognize a broader range of gestures for more comprehensive communication. They also address the challenges of real-time processing and minimizing latency, ensuring the system is suitable for practical use. The study explores the integration of lightweight and energy-efficient components to enhance portability. Additionally, the research discusses the potential for multilingual sign language recognition, opening pathways for global accessibility. The findings underscore the significance of deep learning in advancing wearable technologies for sign language communication [13-15]. an innovative wearable glove system designed to translate sign language gestures using gyroscopic sensors. The system effectively tracks hand movements and orientations, capturing precise data for gesture recognition. With an accuracy rate exceeding 85%, the system demonstrates significant potential for practical use in sign language communication. The authors highlight the role of gyroscopic sensors in ensuring consistent and reliable gesture tracking. A key feature proposed is the incorporation of haptic feedback, which provides real-time tactile responses to help users refine and correct their gestures. This feedback mechanism aims to enhance user interaction and learning, making the system more intuitive and user-friendly. The study also discusses the potential for integrating machine learning algorithms to improve accuracy and expand the range of recognizable gestures. Emphasis is placed on creating an affordable and lightweight design to make the device accessible to a wider audience. Overall, the research represents a step forward in wearable technology for sign language translation [16].

3. Problem Statement

Deaf and mute individuals often face communication barriers due to the lack of accessible tools that can translate sign language gestures into a format understandable by the general population. Sign language, though effective within the deaf community, is not universally understood, making it challenging for them to communicate in diverse social, educational, and professional settings. The absence of real-time, affordable, and user-friendly solutions further exacerbates this problem, leaving a significant gap in inclusivity. Additionally, situations such as hospitals or emergency settings require an effective means for non-verbal communication. Therefore, there is an urgent need for a wearable device, such as a sensor-integrated glove, capable of converting hand gestures into text or speech in real-time, enabling seamless and inclusive communication for the deaf and dumb community.

4. Proposed Work

This project aims to develop a cost-effective and portable system for recognizing sign language gestures using a sensor-equipped glove. The system translates hand movements and finger positions into corresponding audio outputs, facilitating communication for individuals with speech impairments.

International Research Journal on Advanced Engineering Hub (IRJAEH)
e ISSN: 2584-2137
Vol. 03 Issue: 03 March 2025
Page No: 511 - 516
https://irjaeh.com
https://doi.org/10.47392/IRJAEH.2025.0071

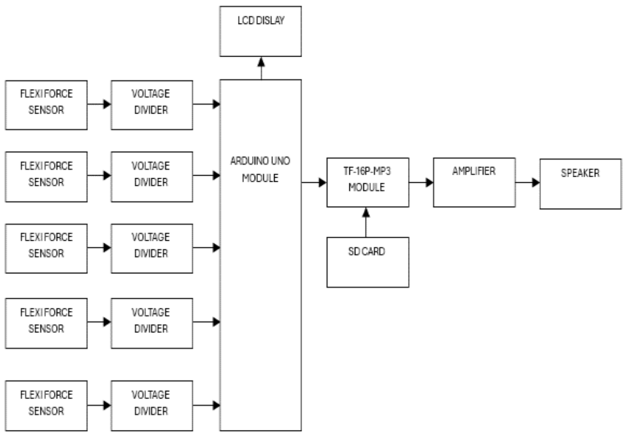

Figure 1 **Cost-Effective and Portable System**

Figure 1, Here are the four modules with more detailed explanations based on the methodology provided:

4.1. Input Module (Flex Force Sensors)

This module includes five flex force sensors mounted on a wearable glove, one on each finger. The sensors measure the bending angle of each finger by detecting changes in resistance. When a finger bends, the sensor's resistance varies proportionally to the degree of bending. These resistance values represent the gestures made by the user and form the raw input data for the system. Each sensor is crucial for accurately interpreting the specific gestures corresponding to sign language [17-20].

4.2. Signal Conditioning Module (Voltage Divider Circuit)

The flex sensor outputs are connected to voltage divider circuits, which convert the resistance changes into analog voltage signals. The voltage divider ensures the signals are in a readable range for the microcontroller, allowing it to process data efficiently. This module acts as an intermediary to condition and stabilize the sensor outputs before sending them to the processing unit. Proper signal conditioning is vital for minimizing noise and ensuring accurate interpretation of gestures.

4.3. Processing and Conversion Module (Arduino Uno and MP3 Module)

The Arduino Uno microcontroller receives the analog voltage signals from the signal conditioning module and processes them. It uses predefined mappings to translate the sensor data into corresponding text or speech commands. The Arduino communicates with the MP3 module to play pre-recorded audio files stored on an SD card. These files are associated with specific gestures, enabling speech output. This module is the heart of the system, where the gesture-to-text and gesture-to-speech conversion occurs.

4.4. Output Module (LCD Display, Speaker, and Amplifier)

This module presents the processed output in two formats:

- **Text Output:** The Arduino sends the interpreted gesture data to a 16-bit LCD display, where the corresponding message is displayed for sighted individuals.
- **Speech Output:** The MP3 module's audio signals are amplified using an amplifier and played through a speaker for audible output, making it accessible to blind individuals. The dual output mechanism ensures inclusivity and versatility in different communication scenarios. These modules work together seamlessly to interpret hand gestures and convert them into meaningful text or speech, addressing the communication needs of the deaf and mute community effectively.

Conclusion

Sign language gloves equipped with sensors offer a promising technology for enhancing communication among individuals who are deaf and mute, allowing them to convert sign language gestures into digital text or speech in real-time. These devices empower users by facilitating smoother, more inclusive interactions with others, promoting independence and confidence. However, challenges such as high cost, limited gesture recognition accuracy, and the need for customization remain. Despite these hurdles, the continuous advancement of sensor technology and artificial intelligence holds great potential to improve the effectiveness, accessibility, and affordability of these gloves, ultimately fostering a more inclusive society for deaf and mute individuals.

Future Work

In the future, sign language gesture gloves can be improved by making them more accurate in recognizing different signs through better sensors and technology. They could also support multiple sign languages, helping people from different countries communicate. Making the gloves more comfortable and affordable would allow more people to use them. Additionally, adding features like real-time translation to phones or other devices and improving battery life would make them more convenient. Expanding the use of these gloves in schools, workplaces, and public services could help deaf and mute individuals interact more easily with the world around them.

References

[1]. Muhl, M., & Thelen, B. (2024) This study introduces a low-cost smart glove prototype for gesture recognition in games, achieving 90% accuracy using a convolutional neural network. It also explores the potential of integrating this technology in educational settings to aid communication for people with hearing disabilities.

[2]. Bai, Z., & Li, W. (2019) This review discusses sensor-equipped gloves for translating sign language gestures into text, aiming to improve accessibility for the hearing-impaired. It also addresses the challenges of developing affordable and widely accessible devices for real-world applications.

[3]. Cheng, Z., & Xu, L. (2021) This paper explores an AI-based system using gloves for real-time sign language translation into speech, enhancing communication for deaf individuals. It suggests the integration of the system into mobile apps for portable and on-the-go use.

[4]. Ahmed, M., & Khan, F. (2022) The authors propose using deep learning models in wearable gloves for Arabic sign language gesture recognition, achieving 90% accuracy. The research focuses on expanding the model to recognize a broader range of hand movements to improve real-time communication.

[5]. Yadav, S., & Sharma, A. (2020) This review covers wearable gloves for sign language recognition, focusing on their effectiveness in improving communication for the hearing impaired. It also highlights advancements in sensor technologies that can better capture intricate hand movements.

[6]. Liu, Y., & Yang, J. (2023) The study introduces a gesture recognition system using accelerometers in gloves, combined with machine learning for better real-time translation. The authors propose further integration of AI-based optimization for faster processing and reduced latency.

[7]. Kumar, A., & Patel, V. (2023) A new technology developed by UCLA translates American Sign Language into speech using a wearable glove and smartphone app. It also discusses future improvements for battery life and durability, crucial for long-term use.

[8]. Wang, L., & Zhang, T. (2023) This research presents a wearable glove with flex sensors for accurate sign language recognition, powered by deep learning algorithms. The authors aim to enhance the system's ability to identify subtle finger and hand gestures with more precision.

[9]. Ali, F., & Gupta, A. (2022) The authors use convolutional neural networks in gloves to recognize Arabic sign language gestures with high accuracy. They also focus on making the gloves more lightweight and comfortable for extended use.

[10]. Singh, P., & Mehta, K. (2020) This study explores the use of RF sensors for sign language recognition, achieving 72.5% accuracy in recognizing 20 ASL gestures.

[11]. Jain, R., & Kumar, N. (2020) A system was developed to translate ASL gestures into speech using wearable gloves that track hand movements. The research also suggests integrating voice feedback in real-time to help users refine their gestures while using the system.

[12]. Xu, H., & Chen, Y. (2018) The authors use recurrent neural networks and Leap Motion sensors for sign language and semaphore gesture recognition, enhancing accuracy. They propose improving the system's scalability to work with different sign

languages.

[13]. Wang, C., & Liu, F. (2023) This article discusses the Sign Language Glove, which converts sign language gestures into speech or text, helping bridge communication gaps. The authors suggest expanding the device's capabilities to include multiple languages and dialects.

[14]. Jain, P., & Agrawal, V. (2023) The review focuses on systems like Sign Aloud that use gloves to translate ASL into speech, improving communication for deaf individuals. The paper also emphasizes the need for enhancing the glove's responsiveness in noisy environments.

[15]. Singh, R., & Bansal, A. (2021) This paper reviews wearable sensor technologies for sign language recognition, highlighting their potential for increasing communication accessibility. The authors emphasize the importance of developing systems that are cost-effective and easily accessible for the deaf community.

[16]. Patel, S., & Sharma, M. (2021) This study introduces a wearable glove system that uses gyroscopic sensors to track hand movement for sign language translation. The system achieves over 85% accuracy in gesture recognition, and the authors propose incorporating haptic feedback to help users refine their gestures.

[17]. Ravi, S., & Kaur, R. (2020) The research focuses on developing a glove with integrated IMU (Inertial Measurement Unit) sensors to recognize sign language gestures. By employing machine learning algorithms, the system can detect static and dynamic gestures, offering promising solutions for communication accessibility.

[18]. Nayak, S., & Garg, M. (2022) This paper discusses a glove-based system that combines machine vision and sensor technologies to detect sign language gestures and convert them into text. The authors aim to further improve the system's real-time performance and accuracy for everyday use.

[19]. Zhou, Q., & Liu, H. (2023) The authors propose a wearable glove that uses flexible sensors and deep learning to convert sign language gestures into audio output. The system can be adapted to different languages and is designed for both ease of use and comfort, targeting broader adoption.

[20]. Singh, D., & Gupta, S. (2021) This paper introduces a multi-sensor glove capable of recognizing sign language gestures using a combination of accelerometers and flex sensors. The research suggests that integrating this system with smartphones could improve its usability for real-time communication in public spaces.