IoT Based Sign Language Recognition System:

Abstract:
Sign language is the key communication medium, which deaf and mute people use in their day-to-day life. Talking to disabled people will cause a difficult s ituation s ince a nonmute person cannot understand their hand gestures and in many instances, mute people are hearing impaired. Same as Sinhala, Tamil, English, or any other language, sign language also tend to have differences according to the region. This paper is an attempt to assist deaf and mute people to develop an effective communication mechanism with non-mute people. The end product of this project is a combination of a mobile application that can translate the sign language into digital voice and IoT-enabled, light-weighted wearable glove, which capable of recognizing twenty-six English alphabet, digits, and words. Better user experience provides with voice-to-text feature in mobile application to reduce the communication gap within mute and non-mute communities. Research findings a nd r esults from the current system visualize the output of the product can be optimized up to 25%-35% with an enhanced pattern recognition mechanism.
Index Terms—sign language, Internet of Things, Gesture recognition, Smart glove, Recurrent neural network

Introduction:
The significant global issue of 5% of the population facing hearing challenges, leading to mutism due to the inability to hear and learn spoken words. It emphasizes the importance of sign language as a crucial bridge between mute and non-mute individuals. The communication gap between them is addressed, as non-mute people often struggle to understand hand gestures. With 125 sign languages spoken worldwide, the need for effective communication mechanisms becomes apparent. The research aims to create an IoT-based Sign Language Recognition System, utilizing machine learning and natural language processing to enhance communication between the mute and non-mute communities. The project involves a mobile application and a user-friendly wearable glove, offering features like new user training and voice-to-text functionality on both iOS and Android platforms.

Methodology:
The proposed system is designed to identify and translate hand gestures into digital voice as its final output. The implementation comprises both a software module and a hardware module. The hardware module includes accelerometers, flex sensors, and a printed circuit board. The process involves capturing flex sensor and accelerometer readings one by one for each sign using a push-button remote.
A push button is used to input the boundaries of a single data frame corresponding to a specific sign in the data stream. Multiple data sets for each sign are collected and saved in CSV file format. The next step involves calculating the mean value for each sign based on the collected data.
After obtaining the mean values, individual CSV files are created for each different sign, and these files include data for the x, y, and z-axis, as well as data from the 5 flex sensors. The next step involves identifying the mean squared error (MSE) using recorded data and actual data sets.

The process results in two different data sets: the actual sign data set and the recorded data set. A comparison is made between the two sets by shifting them frame by frame to calculate the MSE value. The fixed value for comparison is determined, and in this case, it's found to be 0.05.
The MSE values are scaled based on this fixed value, and the data is processed through a Long Short-Term Memory (LSTM) network, which identifies patterns and provides output. The system is designed to recognize gestures and convert them into voice format, which is transmitted to a mobile application via Wi-Fi.
The system also includes a training mode for new users, where they can register and complete training to improve the accuracy of their hand gestures. Customized PCB design reduces the space usage and weight of the device. Data is transferred to a Raspberry Pi for processing through a micro USB connection. Live data is stored in an array, and a rolling window approach is used to manage the data before processing.

Issues:
The determination of the fixed value (0.05) for MSE comparison may not be universally applicable and could vary based on different factors. Additionally, the paper does not address how the system handles variations in the execution of signs or the potential for imprecise sign gestures, which are common in real-world scenarios. Furthermore, the paper could benefit from a discussion on the potential limitations and challenges associated with the hardware module, such as sensor accuracy and signal interference. Finally, the explanation of how LSTM networks are trained to recognize patterns and the potential challenges related to pattern recognition could be more detailed.

Conclusion:
The project's end product serves the mute community by bridging the gap between sign language users and those who don't understand it. It consists of a wearable glove with sensors like flex sensors and a gyroscope, enabling the capture of hand gestures. A Raspberry Pi device facilitates wireless data transmission for processing. The mobile application, developed using Flutter for iOS, Android, and web platforms, identifies non-mute voices, converts glove-generated signals into electronic voice, offers a training mode for new users, and enables monitoring of the glove's battery percentage via WiFi connectivity. This system initially supports American Sign Language.