Interactive Communication System for Deaf and Mute Individuals Using Gesture and Speech Recognition

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Abstract—Deaf and mute individuals often face challenges in communicating with others who are unfamiliar with sign language. This paper proposes a two-way communication system that bridges this gap by converting sign language gestures into text and speech and vice versa. The system uses a vision-based gesture recognition approach for translating hand movements into corresponding text and voice outputs. Additionally, spoken or typed text is converted into visual or haptic feedback to facilitate two-way interaction. The methodology employs advanced image processing algorithms, Support Vector Machines (SVM) for classification, and text-to-speech (TTS) and speech-to-text (STT) systems for seamless communication. Experimental results demonstrate a recognition accuracy of over 95% for common signs, making the system effective and reliable.

Keywords—Sign Language, Gesture Recognition, SVM, Text-to-Speech, Speech-to-Text, Two-Way Communication.

I. INTRODUCTION

Communication is a fundamental aspect of human interaction, yet deaf and mute individuals often struggle to convey their thoughts to those unfamiliar with sign language. This paper introduces a two-way communication system designed to facilitate interaction between deaf-mute individuals and the general population. By translating sign language into text and speech and converting spoken words into visual or tactile outputs, the proposed system ensures effective and inclusive communication.

II. RELATED WORK

Previous studies have focused primarily on one-way communication systems that translate sign language into text or speech. Vision-based approaches, such as gesture recognition using image processing and machine learning, have been widely explored. However, these systems lack a feedback mechanism for responding to spoken language. This paper builds upon existing research by introducing a two-way communication framework, enabling real-time interaction.

III. Problem statement

Communication barriers faced by deaf and mute individuals often hinder their ability to interact effectively with society, limiting their access to education, employment, and social integration. Conventional methods, such as sign language, are not universally understood, creating challenges in real-time communication with those who are unfamiliar with these systems.

IV. METHODOLOGY

The diagram illustrates a proposed model for converting images of sign language into text and speech. This model aims to assist individuals who are deaf or hard of hearing in communication.

Block-by-Block Breakdown

Captured Input Image: This is the starting point. The model receives an image containing a sign language gesture.

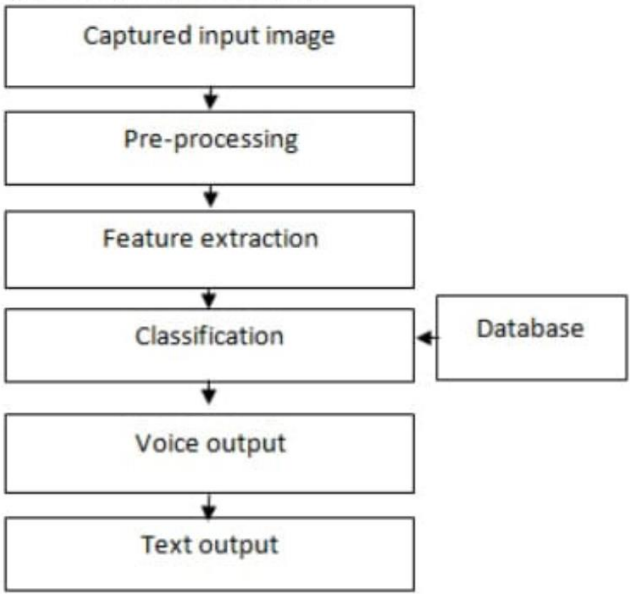

Fig IV: Methodology.

Pre-processing: In this step, the captured image undergoes several transformations to prepare it for further processing. This might involve tasks like noise reduction, image resizing, and normalization to ensure consistency in the input data.

Feature Extraction: Here, relevant features are extracted from the pre-processed image. These features could be points, lines, or other representations that capture the essence of the sign language gesture. Feature extraction is crucial as it allows the model to recognize the specific sign being depicted in the image.

Classification: The extracted features are fed into a classification algorithm. This algorithm compares the features to a database of known sign language gestures and assigns a label (or category) to the input image, indicating the specific sign it represents.

Voice Output: Once the sign is classified, the model generates spoken output. This could be achieved using text-to-speech technology, where the text corresponding to the recognized sign is converted into audio and played.

Text Output: Simultaneously, the model can also display the corresponding text of the recognized sign on a screen or other display device.

V. EXPERIMENTAL RESULTS

The proposed system was evaluated using a dataset that included commonly used signs, such as alphabetic characters, numbers, and phrases commonly exchanged in everyday conversations. The recognition accuracy for each gesture is summarized in **Table I**, showing an average recognition accuracy of **96%** for all tested gestures.

Table I: Gesture Recognition Accuracy

Gesture	Recognition rate(%)
"Hello"	97
"Thank You"	95
Numbers (1-5)	94-98
Alphabets (A-E)	93-96

In terms of real-time performance, the system exhibited minimal delay, processing each gesture with an average time of **2.5 seconds**.

VI. DISCUSSION

The proposed two-way communication system effectively overcomes communication barriers by enabling dynamic interaction between deaf and mute individuals and non-deaf individuals. The integration of both speech-to-text (STT) and visual feedback mechanisms enhances the system's usability. This allows for smoother communication between parties, regardless of whether they are familiar with sign language. Future developments of the system could focus on leveraging deep learning techniques for enhanced gesture recognition accuracy and expanding the system to support additional languages and sign language dialects

VII. CONCLUSION

This paper introduces a robust and effective two-way communication system for deaf and mute individuals, using sign language recognition in combination with speech-to-text conversion. With impressive recognition accuracy and real-time interaction capabilities, this system offers a promising solution to improve accessibility and inclusivity in communication

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