Talkhands: Communicating with the Silenced Using an Artificial Intelligence Powered Sign Language Converter

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Abstract—The Talk Hands project is developing a sign language converter to help deaf or hard-of-hearing individuals communicate effectively with non-signers. It uses a camera to capture sign language gestures and translates them into text and speech in real-time. By supporting multiple sign languages, the system can cater to users from diverse regions. The goal is to create a solution that is both accurate and scalable, using readily available camera technology for easy implementation. This project aims to improve accessibility, enabling those with hearing impairments to communicate independently in various settings, from social interactions to professional environments. Ultimately, Talk Hands seeks to remove communication barriers and promote inclusivity.

Key words: Sign Gesture Recognition Convolutional Neural Network (CNN)Trained Model Output Identification
Text and Audio Output.

1. INTRODUCTION

In today's hyper-connected global landscape, where technological advancements continually redefine the way we interact and communicate, the imperative of ensuring equitable access to this fundamental human right has never been more pressing. Despite the strides made in connectivity, a significant segment of the world's population grapples with formidable barriers that impede effective expression and comprehension, exacerbating the already existing chasms between individuals and communities. Among these hurdles, the challenges faced by individuals who are deaf or hard of hearing loom large, often relegating them to the fringes of social interaction and marginalizing their voices.

The inability to seamlessly communicate not only isolates individuals but also restricts their opportunities for education, employment, and social integration, further perpetuating cycles of exclusion and inequality. In this landscape of communication barriers, sign language emerges as a beacon of hope, offering a rich and nuanced means of expression utilized by millions across the globe. It is within this context that TalkHands emerges, a pioneering venture situated at the intersection of innovation and social impact, driven by a steadfast mission to empower and enrich the lives of those in the deaf and hard of hearing community. At its very core, TalkHands is dedicated to harnessing the transformative potential of cutting- edge machine learning technologies to develop an unprecedented Sign Language Converter. By transcending the limitations inherent in traditional communication methods, TalkHands seeks to cultivate a truly inclusive society where every voice, irrespective of its mode of expression, is not only heard but deeply understood. Through its unwavering commitment to inclusivity and equality, TalkHands aspires to pave the way for a future where communication transcends boundaries, where silence is not a barrier but rather a gateway to profound connection and understanding, fostering a world where every individual's voice is not only valued but celebrated. Through its proactive engagement with communities, collaboration with experts, and dedication to ongoing refinement and improvement, TalkHands aims to set a new standard for accessible communication tools.

2. LITERATURE REVIEW

Fazlur Rahman Khan: Developed a prototype using Leap Motion for tracking hand motions. Geometric template matching achieved the highest accuracy with American Sign Language alphabets.

Rahib H. Abiyev: Designed a sign language translation system using deep learning with SSD architecture for hand detection the inception v3 model with SVM for gesture classification, showing high efficiency.

Necati Cihan Camgoz: Proposed a system to translate sign language videos into spoken language, focusing on the grammatical and linguistic structures of sign languages.

Shawn Clifford M. Murillo: Developed a real-time web application to convert hand gestures into text. Evaluated by students, teachers, and non-disabled people for content, design, and functionality.

Adarsha Sagar H V: Surveyed gesture-to-text conversion technologies using deep learning techniques like CNN and LSTM, highlighting challenges and suggesting improvements for accessibility.

Ankita Shinde: Created a two-way sign language converter for the speech-impaired. Uses deep neural networks for real-time gesture recognition and converts audio into text, supporting Indian Sign Language.

3. SYSTEM DESIGN

The system starts by capturing gestures using a camera, which continuously streams visual data for processing. An intuitive interface connects the captured gestures to the recognition system, ensuring smooth user interaction. A Convolutional Neural Network (CNN) model is used to recognize and interpret sign language gestures accurately. The CNN is trained on a diverse dataset, allowing it to generalize well across different gestures. Once a gesture is recognized, the system compares it with stored gestures in the model. If a match is found, the system confirms successful recognition and generates an output. The recognized gesture is then displayed in both text and audio formats for accessibility. A flow control mechanism ensures each step is executed correctly and informs users if recognition fails. This improves system reliability and enhances user experience.

System Architecture:

Once the camera captures the gestures, the system processes them to recognize and interpret sign language. An easy-to-use interface helps connect the captured gestures with the recognition system, making communication smooth and efficient. The core of the recognition process is a powerful Convolutional Neural Network (CNN) model. This model is trained on a wide variety of sign language gestures, allowing it to learn and recognize different signs accurately. The CNN uses advanced machine learning techniques to analyze the gestures and identify their meanings. To recognize a gesture, the system compares it with a set of stored gestures in the trained CNN model. If the captured gesture matches a stored gesture, the system confirms successful recognition. A "match point" is generated to indicate that the input gesture corresponds to a known sign. After identifying match points, the system verifies whether the recognition was successful. If match points exist, the system proceeds to display the recognized sign. Finally, the recognized gesture is presented to the user in both text and audio formats. This ensures accessibility for everyone, including those who rely on either visual or auditory feedback.

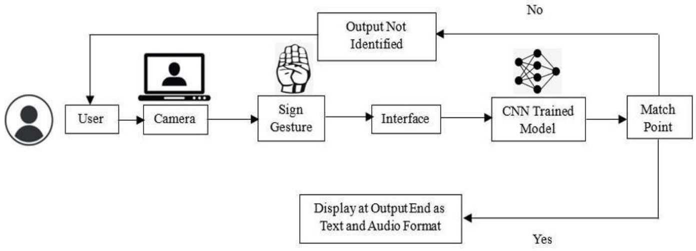

Figure 2: System Architecture

4. METHADOLOGY

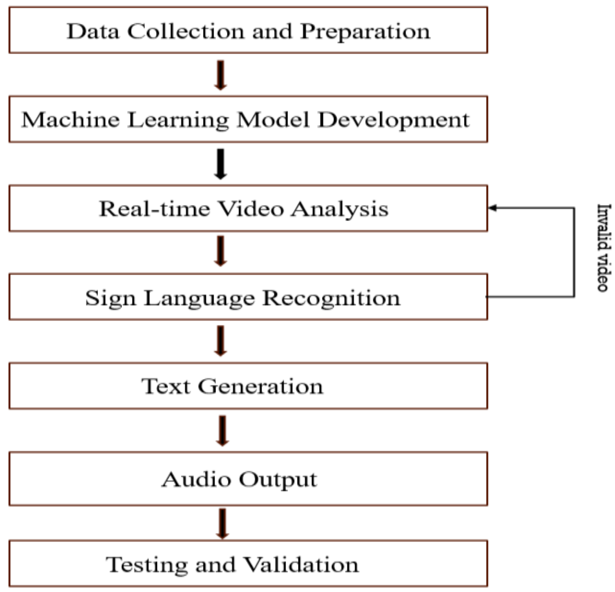

Figure 2: Data Flow Diagram

A data flow diagram is a graphical representation of a system that shows the flow of data between various components and processes. The purpose of a DFD is to provide a visual representation of how data moves through a system and how it is processed, stored, and transformed.

A data flow diagram consists of four main components: entities, processes, data stores, and data flows. Entities are external sources or destinations of data, such as users or other systems. Processes are activities that transform data from one form to another, such as calculations or filtering. Data stores are places where data is stored, such as databases or files. Data flows represent the movement of data between the various components of the system. Data flow diagrams are usually presented in a hierarchical format, with higher-level diagrams showing an overview of the system and lower-level diagrams providing more detailed information about specific processes or components. A typical data flow diagram starts with a context diagram, which shows the system as a whole and its external entities. From there, more detailed diagrams are created to break down each process and component of the system. Data flow diagrams are often used in system analysis and design, as they provide a clear and concise way to represent the flow of data in a system. They are also useful in identifying potential bottlenecks, redundancies, or inefficiencies in a system, which can help in improving its overall performance and effectiveness.

5. CONCLUSIONS

The project successfully converts sign language gestures into text and speech, helping deaf and mute individuals communicate effectively. Using computer vision and deep learning (CNN), the system achieves high accuracy (97-99%) in recognizing American Sign Language (ASL). The MediaPipe hand tracking ensures performance across different lighting and backgrounds. This cost-effective and real-time solution enhances accessibility in education, workplaces, and daily interactions.

6. FUTURE DIRECTIONS

1. Mobile App Development – Expanding the system for Android and iOS.
2. Sentence Formation – Implementing NLP for full sentence recognition.
3. Support for Multiple Sign Languages – Adding ISL, BSL, and more.
4. Integration with Smart Assistants – Enabling compatibility with Alexa, Google Assistant.
5. Better Real-World Performance – Improving recognition in low-light and complex backgrounds.

REFERENCES

[1] "A Sign Language to Text Converter Using Leap Motion" by Fazlur Rahman Khan Technique Used Geometric Template Matching, Artificial Neural Network, Cross Correlation.

[2] "Sign Language Translation using Deep Convolutional Neural Networks" by Rahib H. Abiyev Technique Used Single Shot Multi Box Detection (SSD), Inception v3 model, Support Vector Machine (SVM).

[3] "Neural Sign Language Translation" by Necati Cihan Camgoz Technique Used Sign Language Translation (SLT) approach.

[4] "A Real-Time Sign Language to Text Converter" by Shawn Clifford M. Murillo Technique Used Purposive sampling for respondent selection.

[5] "A Comprehensive Survey of Gesture-to-Text Conversion Technologies Using Deep Learning Techniques" by Adarsha Sagar H V Technique Used Convolutional Neural Networks (CNN), Long Short-Term Memory (LSTM) networks.

[6] "Two-Way Sign Language Converter for Speech-Impaired" by Ankita Shinde Technique Used deep neural network, edge detection algorithm.

[7] "Hand Gesture to Speech and Text Conversion Device" by K. P. Vijayakumar Technique Used Raspberry Pi-3 microcontroller, flex sensors, accelerometer sensor, and Python programming.

[8] "A Spoken Language Generator for Deaf People" by Veronica Lopez-Ludena Technique Used a Sign language into speech translation system, an SMS into speech translation system, and an emotional text-to-speech (TTS) converter.

[9] "Real-Time Speech-To-Text / Text-To-Speech Converter" by K. P. Vijayakumar Technique Used: Natural Language Grammar (NLG), Abstract Meaning Representation (AMR) graphs.

[10] "Sign Language Recognition System for Communicating to People with Disabilities" by Yulius Obia Technique Used: Convolutional Neural Networks (CNN), American Sign Language (ASL) datasets.