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INDIAN SIGN LANGUAGE COMMUNICATION FACILITATOR FOR HEARING-IMPAIRED USING MACHINE LEARNING

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Abstract:

Sign Languages were primarily developed to aid deaf and other verbally challenged people. Indian Sign Language (ISL) is a sign language that is predominantly used in South Asian countries and other regions. Many special features are integrated into the Indian Sign Language that distinguishes it from other Sign Languages. Features like Number Signs, Family Relationships, use of space, etc. are crucial features of Indian Sign Language (ISL). The system is built for facilitating learning and communicating Indian sign language for hearing impaired people. Live Voice or audio recording is given as input and converted to text and the relevant Indian Sign Language images or animation is displayed to the user. Since learning sign language is time-consuming, people find it difficult to communicate with these specially-abled people, creating a communication gap. Thus this system is significant because it helps in providing service to deaf people in Indian sign language.

Keywords — **Indian Sign Language (ISL), Sign Language, Hand Movements, Speech to Text, Natural Language Processing, Speech Recognition.**

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I. INTRODUCTION

Nowadays Sign language is used worldwide to reduce the communication gap between hearing or speech impairment. According to the Recent Census, India is the second-largest country with approximately 63 million people in Deaf and Hard of Hearing Communities. Currently, we do not have efficient models that are User Friendly and have audio-visual support for oral communication. Most of the systems are used only to facilitate American Sign Language (ASL) or British Sign Language (BSL), but for Indian Sign Language, there are hardly a few systems developed. The Basic architecture for most of the systems that are created is based on the Direct Translation method, Statistical Machine Translation method, and Transfer-based Architecture. The proposed system mainly focuses on training the hearing impaired or normal people to learn the Indian Sign Language.

Thus, the system is for people who want to interact with people through sign language and reduce communication gaps. The proposed application takes Live Voice as input and converts it into a sequence of words.

A. Easy GUI and Flask are used for the Front end of the system.
B. Live Voice is taken as input through the microphone using the PyAudio package.
C. Voice is recognized using Google Speech API and pre-processed using Natural Language Processing (NLP).
D. Finally, using Dictionary for each common word the system displays its relevant animation, and for words that are not common Indian Sign Language images are displayed.

In Computer Science, Speech recognition is one of the interdisciplinary subfield. Computational linguistics which was developed with certain methods and techniques and it is also called automatic speech recognition (ASR), computer speech recognition, or speech to text (STT) [6]. It integrates both the knowledge and research and computer engineering fields. Speech recognition is worked by using algorithms through acoustic and language modelling. Acoustic modelling represents the relation among units of speech and audio signals whereas language modelling matches sounds with word sequences which help to distinguish between words that sound similar.

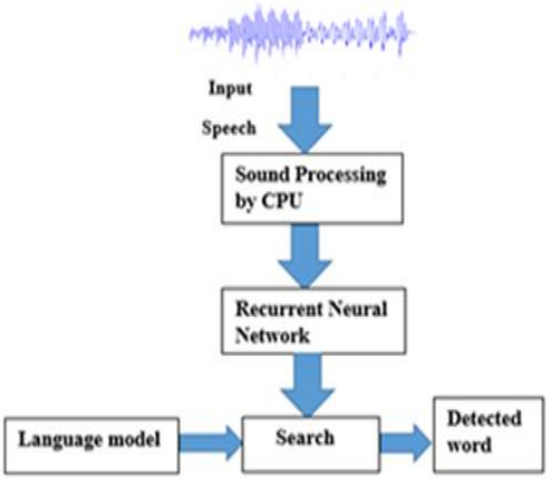

Fig. 1. Speech Recognition format. [9]

Natural language processing comes mainly under linguistics and artificial intelligence and is mainly used in human computer interaction [5]. It is a subset technique of Artificial Intelligence that is used for reducing the communication gap between the Computer and Humans. In origin, the idea of Machine Translation (MT) came during the Second World War. The primary idea is to convert one human language to another human language

II. RELATED WORK

A. *Deep Learning*

Ankita Shinde and Raveena Dandona proposed a Two-Way Sign Language Converter for Speech-Impaired using Deep learning [1] that the system has two-phase. In the first phase, the sign-language gestures are fed in real-time using computer vision Facilities are recognized using Deep Neural Network (DNN) where it interpreters text and audio. The second phase accomplishes converting audio (Live) into text and displays relevant hand-gesture and is capable of predicting 300 words of Indian Sign Language (ISL).

Boon Giin Lee, Teak-Wei Chong and Wan-Young Chung have designed a smart wearable American Sign Language hand gesture Recognition system [4] composed of sensing and preprocessing. And its classification using Deep Learning. The sensing module consists of 6 inertial measurement units (IMUs) and it applies a sensor fusion and fuses it. There was an issue in their size initially because the inertial measurement units (IMUs) were large. Later they redesigned the module using BNO055 IMU Sensor Chip and it successfully decreased the weight to 30% and the size of the Board to 77%.

B. *Hidden Markov Model (HMM)*

Speech to text and vice versa was designed by Choi [2]. In this model, they used a dynamic Time Wrap for extracting the features and distance calculations between those features, and Hidden Markov Model (HMM) a stochastic model is mainly used to connect multiple states of transition. For the conversion of Voice to the text they used Dynamic Time Warping (DTW) and Hidden Markov Model (HMM) models along with some Neural Networks Models.

C. *Internet of Things (IoT)*

Raveen Wijayawickrama, Ravini Premachandra, Thilan Punsara & Achintha Chanaka have proposed IoT (Internet of Things) Based on Sign Language Recognition System [3]. This System had a combination of Mobile Application For Translating Sign to Live Voice and a glove (Light Weight) is used for recognizing 26-Alphabets and 0-9 Numeric Numbers using the Internet of Things (IoT).

D. *Surf (Speeded Up Robust Features)*

Shagun Katoch has designed an Indian Sign Language recognition system using Speeded up Robust Features (SURF), Support Vector Machine (SVM) and Convolutional Neural Networks (CNN) [8]. In this system, they used a technique that uses the Bag of Visual Words model (BOVW) for recognizing the Indian Sign Language (ISL) and the Numeric Digits which takes Live voice as an input and produce the relevant predicted labels in both text and speech forms. Skin Based segmentation is done. For Classification Support Vector Machines (SVM) and Convolutional Neural Networks (CNN) are used.

III. PROPOSED MODEL

The main aim of this system is to help people who are suffering from hearing issues. There is a major lack of learning modules that helps both the normal and hearing-impaired people to learn Indian Sign Language with ease. So it is useful for a person who wants to communicate and it is developed using python. The system takes Live Voice as input, and Google Speech API is used to search that recording, and the sequence of words is tested against the words in the dictionary. The dictionary/ database contains the Indian Sign Languages

(ISL) images and the animation of certain Indian Sign Language (ISL) sentences. Finally, the sequence of words is checked against the dictionary and displays the relevant Indian Sign Language images or animations. The proposed system can be mainly used to help people who want to communicate using sign language. Easy Gui and Flask are used to design the front end.

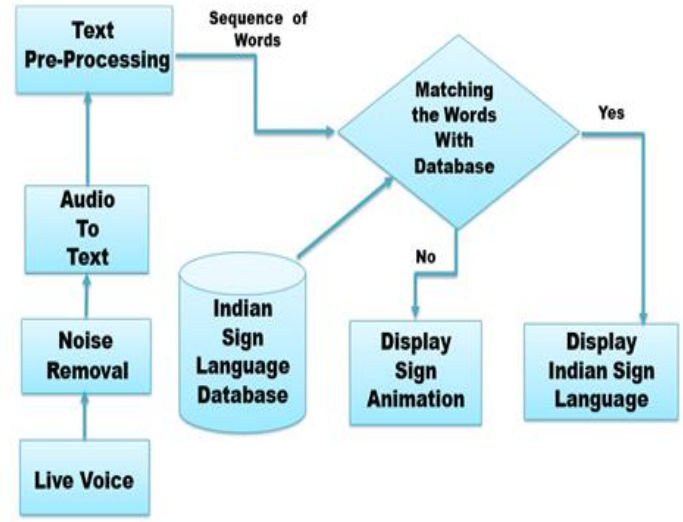

Fig. 1. Architecture Diagram for the proposed solution

IV. IMPLEMENTATION

The Indian Sign Language images and animations where obtained from the Talking Hands organization [11], which is the only approved resource that provides a dictionary for the Indian Sign Language. The proposed system uses 27 images and 150 animations (GIF).

Fig. 1. Indian Sign Language Alphabets [11]

Fig. 2. Indian Sign Language Animations [11]

A. Live Voice Input

1) The Live voice is received from the user via an inbuilt microphone or external microphone.
2) The audio is being captured using a python package known as PyAudio.
3) PyAudio is a set of Python bindings from Port Audio, a cross-platform C++ library interfacing with audio drivers.

B. Removal of Noise

1) Noise is removed from the given input using a adjust_for_ambience_noise function in Speech Recognition Module.
2) It reads each 1-second duration of the file stream and the recognizer calibrates to the noise level of the audio.

C. Audio to Text Conversion

1) After the removal of noise, the audio is converted into text using recognize_google function from the speech recognition module.
2) recognize_google function uses Google Speech API and methods of the Recognizer class to convert the given audio input into text.

D. Text Pre-Processing

1) After the conversion of audio to text, the text is pre-processed (i.e.) text conversion (uppercase to lowercase) and removal of punctuation.
2) Text is converted into lowercase using the lower function in python.
3) The punctuation is removed by replacing it with empty space.

E. Display of Pictures and Animations

1) Once the given audio input is pre-processed, the relevant Indian Sign Language (ISL) images or sign animation are displayed.
2) Several common sentences such as “good morning”, “how are you”, etc. are presented as animations for easier understanding.
3) The rest of the sentences are displayed as sign language images. The above-mentioned is possible using the tkinter.

V. ADVANTAGES OF THE PROPOSED MODEL

A. Ease of learning for hearing-impaired
B. Benefits voice to sign language conversion to help with communication.
C. User-Friendly Environment.

VI. PERFORMANCE AND ACCURACY

The accuracy of a speech-to-text model can be identified using Word Error Rating (WER) [10]. WER is a very common metric that can be used to determine how efficient speech recognition is. It compares the manual transcript created by the user with the transcript that is generated by the speech recognition model. The formula is represented below

Word Error Rating = (S + I + D) / N

Where,

S – Substitutions made (replacing words)
I – Insertions made (inserting words)
D – Deletions made (removing words)
N – Number of words said by the user

The model scored a WER of 5%, which is said to be efficient. The model took about 15 seconds to get the input from the user and display an animation, and about 30 seconds to display sign language images (duration may vary based on the length of the input sentence).

VII. CONCLUSION

The application can be used as a learning medium for the hearing impaired. The proposed system helps to remove communication hurdles for hearing-impaired and is proved to be user-friendly.

The proposed work can be further developed by converting it into a mobile application to provide easy access to many users, and also can be made as a 2-way application (voice to sign and sign to voice/text) to facilitate efficient learning and communication of Indian Sign Language.

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