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SignEase Automated Hub A Sign Language Recognition System

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ABSTRACT: In daily lives, deaf and mute people face lot of challenges while performing simple tasks. The major challenge is being able to communicate with others through sign language. Unfortunately sign language is used and practiced by only 0.2% of the population. This separates the deaf and mute from those who want to communicate with them. To overcome this our system "SignEase" aims to bridge that gap and we hope that it will help deaf and mute people to converse with people who do not know sign language. The main goal of this system is to translate speech into sign language and to create a two-way communication without the need for a mediator. Sign language serves as a vital means of communication for deaf and non-speaking individuals who rely on visual gestures, orientation, hand movements, body language and facial expressions to convey messages. But few people know sign language to make this process easier. The SignEase system is incorporated with lessons to learn and a way to practice sign language. In addition to this it converts audio and text input into sign language, making it a versatile and inclusive platform for improving accessibility and communication for individuals using sign languages.

KEYWORDS: SignEase, machine learning, Sign Language, Communication tool, Audio inputs, Text inputs.

I. INTRODUCTION

Sign Language is an essential medium of communication for the Deaf and non-speaking which includes visual signs, empirical patterns, hand gestures, bodily motion language and gaze inflections to express messages. Like oral languages, Sign Language is variable, and its expressions rely on characteristics related to every language, such as location and ethnicity and culture. Sign Language that has become standardized in India is known as Indian Sign Language and mostly the sign language is differ from country to country. Communication plays an important role in the transfer of information from one person to another.

Multiple forms of communication are used by the general population to convey their thoughts. Language plays a dominant role in conveying thoughts. Though we live in a multi-lingual community, the technological advancement in real-time language translation has substantially reduced the communication gap between people with different language backgrounds. Though there are many tools that can convert the local languages to English and vice versa, very little attention is given to the conversion of sign language used by the deaf and mute population.

As per the data from World Health Organization (WHO), over 5% of the World's Population has some form of hearing or speaking disability. With such a high number of deaf and mute people, there needs to be an automated system that will facilitate the learning of the deaf population, especially the children. Hearing loss or partial deafness significantly affects the academic performance of children. Along with academic loss, deafness, and muteness cause social and emotional imbalance. This is due to the lack of communication mediums leading to exclusion from the

social circle. Hearing disability also leads to financial losses as the productivity of an individual is directly influenced by the efficiency with which he/she can communicate.

Therefore, in spite of all the wealth and multitudes of Sign Language, there still exist communication gaps when the speech partners do not know sign language, among others. The initiative of SignEase contributes hugely to the overcoming of this barrier by imagining a system that can convert the sounds and the written form from sign language. Achieving this innovation, SignEase simplifies everyday interaction and makes the unscrupulous lifestyles of the Deaf and other people with speech disabilities easily integrated into the everyday system of communication

We propose to tackle the communication gap between the general population and the hearing impaired using the widely used technology which is smartphone. The basic idea is to use the camera in smartphones to convert the hand movements of a person communicating into sign language in real-time. Our system extracts the key features from the locally available video or from the live feed from the smartphone camera and converts them into different segments representing the individual words. The word is then extracted from the video segment using a machine learning based approach. The extracted words are combined to form sentences in real time. The sentences can also be converted into audio after text extraction.

The 2018 Indian census refers to generally 13 lakh "hearing speech impaired" individuals. Rather than that numbers from NAD (National Association of the Deaf) of India gauges that 180 lakh individuals approximately 1% of Indian populace are hearing speech impairment. These insights moulded the motivation for our system. As these hearing speech impaired individuals need an appropriate channel to speak with ordinary individuals there is a requirement for a system. Not every individual can grasp sign language of impaired individuals. Our system henceforth is pointed toward changing over the communication through sign language into text and vice versa that is lucid for ordinary individuals and changing over text/speech into sign language and sign language into either text or speech that is understandable by impaired individuals.

This project will have a reach towards the deaf and mute community of society. The project will contain knowledge of ISL grammar and lexicon, in hopes for people with disability to use the system in everyday life for ease of communication and for nonnative people who are interested in learning sign language.

II. DATASET

The availability of large, standardized datasets is critical for machine learning model development and valuation. There have been several previous attempts to create datasets for ISL. Importantly, many of these datasets are not publicly accessible, preventing additional research. These databases also feature a number of significant flaws. Additionally, the class count (number of words signs), is also extremely minimal. Multiple datasets for Indian Sign Language are also available.

This includes the dataset [4] which contains 290 images that can be used for fingerspelling and has 26 letters of the alphabet it only used for letter-by-letter prediction of the sign language. These static photos have been cropped to show only the signer's hands, making it easier to extract features. In another dataset [6], 600 videos are divided into 22 categories. The videos are in grayscale and cropped so that only the hands can be seen. Next, we have another dataset [11] of 800 videos and close to 80 classes but has restrictions on how they are recorded. As a result, existing ISL datasets lack the required quality and scale needed to train deep learning models.

A. Collecting the dataset:

The collection of data is a critical aspect of any research or investigation. It is crucial to gather pertinent information that satisfies the study requirements, including extreme cases, to produce thorough and realistic observations. The data must be carefully collected to ensure correctness and precision because it forms the basis for the research.

B. Loading and Preprocessing of Dataset:

The initial step in the process is to import the necessary dataset and make the needed modifications to enable the implementation of various algorithms for accurate prediction of sign language using the loaded dataset. The dataset contains extracted key points or landmarks from sign videos, which are conducive to real-time detection, and has been used to train the model.

C. Model Building:

The machine learning model was implemented using the feedforward neural network with fully connected (Dense) layers. To prevent overfitting, the model was further regularized using batch normalization and dropout layers. Additionally, a call back function was used to monitor the accuracy of the validation set and halt the training process if the accuracy failed to improve over a certain number of consecutive epochs.

III. METHODOLOGY

The existing sign language communication systems have limitations like one-way translation, making communication tricky. Though detecting signs as letters, they miss key features for two-way interaction. Mainly, they convert signs to speech or text but overlook translating from speech/text to sign language. This hampers smooth, professional user experience.

In the proposed Methodology the SignEase System represents a significant advancement in the sign language communication tools. Unlike existing systems whose primary focus is on detecting individual alphabets, the main functionality of the SignEase System lies in its ability to provide real-time translation of sign language gestures into text and text/speech into animated sign language gestures, either in sentence or word format.

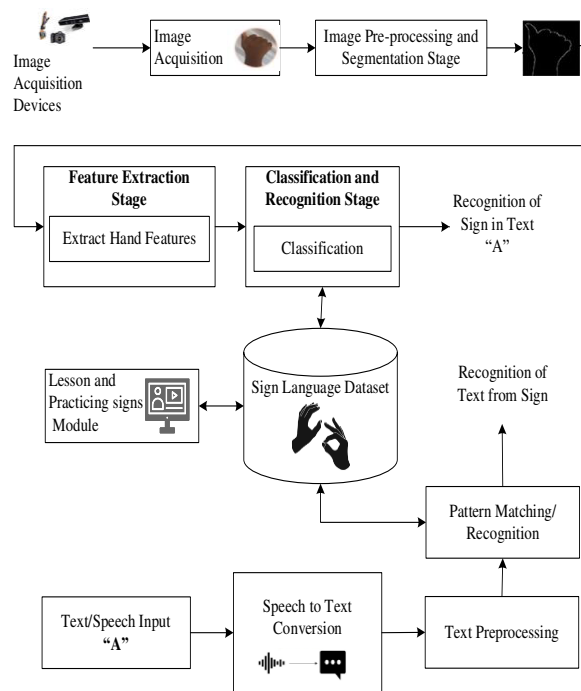


Fig. 1. System Architecture of SignEase System

1. Data Preprocessing

The input data consists of features extracted from sign language videos. These features are likely landmarks or key points extracted from hand movements and gestures captured in the videos. The data preprocessing steps involve loading the feature data from NumPy files, reshaping the data if necessary, and splitting it into training and validation sets.

2. Feature Engineering

The FeatureGen layer preprocesses the input features by performing various operations, including averaging over specific subsets of landmarks, padding, flattening, and resizing. These operations are designed to extract relevant information from the input features and prepare them for further processing by the neural network.



3. Neural Network Architecture

The neural network architecture consists of fully connected (dense) layers with batch normalization, GELU activation, and dropout regularization. The number of fully connected layers and their sizes are configurable based on the DROPOUTS list and the STARTING_LAYER_SIZE parameter. The model uses the SoftMax activation function in the output layer, allowing it to output probabilities for each class.

4. Training

The model is trained using the Adam optimizer and sparse categorical cross entropy loss function. During training, the model adjusts its parameters (weights and biases) based on the gradients computed using backpropagation. Early stopping and learning rate reduction on plateau callbacks are used to prevent overfitting and fine-tune the learning rate during training.

IV. SYSTEM OVERVIEW

System architecture consists of four modules:

- A. Sign to text
- B. Text to sign
- C. Sign language Learning
- D. Practicing Sign language

A. Sign to text:

The Sign to Text module enables the conversion of text to sign language. In this module the users can access the camera to record the video which temporarily stores the video automatically for every 3sec. using the stored video the system extracts the key points using Media Pipe Holistic model and use the extracted landmarks or key points to detect and identify the sign and display it to the user.

B. Text to sign:

Text to sign module enables the translation of text or audio inputs into sign language interactions. By providing the appropriate sign animation based on the given input using the natural language processing.

C. Sign language Learning:

In this module the user can utilize videos and flashcards to learn lessons on alphabets, numerals, and common words used in sign language. It serves as a unified hub for those individuals seeking to learn sign language and improve the current skills by offering structured lessons and interactive materials like flash cards, this module facilitates effective learning and skill development in sign language communication.

D. Practicing Sign language:

In this module the user can practice sign language learned from videos lesson from the learning module through quizzes and real-time alphabetical recognition exercises. By offering interactive activities, it improves the learning capability and enhances proficiency of the user in sign language communication. This module provides engaging opportunities for users by appreciating their skills and improve their confidence in expressing themselves through sign language.

V. RESULT

At SignEase System we represent a significant advancement in communication technology, with its primary objective being centred on bridging the communication gap between individuals with and without physical disabilities. This system aims to identify facial and hand expressions through images and seamlessly convert them into speech or text, and signs into text or speech. SignEase system gives a platform for sign language users to talk with everyone. It can translate sign language gestures to text instantly. This is very important. It lets people using sign language communicate effectively with others who don't know sign language or prefer spoken or written communication, even blind people. By offering translation, SignEase enables physically disabled individuals to better engage in social situations, education settings, and workplaces. This greatly improves their life quality.

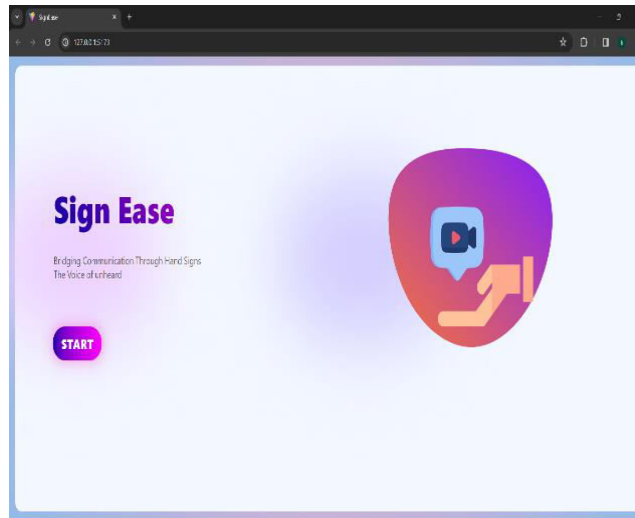


Fig. 2. Homepage of the SignEase System

SignEase is user friendly. It values diverse user needs and preferences. The design's intuitive and easy navigation helps all skill levels utilize features with minimal barriers. Usability enhances accessibility, promoting greater adoption among the target user base. Also, SignEase is adaptable and versatile. It identifies and interprets a wide range of symbolic expressions. This allows effective communication across various contexts and situations. It can translate- sign language gestures into text. Or, it can convert spoken or written language- into sign language. The system offers a flexible solution tailored to specific user needs. This can be said from the text to Sign Language module from Fig.3 which is a sample of the sign to text module working with the animations.

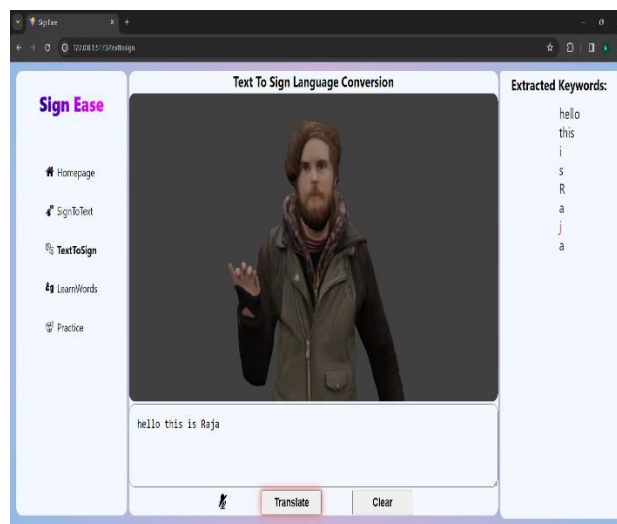


Fig. 3. Text to Sign module working with the animations for the given input

In Fig.3 the text to sign module, it's working is mainly based on the input if the given input is processed by natural language processing which analyses the input based on the words if the word is unknown that is a either a name or any other word it processes the word an alphabet and return the appropriate sign language animation in fig.3 the name from the input is processed and separated as alphabets.

The fig 4 module enables the conversion of text to sign language. In the module the users can access the camera to record the video which temporarily stores the video automatically for every 3sec. using the stored video the system extracts the key points using Media Pipe Holistic model and use the extracted landmarks or key points to detect

and identify the sign and display it to the user. The Sign to text module is shown in the Fig.4 it shows the working of sign to text module it shows the predicted word along with its confidence score.

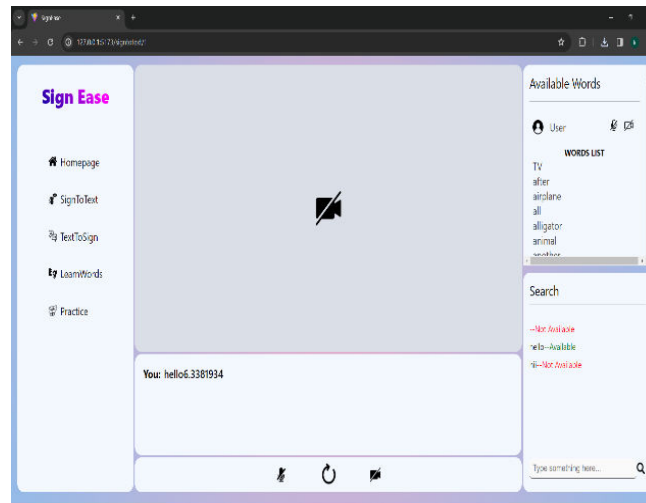


Fig. 4. Sign language prediction along with its confidence score of the predicted text

SignEase gives more than translating signs. It's a way to practice signing too. The system has lessons and activities. These make users better at sign language. Their skills improve by using SignEase Communication gets easier over time. SignEase teaches users to sign well. This helps them feel confident. Users gain knowledge and ability. SignEase is useful for this reason. The Fig.5 shows the sign language practicing module.

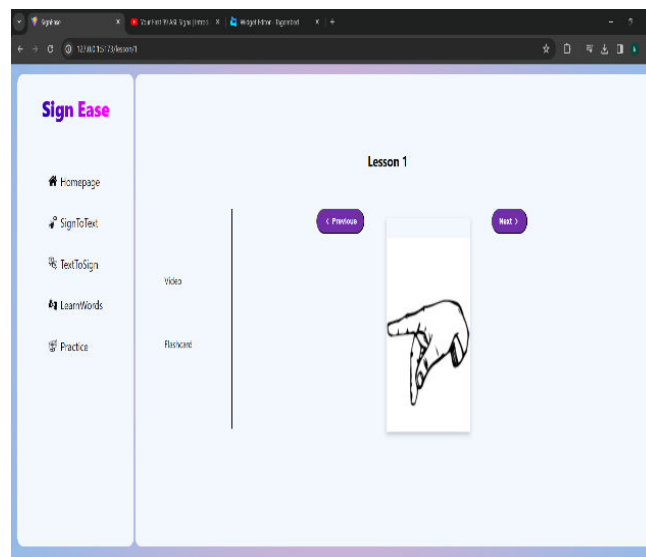


Fig. 5. Sign language lesson and practicing module using flash cards

The SignEase system acts as a common platform for the deaf and dumb people by helping them with one of the main problems in their daily life as a sign language interpreter and a teacher, thus improving the confidence of the mute people and help them have a good life in the society.

Overall, the SignEase is a huge advancement. It aids communication for those with physical issues. SignEase does real-time sign language translations. An easy interface lets users smoothly interact. Learn sign language too from built-in educational tools. By focusing on user needs, SignEase makes communicating easier for all. Its smart features aim to

include those using sign language more. SignEase could revolutionize how we interact across all abilities. This well-designed system promotes vital social inclusion through accessible communication.

VI. CONCLUSION

The SignEase System is an amazing breakthrough in communication tech. It helps people with and without disabilities communicate better. SignEase translates sign language into text instantly. This lets people chat more easily. The Sign Ease system is very user-friendly, making it simple for anyone. It can adapt to different situations too. SignEase gives people without disabilities more power. They gain a fresh way to have conversations. The system opens doors for smooth chatting everywhere. SignEase epitomizes a big leap in communication innovation.

The most Important feature of this system is its commitment to education and skills development. it actively encourages users to increase their communication skills and confidence. This emphasis on educational benefits not only benefits individual users but also contributes to a greater public understanding and appreciation of sign language as a legitimate form of communication.

The SignEase System transcends technology; it reshapes lives and cultivates inclusiveness in society's every facet. Envision a classroom where students with hearing impairments blend seamlessly, connecting with peers and instructors effortlessly, barriers nonexistent. It extends beyond mere communication facilitation; it nurtures an atmosphere where each learner feels cherished and empowered to absorb knowledge.

In professional domains, SignEase unlocks opportunities for individuals with disabilities, granting e-employment access, enabling them to wholly contribute skills and talents. It equalizes playing fields, acknowledging abilities and potential irrespective of physical differences. SignEase guarantees all patients can smoothly converse with healthcare workers. It promotes dignity, access to needed care, irrespective of one's communication needs. SignEase transcends being a tool. It symbolizes dismantling barriers, championing diversity. Communication's richness embraces languages, modes. True inclusion fosters feeling seen, heard, valued.

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