SIGN LANGUAGE RECOGNITION USING RANDOM FOREST CLASSIFIER

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ABSTRACT—Sign language serves as the primary means of communication for deaf and hearing-impaired individuals, allowing them to convey thoughts, ideas, and emotions through gestures and hand movements. Inclusive technological solutions are crucial to bridge the communication gap between the deaf community and the wider world.

This paper presents a novel approach for real-time sign language to text conversion using OpenCV (Open-Source Computer Vision Library) in the Python programming language.

The proposed system leverages computer vision techniques to recognize and interpret sign language gestures captured through a camera. The process involves several stages, starting with hand detection and tracking, followed by the extraction of relevant features from the hand region. These features are then fed into a machine learning model, such as a model created using Random Forest Classifier algorithm is trained to recognize various sign language gestures.

Creating a thorough sign language dataset with contributions from a diverse group of signers is essential for enhancing the accuracy and robustness of the model, ensuring adaptability to various sign styles and expressions. The system's real-time capabilities enable the immediate translation of sign gestures into corresponding text, fostering smooth communication between deaf individuals and those who can hear.

Keywords- OpenCv, Random Forest Algorithm, Mediapipe

I. INTRODUCTION

Sign language plays a vital role in facilitating communication for deaf and hearing-impaired individuals. It allows them to express their thoughts, emotions, and ideas through a combination of hand gestures, facial expressions, and body movements. However, the lack of universal standards and variations in sign language across different regions pose significant challenges for seamless communication with hearing individuals. The system aims to comprehend sign language, enabling individuals with hearing and speech impairments to communicate directly with the external world without the need for an interpreter.

In this paper, the key components of the proposed system include hand detection and tracking, feature extraction, and machine learning-based gesture recognition. OpenCV provides a robust platform for implementing computer vision techniques, enabling the system to identify and track the signer's hand in real-time video streams. Subsequently, relevant features are extracted from the hand region, which serve as input to a machine learning model.

Training the machine learning model on a comprehensive sign language dataset is crucial for achieving high accuracy and robustness. The dataset should encompass a diverse range of sign gestures performed by different signers to account for variations in sign styles and individual expressions.

The successful implementation of this sign language to text conversion system holds immense potential for enhancing the lives of the deaf community. By enabling real-time translation of sign language into text, this technology can bridge communication gaps, facilitate inclusive interactions, and empower deaf individuals to actively participate in various social, educational, and professional settings. Additionally, the versatility of Python and OpenCV allows for potential integration into diverse devices and platforms, fostering a more inclusive and interconnected society.

The primary objective of this paper is to develop an innovative real-time sign language detection system with machine learning methodologies to enhance communication accessibility for individuals with hearing impairments. The system uses Media Pipe library for precise hand tracking and landmark extraction for diverse sign language gestures.

A key feature of the system is using a pre-trained model of random forest classifier, enabling real-time sign language interpretation based on extracted hand landmarks. Beyond technical advancements, the research addresses ethical considerations in AI, including dataset balancing, real-time responsiveness optimization, and user interface refinement. By rigorous evaluation methods, accuracy of the detection of gesture is increased. The advocacy for responsible AI practices and the promotion of an open-source community approach underscores the research's contribution

to the intersection of computer vision, machine learning, and inclusive technology solutions.

II. WORKING

The system's functionality initiates with the application of the Media Pipe library, a robust tool for computer vision, to facilitate accurate hand tracking and landmark extraction. As a user engages in sign language communication in front of a webcam, the system meticulously processes each video frame in real-time, adeptly detecting and tracking the intricate movements of the user's hand. The precision of this tracking process is crucial as it enables the extraction of key landmarks representing pivotal points on the hand, including fingertips and joints. This initial phase establishes a foundational understanding of the sign language gestures performed by the user, capturing the dynamic nature of these expressions with granularity.

Following the extraction of hand landmarks, the system seamlessly integrates a pre-trained random forest classifier to undertake the intricate task of gesture recognition. Trained on a diverse dataset encompassing a spectrum of sign language gestures, the machine learning model leverages the extracted hand landmarks as input features.

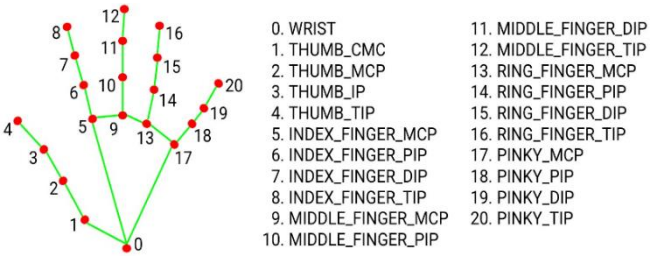

Fig 1: Hand Landmarks and their Indices

The model's architecture, based on a random forest classifier, facilitates robust generalization, allowing it to deliver reliable predictions for a myriad of sign language expressions. This critical phase forms the bridge between computer vision and machine learning, transforming raw landmark data into meaningful predictions about the conveyed sign language messages.

Upon successful recognition of the sign language word or phrase, the system dynamically translates this interpretation into a real-time display on a user-friendly interface. Simultaneously, the system employs a visual cue by drawing a bounding box around the detected hand region, providing users with a tangible representation of the system's interpretation. This ensures users receive prompt and accurate responses to their sign language expressions.

Data stored in CSV has been imported into Pandas Data frame. The data have been normalized to make a standard scale without distorting differences in the range of values. As there are many features, feature extraction has been implemented using PCA to extract the few best features. The normalization and feature extraction is required as many features with fluctuated data points were selected for classification.

Fig 3: Hand landmarks detection on an image using Mediapipe and OpenCv in different positions

Classification

To make classification more accurate, three different machine learning algorithms like Random Forest Classification, Decision Trees is implemented, and their results have been compared. Support vector machine classifiers are based on maximizing the minimum distance from the separating hyperplane to the nearest example. Random Forest for Indian sign recognition, extract relevant features from the sign images and use them as input to train the model. The algorithm then learnt how to associate these features with the corresponding sign labels during the training process. After the model is trained the Random Forest model can predict the sign represented in a new image based on its learned patterns and relationships. Decision Trees is based on the values of the available features to produce a good generalization. A decision tree with recursive binary splitting is used to consider all the features and split on a different data point.

The Hand Gesture Recognition system is a widely used technology for helping dumb and deaf people. The human hand has remained a popular choice to convey information and messages in situations where other forms like speech cannot be used. Gesture recognition is a type of perceptual computing user interface that allows computers to capture and interpret human gestures as commands. The general definition of gesture recognition is the ability of a computer to understand gestures and execute commands based on those gestures. In the proposed approach, we will first look at the related works done in this field. The general purpose of the Hand gesture recognition system is to make a system capable of detecting and monitoring some features for objects that are specified according to image processing algorithms using a camera module. The feature extraction algorithm is programmed with Python supported by OpenCV libraries and executed with the trained model with an attached camera in the Device.

This system is working well even in poor illumination conditions. The hand gesture algorithm is used to detect and monitor hand gestures with the image thresholding. Images thresholding is a type of images processing. Images thresholding is a type of images processing. This image analysis technique is a type of image segmentation that isolates objects by converting grayscale images into binary images. Image thresholding is most effective in images with high levels of contrast. In this way, by using the above algorithm, a pretrained model is obtained and the system now works for different hand gestures in real time.

III. RESULT

The below shown pictures are the few examples of how sign language is detected after implementing the model. Sign Language Recognition using a Random Forest Classifier offers several benefits which can make the communication between deaf and normal people easier. In this project OpenCv and Mediapipe are used to detect the hand gesture and Random Forest algorithm is used to model and train the machine which was further tested and corrected the errors for better accuracy rate.

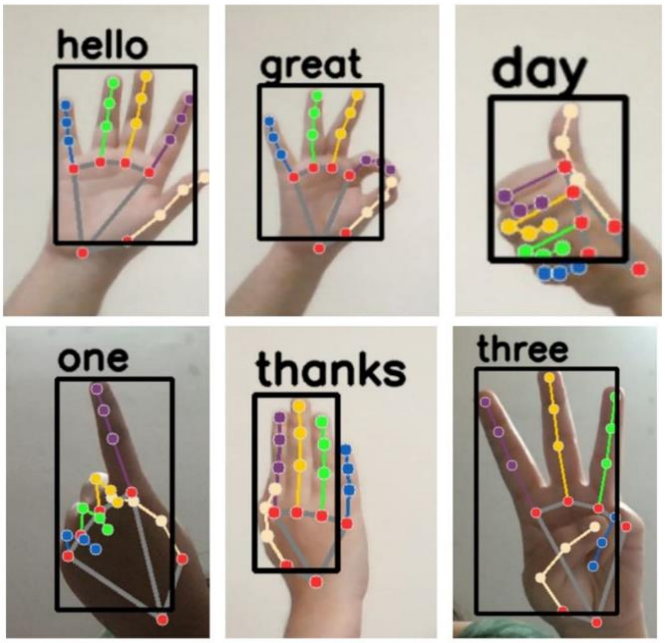

Fig 3.1: Hello Gesture, 3.2: Great Gesture, 3.3: Day Gesture
Fig 3.4: One Gesture, 3.5: Thanks Gesture, 3.6: Three Gesture

These are the few examples of the results of different hand gestures applied

By this project, offers several advantages, particularly for individuals in the Deaf community and those interacting with them. The communication gap between deaf-mute community and normal people will become thin. So that they can also get more professional opportunities to grow in their life. Which can further strengthen their familial bonds and relationships.

Looking ahead, the project underscores the importance of ethical considerations in AI implementation, ensuring unbiased and responsible practices. Future iterations are envisioned to delve deeper into user interface enhancements, the incorporation of additional sign language expressions, and optimization for diverse environmental conditions. By embracing a commitment to continuous improvement and user-driven refinements, this research not only addresses immediate challenges in assistive technology but also sets the stage for the evolving landscape of inclusive and ethically grounded AI applications. Through this interdisciplinary endeavour, the potential impact of technology in breaking down communication barriers and fostering inclusivity becomes increasingly tangible.

IV. CONCLUSION

In conclusion, this research endeavours to bridge the gap in communication accessibility for individuals with hearing impairments through the development of a real-time sign language detection system. By seamlessly integrating computer vision with machine learning techniques, the project achieves a significant milestone in providing prompt and accurate interpretations of sign language gestures. The utilization of the Media Pipe library for precise hand tracking and landmark extraction, coupled with a pre-trained random forest classifier for gesture recognition, forms a robust foundation for the system's functionality. The real-time interpretation and user-friendly interface contribute to the immediacy and usability of the system, presenting a promising avenue for fostering inclusive communication.

Overall, Sign Language plays a vital role in the lives of Deaf individuals, contributing to their personal, educational, and professional development while promoting a more inclusive and accessible society.

V. ACKNOWLEDGMENT

This research concentrates on anticipating the requirements of individuals with hearing and speech impairments. Future developments may include incorporating communication functionalities into their mobile devices. This advancement would empower the system to gather additional insights into the user's needs, laying the groundwork for recommender systems. Utilizing neural network models, these systems can adeptly analyze and comprehend relevant data concerning the needs of individuals with hearing and speech impairments, thereby enabling the provision of personalized recommendations derived from learned patterns.

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