SHREE L. R. TIWARI COLLEGE OF ENGINEERING,
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Academic Year 2023–2024

“SIGN LANGUAGE RECOGNITION FOR DEAF AND MUTE PEOPLE”

Mini Project Synopsis
Submitted in Fulfillment of the Requirement for the Degree of

BACHELOR OF ENGINEERING
(Electronics & Computer Science)

MUMBAI UNIVERSITY

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Under the Guidance of

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CERTIFICATE OF APPROVAL

For

Mini Project Synopsis

This is to certify that

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have satisfactorily carried out the Mini Project work entitled ***"Sign Language Recognition For Deaf And Mute People"*** in partial fulfillment of Bachelor of Engineering in Electronics & Computer Science as laid down by University of Mumbai during the academic year 2023-2024.

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Head of Department: ____________________

(Mrs. Manjiri M. Gogate)

Principal: ____________________

(Dr. Deven Shah)

ACKNOWLEDGMENTS

Special thanks to our Guide ***Dr. Poorva Waingankar*** for assisting us to partially complete ourSkill Lab on ***"Sign Language Recognition For Deaf And Mute People".***

His / Her expertise and talent in designing and troubleshooting projects helped us effectively to partially complete this project.

We'd like to express our gratitude to ***Mrs. Rohini Rathod*** Madam, our Project Coordinator (Mini Project), for guiding us through the process to fulfil Mumbai University's Mini Project requirements.

Special thanks to Head of Department ***Mrs. Manjiri M. Gogate*** madam for her constant motivation, without which this work would not have become successful.

We are also thankful to our Principal ***Dr. Deven Shah*** Sir for his continuous encouragement throughout the process.

We would also like to thank our **Electronics and Computer Science** Department for providing us online/offline facility and labs, which helped us constantly in increasing our technical knowledge, and to write this report.

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ABSTRACT

Sign Language Recognition For Deaf And Mute People

Our project introduces a user-friendly system that harnesses the power of cameras and computers to interpret sign language gestures. By combining Machine Learning models, Python programming language, and the OpenCV library, our system accurately recognizes American Sign Language (ASL) gestures in real time. This real-time recognition capability facilitates efficient communication for individuals who are newly deaf or mute, enabling them to express themselves more effectively. Central to the system's effectiveness is its extensive training on a diverse dataset of ASL gestures, ensuring rapid and precise conversion of gestures into text. Through continuous learning and adaptation using machine learning techniques, our system improves its recognition capabilities over time. This adaptability enhances inclusivity and accessibility for users, empowering them to communicate with greater ease and confidence in various environments.Thorough testing under diverse conditions, including different lighting settings, camera angles, and user demographics, validates the system's robustness and reliability. By successfully bridging communication barriers between individuals with and without disabilities, our system promotes inclusivity. It fosters a more connected and inclusive society where everyone can communicate effectively and participate fully.

INTRODUCTION

American sign language is a predominant sign language Since the only disability Deaf and Dumb (hereby referred to as D&M) people have is communication related and since they cannot use spoken languages, the only way for them to communicate is through sign language. Communication is the process of exchange of thoughts and messages in various ways such as speech, signals, behavior and visuals. D&M people make use of their hands to express different gestures to express their ideas with other people. Gestures are the non- verbally exchanged messages and these gestures are understood with vision. This nonverbal communication of deaf and dumb people is called sign language. A sign languageis a language which uses gestures instead of sound to convey meaning combining hand-shapes, orientation and movement of the hands, arms or body, facial expressions and lip-patterns. Contrary to popular belief, sign language is not international. These vary from region to region.

Sign language is a visual language and consists of 3 major components:

Communication Element	Description
Finger spelling	Used to spell words letter by letter.
Word Level Sign Vocabulary	Sign language vocabulary at the word level.
Non-Manual Features	Involves facial expressions, tongue, mouth, & bodyposition.

Minimizing the verbal exchange gap among D&M and non-D&M people turns into a want to make certain effective conversation among all. Sign language translation is among one of the most growing lines of research and it enables the maximum natural manner of communication for those with hearing impairments. A hand gesture recognition system offers an opportunity for deaf people to talk with vocal humans without the need of an interpreter. The system is built for the automated conversion of ASL into textual content and speech In our project we primarily focus on producing a model which can recognize.
Fingerspelling based hand gestures in order to form a complete word by combining each gesture. The gestures we aim to train are as given in the image below.

PROBLEM STATEMENT

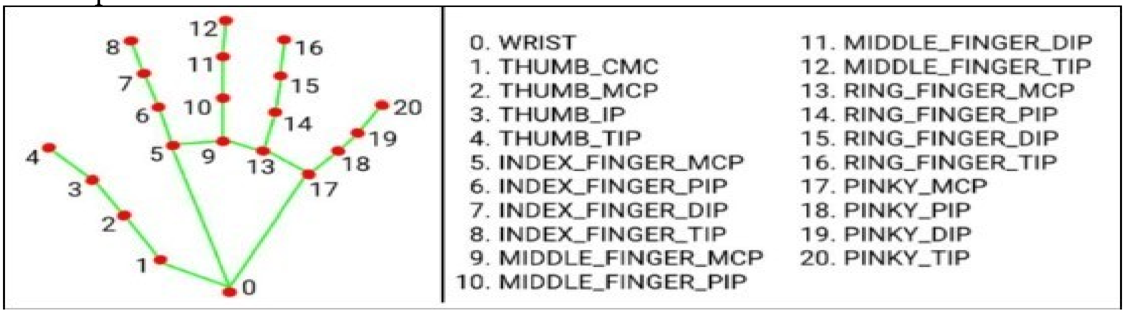
The Deaf community faces significant communication barriers when interacting with those who can hear and speak. While American Sign Language (ASL) is their primary language, the lack of widespread understanding and reliable translation technology hinders seamless communication. Additionally, current limitations in fingerspelling recognition technology restrict the ability of Deaf individuals to fully express themselves across various contexts.
Fingerspelling, a core component of ASL, allows Deaf individuals to spell words letter-by-letter using hand gestures. It's essential for conveying proper nouns, technical terms, and nuances not readily expressed with standard ASL signs. However, existing fingerspelling recognition systems often suffer from inaccuracy, lack robustness, and struggle with real-time performance. These limitations impede effective communication for Deaf individuals and hinder their ability to fully participate in all aspects of society.
Our goal is to significantly improve the accuracy and real-time performance of fingerspelling recognition. This will empower Deaf individuals with a reliable tool for fluent ASL communication, inclusivity, accessibility, and more effective communication with the wider community.

LITERATURE SURVEY

Paper	Focus	Potential Application for Fingerspelling Recognition
Sign Language Recognitionwith Unsupervised FeatureLearning (Taylor et al.)	Unsupervised feature learning techniques for SLR	Reducing reliance on large labeled datasets forfingerspelling recognition.
Sign Language Recognition: A Comparative Study of the State of the Art (Silveira et al.)	Comparative analysis of SLR techniques	Framework for a similar analysis specifically on fingerspelling recognition methods.
Sign Language RecognitionUsing 3D Convolutional Neural Networks (Duong et al.)	3D CNNs for SLR (considering temporal aspects)	3D CNNs are well-suited for capturing the dynamic nature of fingerspelling gestures.
Sign Language RecognitionBased on 3D Convolutional Neural Networks (Li et al.)	3D CNNs for SLR (emphasizing spatiotemporal information)	Importance of capturing bothspatial and temporal information for accurate fingerspelling recognition.
Sign Language RecognitionUsing Principal ComponentAnalysis and NeuralNetworks (Bourlai & Pavlidis)	PCA with neuralnetworks for SLR	Exploring PCA as a pre- processing step fordimensionality reduction andimproved efficiency in fingerspelling recognitionsystems (although not directly applicable).

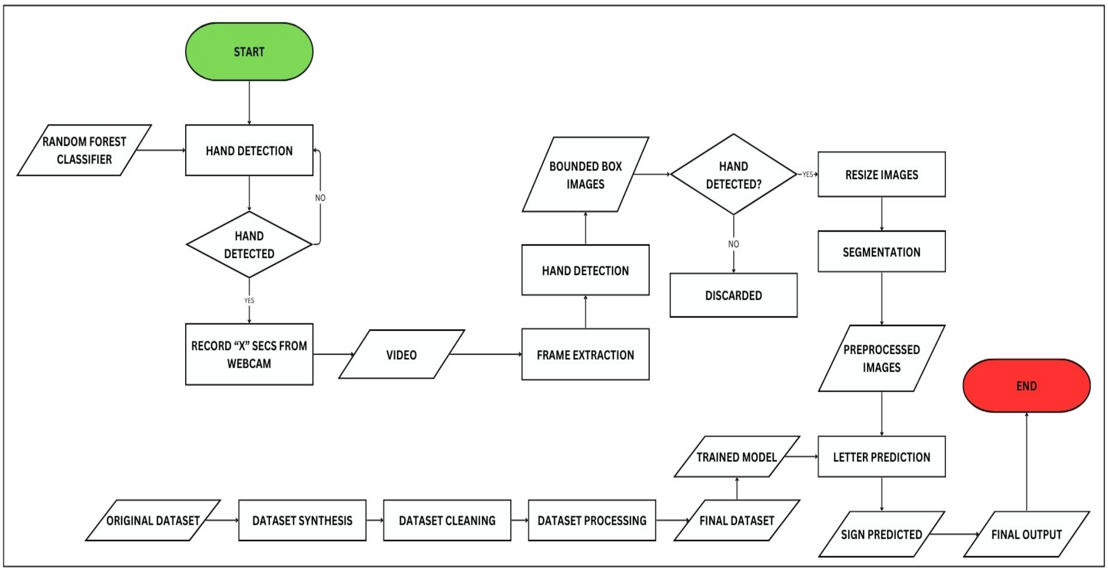
SOFTWARE REQUIREMENT

● Operating System:
Linux Programming Language: Python Computer Vision Library:
OpenCV (version 4.7.0.68)
OpenCV provides essential functionalities for image and video processing, crucial for tasks such as image manipulation and feature extraction.
● Machine Learning Framework:
Scikit-learn (version 1.2.0)
Scikit-learn is instrumental in implementing machine learning algorithms for tasks like classification and regression. It enables us to train and deploy models efficiently.
● Computer Vision Framework:



MediaPipe HandPose (version0.9.0.1) MediaPipe's HandPose offers hand landmark detection capabilities, geometric constraints for accurate hand pose estimation.
● Data Visualization Library:
Matplotlib (version 3.4.x)
Matplotlib facilitates the visualization of data and results, allowing us to plot images with drawn landmarks for analysis and presentation purposes.

ER DIAGRAM



EXISTING SYSTEM

Sign Language Recognition (SLR) systems are crucial tools designed to facilitate communication for deaf and mute individuals by translating sign language into spoken or written language, or vice versa. These systems employ various technologies, including computer vision, machine learning, and artificial intelligence, to interpret
and understand sign language gestures.
Currently, there are several existing SLR systems, each with its unique approach and functionality:
Computer Vision-Based Systems: These systems use cameras to capture video of sign language gestures, which are then processed using computer vision algorithms to recognize and interpret the signs. Some systems rely on hand tracking and gesture recognition techniques to identify specific hand shapes and movements associated with different signs.
Wearable Devices: Wearable devices equipped with sensors and accelerometers can detect hand movements and gestures, allowing deaf and mute individuals to communicate through sign language. These devices may also incorporate haptic feedback or visual displays to provide real-time feedback or translation of signs.
Mobile Applications: There are several mobile applications available that offer SLR functionality, allowing users to communicate through sign language using their smartphones or tablets. These apps often utilize a combination of image processing algorithms and machine learning models to recognize and interpret signs captured through the device's camera.
Gesture Recognition Gloves: Gesture recognition gloves are wearable devices that track hand movements and gestures using sensors embedded in the gloves. These gloves can recognize and translate sign language gestures into text or speech, enabling real-time communication between deaf and mute individuals and hearing individuals.
Research Prototypes: In addition to commercial systems, there are ongoing research efforts focused on advancing SLR technology. These prototypes often incorporate state-of-the-art machine learning algorithms and deep neural networks to improve the accuracy and efficiency of sign language recognition.

PROPOSED SYSTEM

Our proposed system aims to revolutionize communication for the Deaf and mute community by leveraging cutting-edge technologies in computer vision and machine learning. It consists of a comprehensive framework that integrates various components to recognize sign language gestures accurately and efficiently. The key features of our proposed system include:
1. Real-time Gesture Recognition: Utilizing advanced computer vision algorithms, the system can recognize sign language gestures in real time, enabling seamless communication between Deaf and mute individuals and the wider community.
2. Fingerspelling Recognition: A core component of the system is its ability to accurately recognize fingerspelling gestures in American Sign Language (ASL). By precisely identifying individual letters, the system can interpret words and

phrases expressed through fingerspelling.

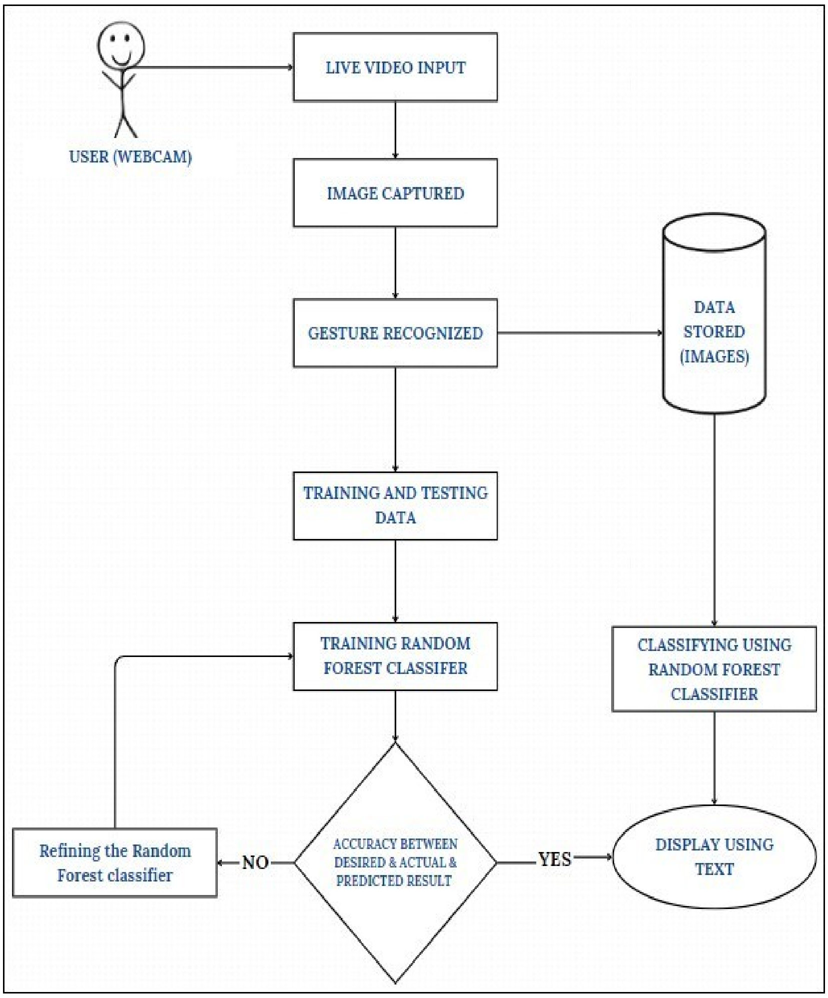
3. Machine Learning Model: The system incorporates a robust machine learning model, such as the Random Forest classifier, to achieve high accuracy in gesture recognition. This model is trained on a diverse dataset of ASL gestures to ensure reliable performance across different scenarios.

4. Integration of MediaPipe HandPose: Leveraging the MediaPipe HandPose framework, the system can detect and localize hand landmarks with precision. This capability enhances the accuracy of gesture recognition and contributes to the overall effectiveness of the system.

5. User Interface: The system features an intuitive user interface that enables Deaf and mute individuals to interact with ease. The interface may include visual feedback to confirm gesture recognition and facilitate smooth communication.

6. Accessibility and Inclusivity: By providing a reliable tool for sign language communication, our proposed system promotes accessibility and inclusivity for individuals with hearing and speech impairments. It empowers them to express themselves effectively and participate fully in various social and professional settings.

FLOWCHART



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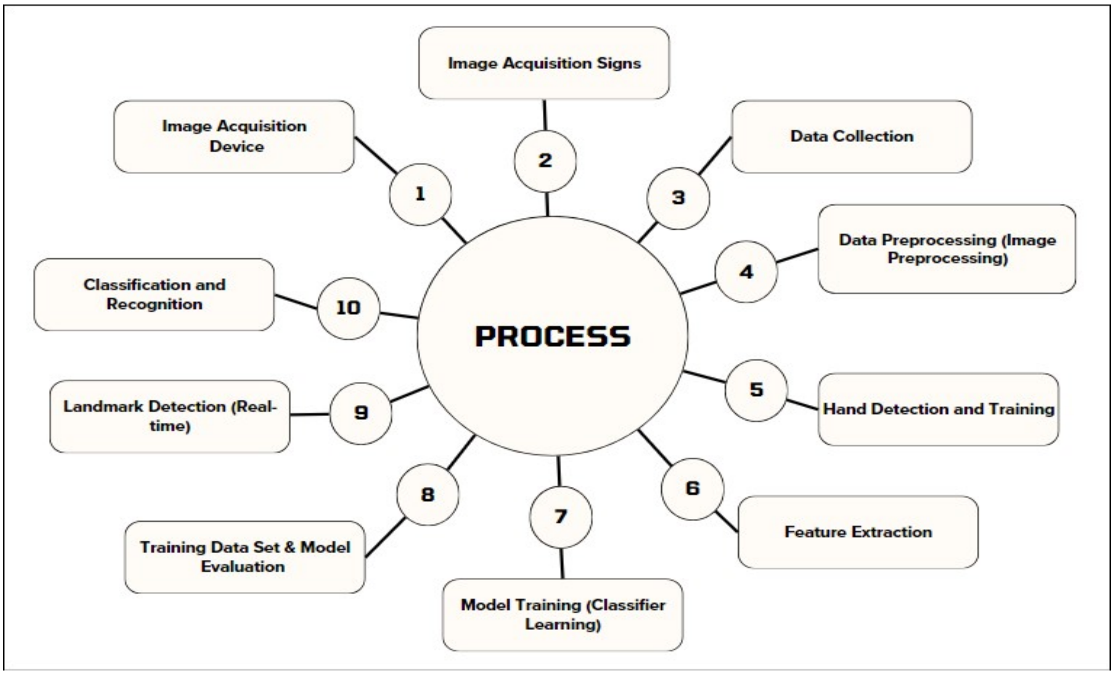
METHODOLOGIES

1.Data Collection: This involves capturing images of hand gestures representing American Sign Language (ASL) alphabets and phrases using a camera.
2. Data Preprocessing: The collected images are preprocessed to enhance their quality and prepare them for feature extraction. This may involve resizing, normalization, and noise reduction techniques.
3.Feature Extraction: Hand landmarks are detected and extracted from the preprocessed images using computer vision techniques. MediaPipe's HandPose model is utilized for accurate landmark detection.
4. Dataset Creation: The extracted hand landmarks are used to create a dataset for training machine learning models. Each gesture corresponds to a label, and the dataset is divided into training and testing sets.
5. Model Training: Machine learning models, such as Random Forest, are trained using the hand landmark data. The models learn to recognize ASL gestures based on the extracted features.
6. Model Evaluation: The trained models are evaluated using performance metrics such as accuracy, precision, recall, and F1 score. This step ensures that the models generalize well to unseen data.
7. Model Optimization: Techniques like hyperparameter tuning and feature selection are employed to optimize the performance of the trained models further.
8. Testing and Validation: The optimized models are tested on real-time sign language gestures to validate their accuracy and effectiveness in recognizing ASL gestures accurately.
9. Deployment:The validated models are deployed in real-world applications, such as mobile apps or assistive devices, to facilitate communication for deaf and mute individuals.
10. Continuous Improvement: The system is continuously monitored and updated based on user feedback and advancements in technology to enhance its performance and usability over time.



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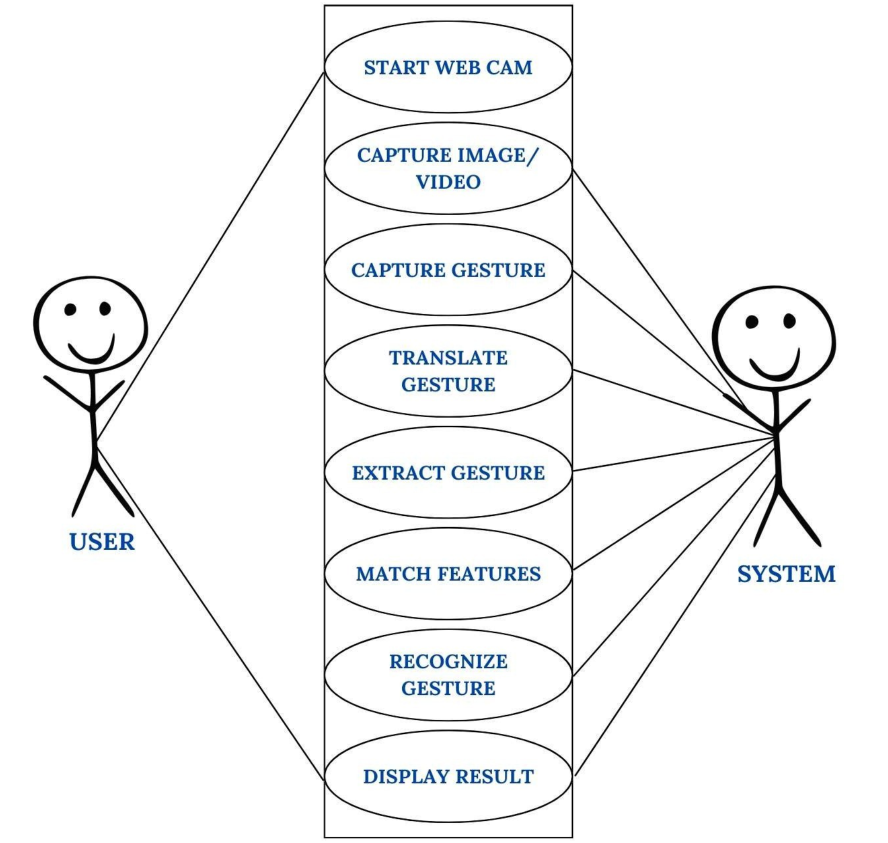
USE CASE DIAGRAM



USE CASE DIAGRAM OF SIGN LANGUAGE RECOGNITION SYSTEM

USE CASE SCENARIO FOR SIGN LANGUAGE RECOGNITION SYSTEM	
Usecase name	Sign Language Recognition
Participating Actores	User, System
Flow of Events	Start The System(U) Capturing Videos(S) Translate Gesture(S) Extract Feature(S) Match Features(S) Recognizing Gestures(S) Display Result
Entry Condition	Run The Code
Exit Condition	Displaying The Label
Quality Requirements	Cam Pixels Clarity, Good Light Condition

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SYSTEM OVERVIEW

The Sign Language Recognition for Deaf and Mute People project aims to develop a user-friendly system that utilizes cameras and computers to interpret sign language gestures, particularly focusing on American Sign Language (ASL). By combining machine learning models, Python programming language, and the OpenCV library, the system can accurately recognize ASL gestures in real time. The project addresses the communication barriers faced by the Deaf community, providing them with a reliable tool for efficient communication.

Key components of the project include data collection and preprocessing, feature extraction using computer vision techniques, dataset creation, model training, evaluation, and optimization. The trained models are then deployed in real-world applications to facilitate communication for deaf and mute individuals.

The project's significance lies in its ability to bridge communication gaps between individuals with disabilities and the wider community, promoting inclusivity and accessibility. Through continuous learning and adaptation using machine learning techniques, the system improves its recognition capabilities over time, empowering users to communicate effectively in various environments. Thorough testing validates the system's robustness and reliability, ensuring its suitability for real-world use.

Overall, the project aims to foster a more connected and inclusive society where everyone can communicate effectively and participate fully, regardless of their abilities.

FUTURE SCOPE

-Advanced Deep Learning Architectures:

Transformers and Beyond: While transformers hold promise, exploring other cutting-edge architectures like spiking neural networks or graph neural networks could further enhance the system's ability to capture complex relationships within fingerspelling sequences.

-Augmented Reality (AR) Integration:

Multimodal Overlays: Incorporating not just text or spoken words, but also relevant animations or 3D models alongside recognized gestures could provide a more intuitive and informative experience.

-Speaker Identification:

Adapting to Signer Variations: The system could not only identify individual signers but also learn and adapt to their specific signing styles over time, leading to personalized recognition accuracy.

-Open-Set Recognition:

Unsupervised Learning Techniques: Leveraging unsupervised learning techniques for sign discovery could enable the system to identify unknown signs and potentially even learn them through user interaction.

-Brain-Computer Interface (BCI) Integration:

Ethical Considerations: BCI integration raises ethical concerns regarding privacy and user control. Research in this area should prioritize ethical frameworks for responsible development and deployment.

-Translation Integration:
Context-Aware Translation: Integrating context-aware translation capabilities would allow the system to not only translate individual words but also capture the overall meaning and intent of the fingerspelled message.
-Wearable Integration:
Seamless integration with smart glasses or other wearable devices could provide a more natural and hands- free experience for finger spelling communication.

CONCLUSION

Our project relied on Python, OpenCV, and Scikit-learn software for building a robust Sign Language Recognition system. These tools provided the necessary framework for implementing machine learning algorithms and computer vision techniques essential for interpreting American Sign Language (ASL) gestures.
Our system's functionality lies in the Random Forest classifier, a machine learning algorithm known for its accuracy and versatility. This classifier works by constructing multiple decision trees and aggregating their predictions, resulting in robust and reliable recognition of ASL gestures in real-time.

To ensure the effectiveness of our system, extensive testing was conducted across various scenarios, including different lighting conditions and user demographics. This rigorous testing process validated the system's performance and confirmed its suitability for real-world applications, instilling confidence in its reliability.

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