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EDUSIGN-AI Powered Application for Deaf and Mute Students

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Abstract: ***EDUSIGN is an artificial intelligence – powered application developed to assist deaf and mute students by improving communication and learning accessibility. The project focuses on recognizing sign language gestures using computervisionandmachinelearningtechniquesandconvertingthemintomeaningfultextandspeechinrealtime.The system captures hand gestures through a camera, processes them using trained AI models, and provides immediate outputthat canbeeasily understoodby hearing individuals.By enabling seamlessinteractionbetweenhearing-impaired students and the general population, EDUSIGN promotes inclusive education and equal learning opportunities. The application is designed to be user-friendly, efficient, and cost-effective, making it suitable for educational institutionsand real-world environments.***
Keywords: Sign Language Recognition, Artificial Intelligence, Gesture Recognition, Deaf and Mute Education, Text-to-Speech, Human–Computer Interaction, Image Processing, Indian Sign Language (ISL)

I. INTRODUCTION

Education plays a vital role in individual and societal development; however, students with hearing and speech impairments often face significant challenges in traditional classrooms due to communication barriers. Conventional teaching methods rely heavily on spoken language and auditory instructions, which are largely inaccessible to deaf and mute students. As a result,these learners depend on interpreters or written notes, resources that may not always support real-time interaction and can limit active participation. To address this issue, EDUSIGN was developed as an inclusive, AI-based solution. The system uses artificial intelligence and computer vision to recognize sign language gestures and convert them into text and speech. This enableseffective, real-time communicationbetween students,teachers,and peerswithoutrequiring knowledge of sign language. By promoting independent expression and classroom engagement, EDUSIGN helps create an accessible learning environment where all students have equal opportunities to succeed academically and socially.

II. OBJECTIVE

Theobjectivesare:

- To design and develop an AI-powered system that enables deaf and mute students to communicate effectively usingsign language.
- Torecognizesignlanguagegesturesinrealtimeusingcomputervisionandconvertthemintomeaningfultextand speech outputs.
- To reduce communication barriers between hearing-impaired students, teachers, andpeers, promoting inclusive classroom participation.

III. WORKING PRINCIPLE

Using its camera, the AI-Powered Teacher captures a student's sign language, then leverages a recognition model to process the sign language and uses an AI to generate unique responses to these signs within lessons based on the meaning sent from the recognition model. The response given to the student via the AI is displayed in the form of an animated avatar that signs the response. The app allows for two-way communication by allowing users to convert sign language into text and text into sign language while securely storing the lessons, user data and progress of each individual in order to provide a simple, easy-to-use mobile application experience for all users.

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Fig.1WorkFlowDiagram

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IV. MODULES

Themodulesare:

A. AuthenticationModule–LoginOutput

ThisscreenenablessecureuserauthenticationfortheEdusignprojectusingemail/passwordorGooglesign-in,providing authorized access to the AI-powered sign language learning system.

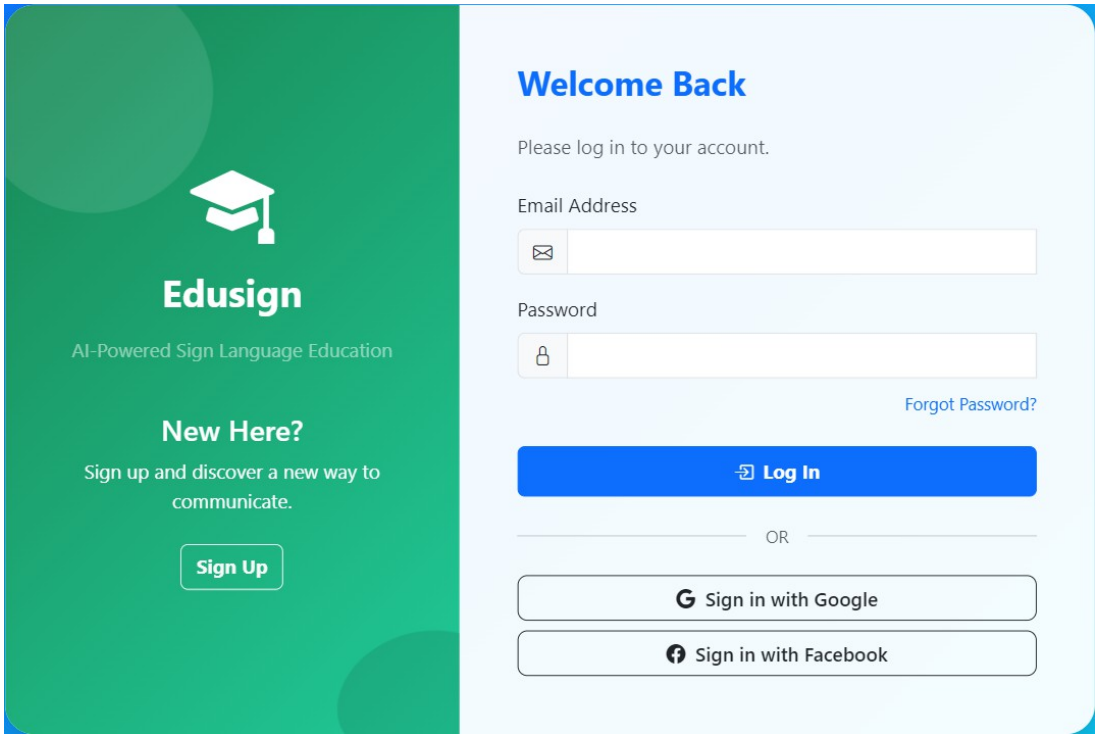


Fig.2EdusignAuthenticationpage

B. DashboardModule–StudentView

This screen displays the student dashboard of the EduSign project. It provides an overview of total lessons, completed lessons, and overall learning progress. The dashboard helps students easily track their performance and manage their learning activities effectively.

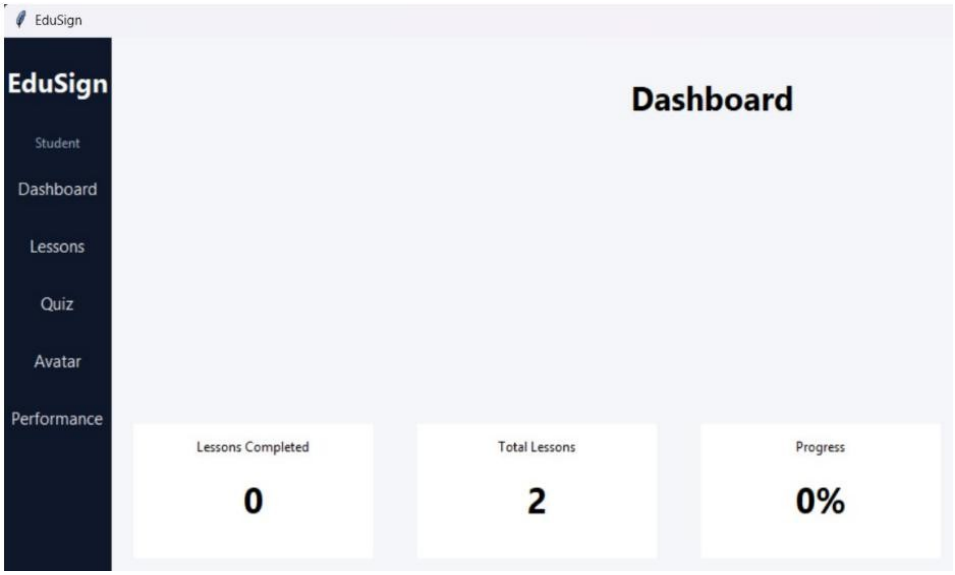


Fig.3EdusignDashboard

C. SignLanguageRecognitionOutput –Signto Text

Thisscreenshowsreal-timehandgesturedetectionusingacamera.TheEduSignsystemrecognizesthesignandconvertsit into text, helping users form words or sentences for effective communication.

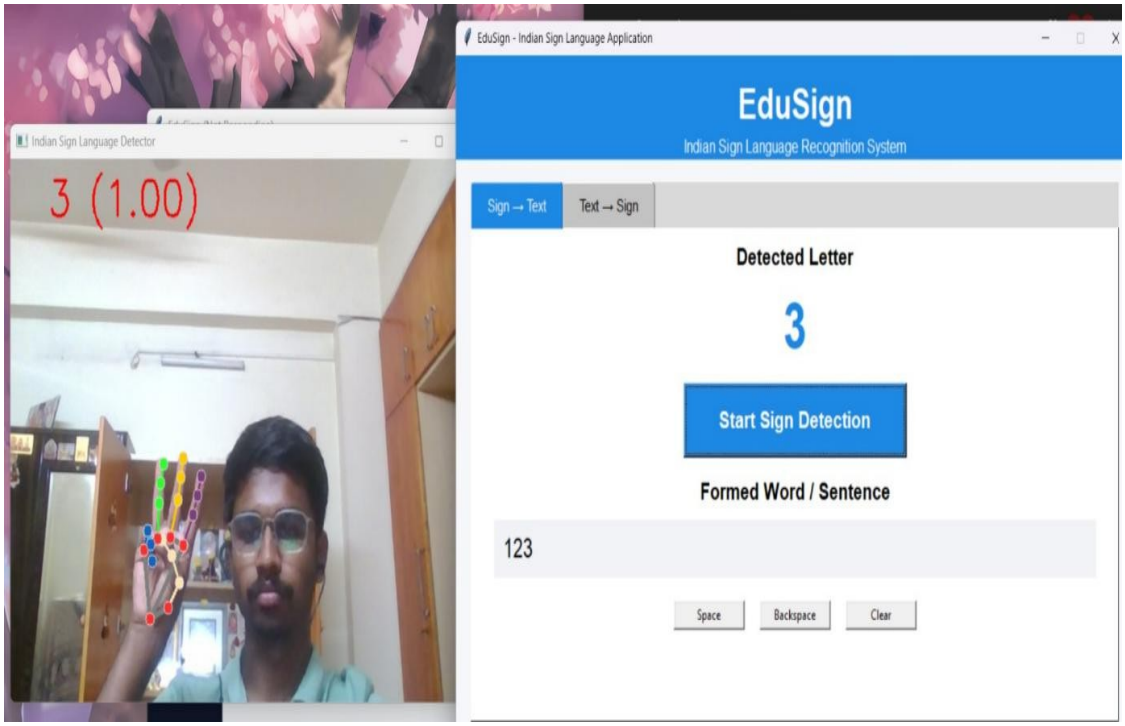


Fig.4Signtotextconversion

D. TexttoSignModule–OutputScreen

This screen shows the Text-to-Sign feature of the EduSign project. Users enter text, and the system converts it into corresponding sign language by playing sign videos or avatar animations letter by letter. This module helps hearing users understand and learn Indian Sign Language for better communication.

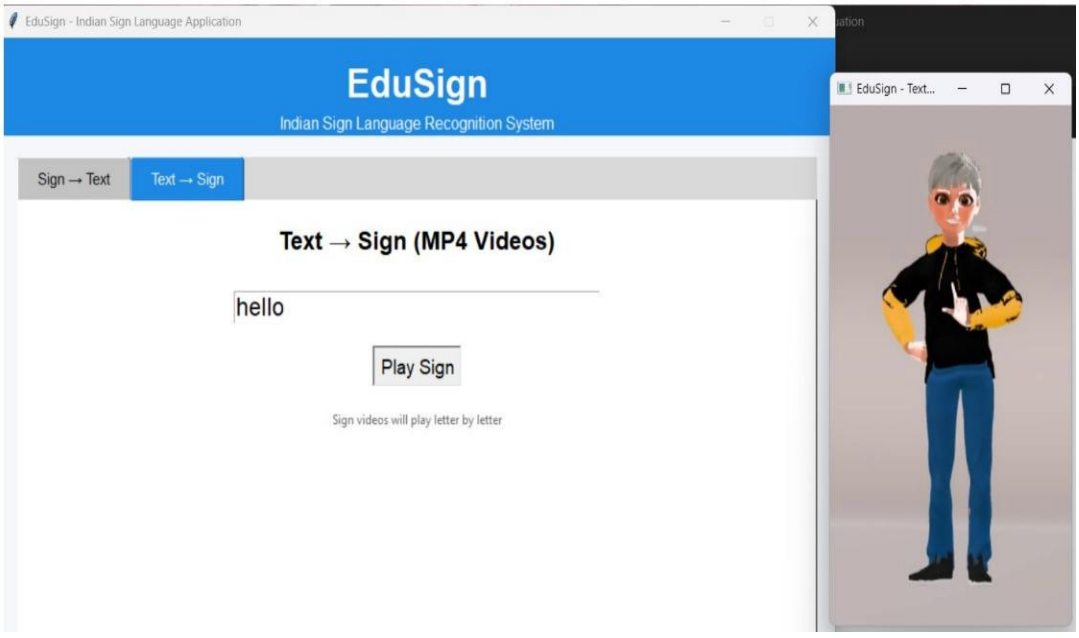


Fig.5TexttoSign conversion

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V. USE CASE DIAGRAM

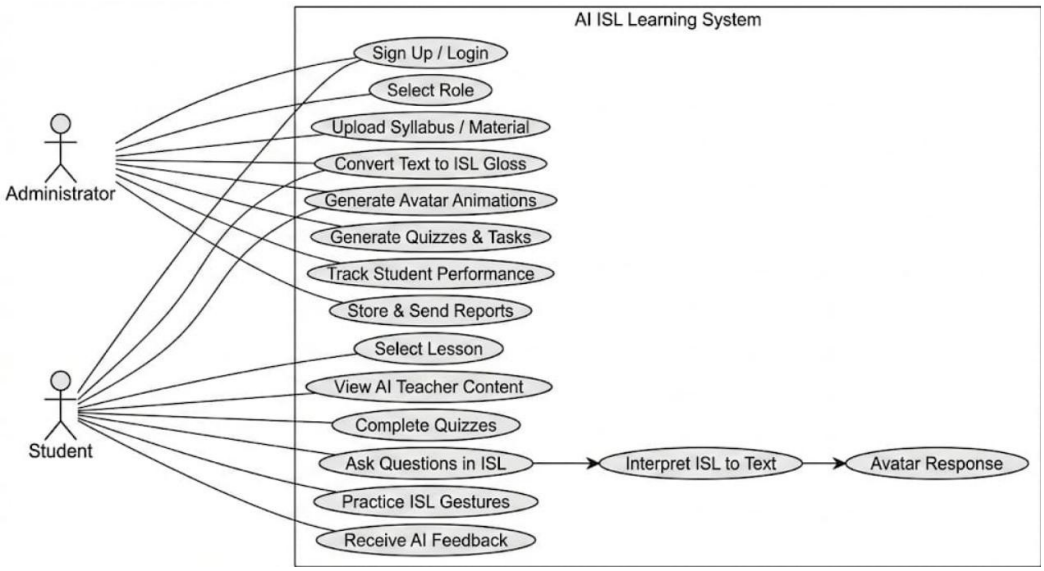


Fig.6UsecaseDiagram

In the **EDUSIGN** application, deaf and mute students securely sign up or log in to access an AI-powered sign language learning platform. After authentication, users are redirected to a personalized dashboard where lessons are organized based on their syllabus. Learning materials uploaded by administrators are converted into **Indian Sign Language (ISL)** and displayed using animated AI avatars for visual understanding. Students can practice ISL gestures in real time, ask questions, and participate in quizzes to test their knowledge. The system uses computer vision and AI to recognize hand gestures and convert them into text and speech, enabling smooth two-way communication. Instant feedback on gesture accuracy helps students improve continuously. Teachers and administrators manage content, quizzes, and student progress through a dedicated admin dashboard. Performance data is analyzed and stored for academic evaluation. Overall, EDUSIGN promotes inclusive education and improves communication for hearing- and speech-impaired students.

VI. CLASS DIAGRAM

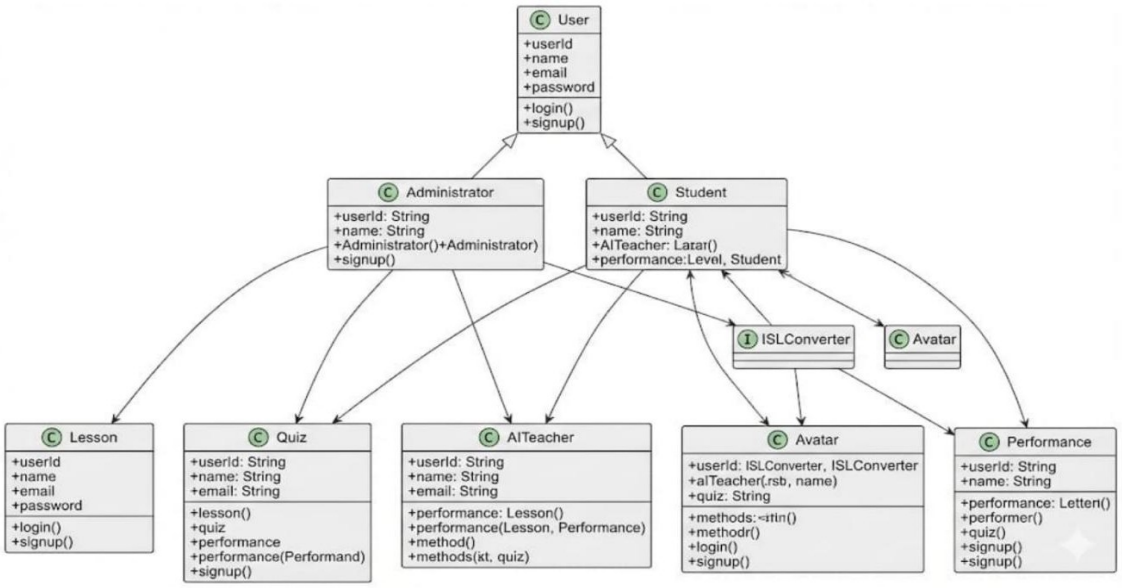


Fig.7ClassDiagram

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The application allows users to register or log in securely using a centralized authentication system. Based on their selected role,usersare categorized as administratorsorstudents.Administratorsmanagetheeducational workflowbyuploadinglessons, creating quizzes, and maintaining learning content. They also track student progress and analyse performance data through the system dashboard. Studentsaccesslearning materialsdelivered by an AI-based virtual teacher using Indian SignLanguage. The AI teacher guides students through lessons and assessments based on their performance level. An ISL converter processes text and gesture inputs and translates them into structured sign language. Animated avatars visually demonstrate ISL gestures for better clarity and understanding. Students can practice gestures, ask questions, and complete quizzes. The system provides instant AI-based feedback to improve learning accuracy. Performance data is continuously recorded and evaluated. Overall, the platform supports inclusive, interactive, and accessible education for hearing- and speech-impaired learners.

VII. ACTIVITY DIAGRAM

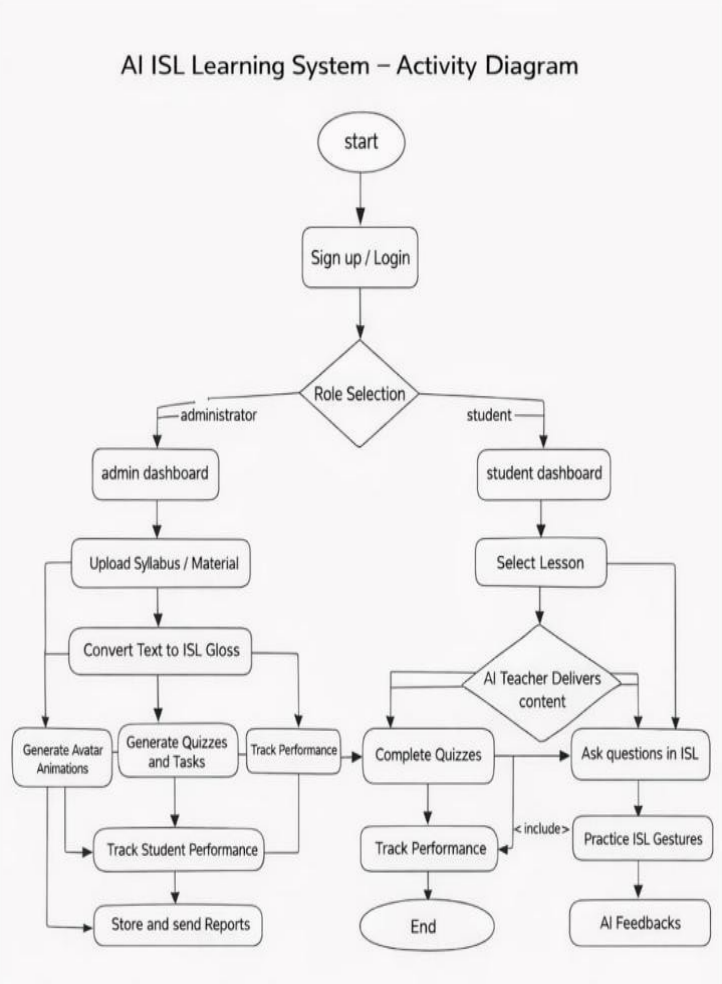


Fig.8ActivityDiagram

The process begins when the user signs up or logs in to the system. After authentication, the user selects a role as either administrator or student.If the administrator roleis selected, the user is directed to the admin dashboard. Administrators upload syllabus materials and convert text content into ISL gloss. The system then generates avatar animations, quizzes, and learning tasks. Student performance istracked, and reports are stored and shared for evaluation. If the student role is selected, the user is redirected to the studentdashboard.Studentsselectlessonsdelivered by the AI teacher through sign language avatars.They can complete quizzes, ask questions in ISL, and practice ISL gestures. The system provides AI-based feedback and tracks performance continuously. The activity flow ends after performance evaluation and feedback delivery.

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VIII. IMPLEMENTATION

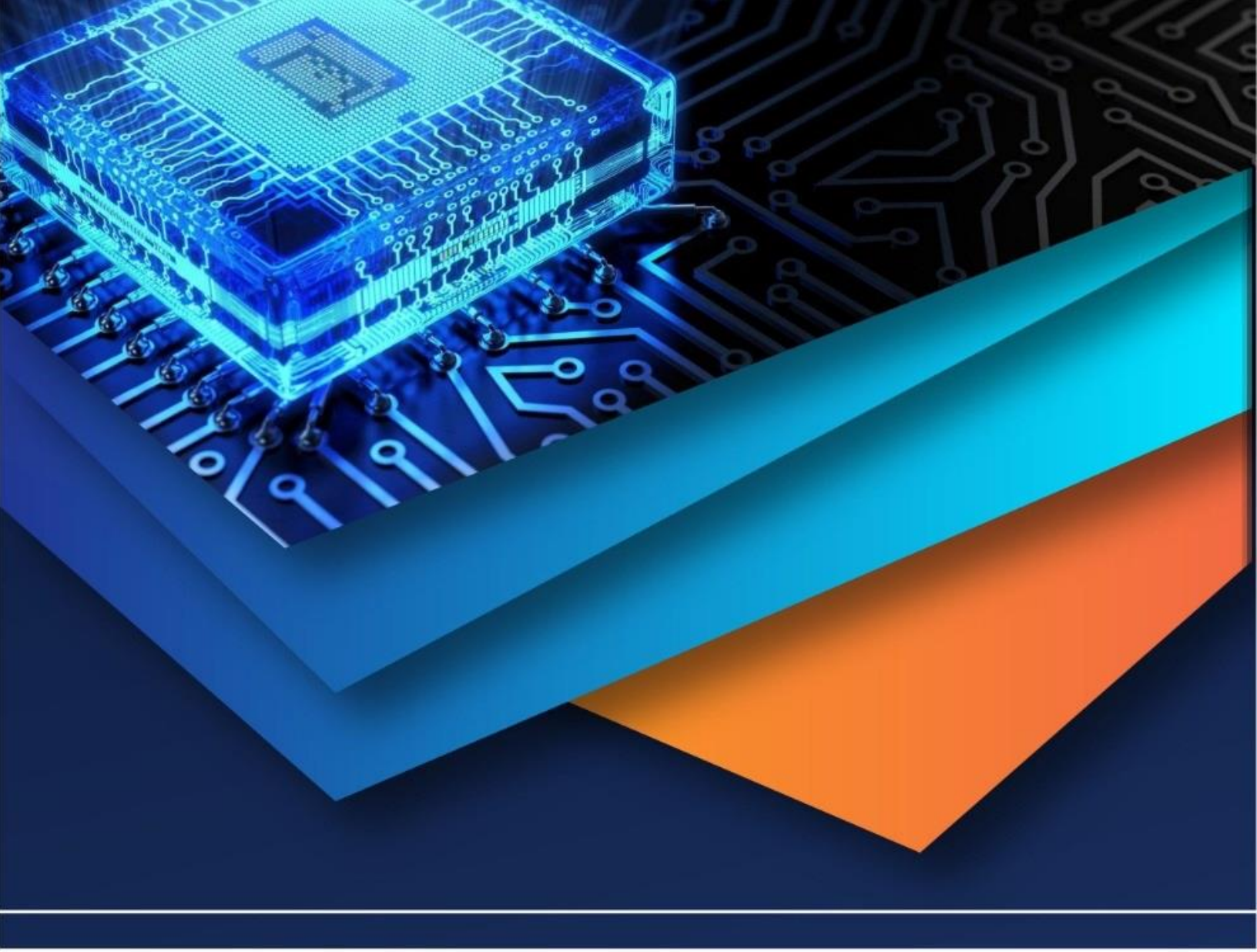
The implementation of the EDUSIGN system begins with capturing real-time video input using a camera or mobile device. Video frames are processed using Open CV to detect and isolate hand regions from the background. Image preprocessing techniques such as resizing, normalization, and noise reduction are applied to improve gesture recognition accuracy. The extracted features are passed to a trained machine or deep learning model developed using Tensor Flow to classify sign language gestures. Recognized gestures are mapped to corresponding text, whichis displayed on the screen and converted into speech using a text-to-speech engine. The system also supports reverse communication by converting text or voice input into sign language through animated visual representations. User data, lesson content, and learning progress are stored securely for personalization and tracking. The system is optimized for real-time performance, ensuring minimal delay and a smooth user experience in educational settings.

IX. CONCLUSION

EDUSIGN is an innovative AI-powered application that aims to make learning and communication easier for deaf and mute students. By using artificial intelligence and computer vision, the system can recognize sign language gestures in real time and convert them into text and speech, helping students interact more effectively with teachersand peers. This project demonstrates how technology can bridge communication gaps and promote inclusive education. EDUSIGN allows hearing-impaired students to participate confidently in classroom activities and social interactions, reducing their reliance on human interpreters. With further development and integration of advanced AI and deep learning techniques, EDUSIGN has the potential to become a comprehensive assistive tool, making education more accessible and empowering students to learn and communicate without barriers.

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