

Learning Web Application for Deaf and Mute with Sign Language Converter

Sanket S. Hiwarale¹, Vedant M. Patinge², Mohit A. Agarkar³, Khushal P. Goyanka⁴, Sarthak Pannase⁵,
Prof. Swati Sakhare⁶

^{1,2,3,4,5}Student, Sipna College of Engineering & Technology, Amravati (MS), India

⁶Assistant Professor, Sipna College of Engineering & Technology, Amravati (MS), India

Abstract: *Hearing and speech-impaired individuals rely on sign language as their primary mode of communication; however, most people are not familiar with it, resulting in a significant communication barrier. This project proposes a real-time sign language recognition system that converts hand gestures into both text and speech, enabling effective interaction between deaf and non-deaf individuals. The system uses a vision-based approach, capturing hand gestures through a standard webcam, eliminating the need for specialized hardware such as data gloves. Advanced image processing and computer vision techniques are employed to detect and recognize hand gestures accurately. The system is designed to identify 26 alphabet gestures and translate them into corresponding textual and audio outputs in real time. Additionally, a learning module is integrated, providing video-based guidance for understanding sign language, including alphabets (A–Z), numbers (1–3), and commonly used phrases, making it beneficial for both learners and users. The proposed solution is cost-effective, user-friendly, and can operate on standard computer systems, ensuring wider accessibility. By bridging the communication gap, this system enhances social inclusion, independence, and overall quality of life for hearing and speech-impaired individuals.*

Keywords: Sign Language Recognition, Hand Gesture Detection, Computer Vision, Image Processing, Real-Time System, Speech Synthesis, Text Conversion, Assistive Technology, Human-Computer Interaction, Accessibility, Deaf Communication, Gesture Recognition, Vision-Based System, Machine Learning, Social Inclusion.

I. INTRODUCTION

Communication is a fundamental aspect of human interaction; however, hearing and speech-impaired individuals often face difficulties in communicating with others due to the lack of widespread understanding of sign language. This creates a significant communication gap between deaf individuals and the general population. To address this issue, there is a need for an intelligent and accessible system that can translate sign language into a commonly understood form such as text and speech [1].

The proposed system is a vision-based sign language recognition application designed to facilitate seamless communication. It begins with a user registration and login module to ensure secure and personalized access. Once logged in, users can explore a learning module that provides educational video content for understanding sign language, including alphabets, numbers, and commonly used phrases. This module helps both beginners and non-sign language users to learn and interact effectively [2].



After accessing the learning resources, users can proceed to the main recognition module, where real-time hand gestures are captured using a webcam. The system applies image processing and computer vision techniques to detect and recognize gestures and convert them into corresponding text and speech output. This eliminates the need for specialized hardware, making the system cost-effective and easy to use.

By integrating user management, learning resources, and real-time gesture recognition, the system not only bridges the communication gap but also promotes accessibility, independence, and social inclusion for hearing and speech-impaired individuals [3].

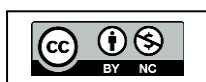
II. LITERATURE ANALYSIS

Several research studies have focused on improving communication and learning for hearing and speech-impaired individuals using sign language technologies. Chaithraj and Kavana H. R (2019) proposed a vision-based system that converts sign language gestures into text and speech using image processing techniques for two-way communication. Sanyukta Bhavsar et al. (2023) developed a mobile-based learning application with interactive modules and real-time feedback to make sign language education more accessible and user-friendly.

Vishnu Priya A. K et al. (2023) introduced a deep learning-based approach using Convolutional Neural Networks (CNN) and OpenCV for real-time gesture recognition and translation between sign language and speech. Additionally, Rekha V et al. (2023) presented an AI-based multilingual system integrating advanced models such as CNN, LSTM, and NLP to support inclusive learning and communication across different languages. Together, these studies highlight the growing role of computer vision, artificial intelligence, and user-centric design in bridging communication gaps and promoting social inclusion for the deaf and mute community.

Table I: LITERATURE WORK

Author and Year	Methods	Future Scope
Chaithraj, Kavana H R (2019)	Vision-based system using webcam; Image processing for hand coordinate extraction; Matching with pre-stored dataset; Gesture-to-text and speech conversion; Two-way communication (sign-to-text/speech and audio-to-sign/text); Sentence formation using continuous gestures	Improve performance in different lighting/backgrounds; Support regional languages and complex gestures; Use advanced ML/DL models; Develop mobile applications; Enhance real-time communication; Implement continuous sentence recognition
Sanyukta Bhavsar, Dhanashree Dhondge, Siddhi Khande, Sejal Zend,	Mobile-based learning application; Interactive modules for alphabets and phrases; User-friendly interface; Real-time feedback system; User-centric design with continuous	Improve gesture accuracy and representation; Add advanced learning levels; Enhance cultural sensitivity; Integrate AI-based personalized learning; Expand to





Prof. M. D. Sanap (2023)	updates; Focus on Indian Sign Language learning	multiple languages; Add real-time communication features
Vishnu Priya A. K, Jayashri S., Sivanjali V., Sneha V., Thamaraiselvi K (2023)	Two-way sign language translator using Deep CNN; Real-time processing with OpenCV; Gaussian Mixture Model for background removal; RGB camera-based gesture recognition; Sign-to-text and speech-to-sign conversion	Develop Android/ mobile application; Improve speed and accuracy; Use advanced deep learning models; Support complex gestures and sentence recognition; Enhance real-world usability
Mrs. Rekha V, Shreya M C, Thanushree H C, Sonu Chouhan, Sumathi V (2023)	AI-based multilingual system; Use of CNN, LSTM, Transformers, hybrid models; Integration of Computer Vision and NLP; ISL gesture to multilingual text/speech conversion; Supports learning and communication	Develop universal communication system; Improve multilingual and real-time performance; Expand large-scale deployment; Enhance collaboration with experts; Advance AI accuracy; Promote inclusive digital environments

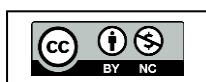
III. WORKING METHODOLOGY

The proposed system is designed to convert sign language gestures into text and speech using a structured and modular approach. The overall workflow consists of user authentication, learning support, and real-time gesture recognition.

- 1. User Registration and Login:** The system begins with a secure user authentication module. New users register by providing basic details such as name, email, and password. The login functionality ensures that only authorized users can access the system. This module also helps in maintaining user-specific data and improving system usability.
- 2. Learning Module:** After successful login, users are directed to the learning module. This module provides educational video content to help users understand sign language basics, including:
 - Alphabet gestures (A–Z)
 - Number gestures (1–3 or more)
 - Common phrases in sign language

This feature is especially useful for beginners and non-sign language users, enabling them to learn before using the recognition system.

- 3. Gesture Input and Image Capture:** When the user starts the recognition process, the system activates the webcam to capture live video. The video stream is divided into frames, and each frame is processed individually. A sufficient number of images (e.g., more than 30 frames) are collected to ensure accurate gesture detection.



4. Image Processing and Feature Extraction: Captured images undergo preprocessing steps such as:

- Background removal
- Noise reduction
- Image resizing and normalization

After preprocessing, important features of the hand (shape, edges, contours) are extracted using computer vision techniques. These features are used to identify the gesture.

5. Gesture Recognition: The processed input is compared with a trained dataset of predefined gestures (26 alphabets). A classification algorithm (e.g., machine learning or rule-based approach) identifies the closest matching gesture. The system continuously checks and validates the gesture for accuracy.

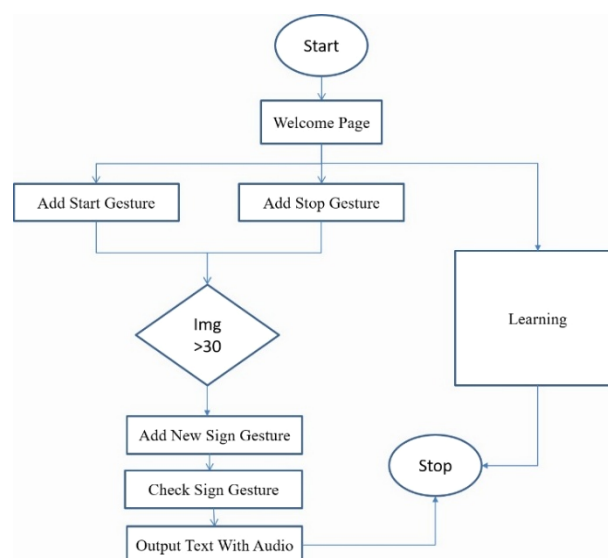
6. Text and Speech Conversion: Once a gesture is recognized, the system converts it into corresponding text. The recognized text is then passed to a speech synthesis module, which generates audio output. This enables real-time communication between the user and others.

7. Output Display: The final output is displayed on the screen as text along with audio playback. This ensures that both visual and auditory forms of communication are supported.

8. System Flow Control: The system includes start and stop gesture controls:

- Start Gesture: Initiates the recognition process
- Stop Gesture: Terminates the process

Additionally, the system allows adding new gestures and verifying them before use, improving flexibility and scalability.



Sign Language Recognition System

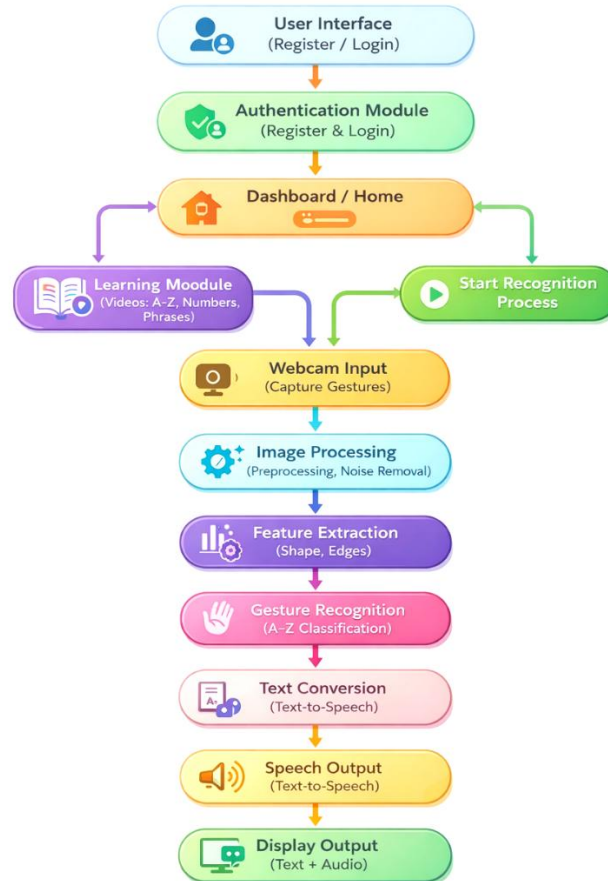
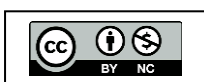


Figure 1: System Diagram

IV. RESULTS AND DISCUSSION

The developed sign language recognition system was successfully implemented and tested under various real-time conditions using a standard webcam. The system effectively integrates user authentication, a learning module, and gesture recognition to provide a complete communication solution for hearing and speech-impaired individuals.

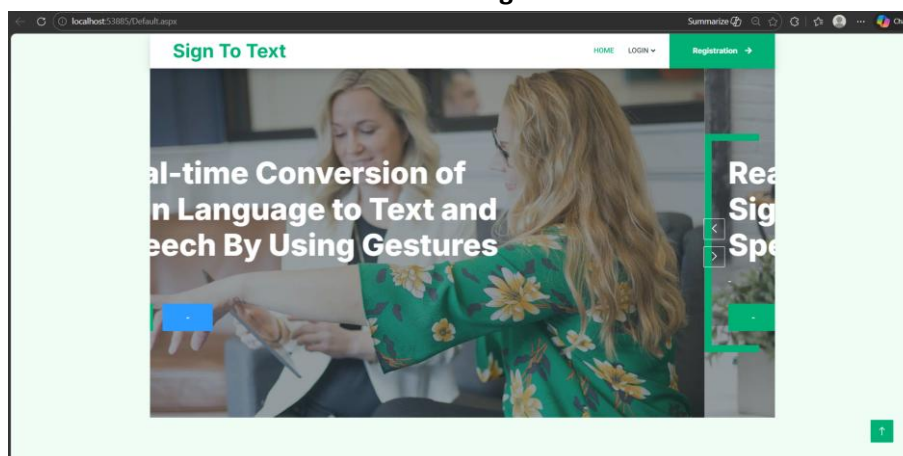
- 1. System Performance:** The system was able to accurately recognize hand gestures corresponding to 26 alphabets in real time. By capturing multiple frames (greater than 30 images) for each gesture, the accuracy of recognition was significantly improved. The use of image processing techniques such as background removal and feature extraction contributed to stable and reliable performance under normal lighting conditions.
- 2. Accuracy and Efficiency:** The gesture recognition module demonstrated good accuracy for predefined gestures when performed clearly in front of the camera. The response time of the



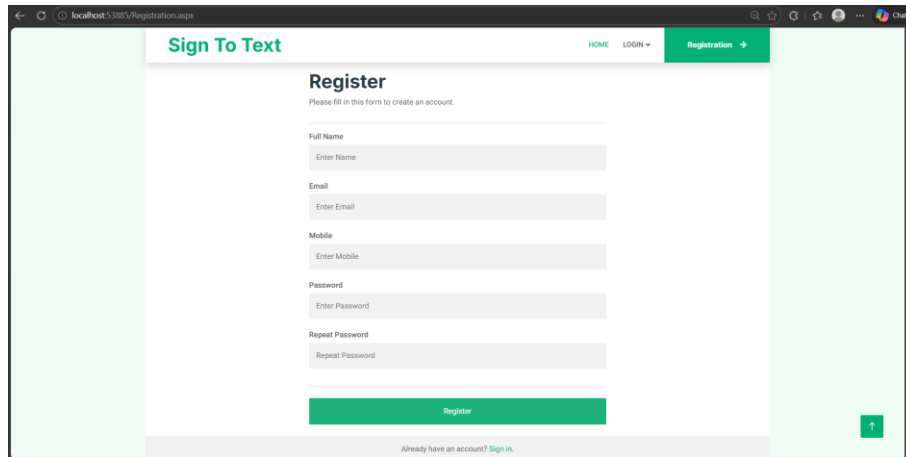
system was fast, providing near real-time conversion of gestures into text and speech. However, slight variations in hand positioning, lighting conditions, and background noise could affect accuracy.

- 3. Learning Module Effectiveness:** The inclusion of the learning module proved to be highly beneficial, especially for beginners. Users were able to understand and practice sign language through videos covering alphabets, numbers, and common phrases. This improved user interaction and made the system more comprehensive, as it supports both learning and practical usage.
- 4. User Experience:** The system was found to be user-friendly due to its simple interface and structured flow (registration → login → learning → recognition). Since it does not require specialized hardware like data gloves, it is cost-effective and accessible to a wider audience. The combination of text and audio output enhanced usability and ensured better communication.
- 5. Limitations:** Despite its effectiveness, the system has certain limitations:
 - Performance depends on proper lighting and background conditions
 - Limited to recognition of predefined gestures (A–Z)
 - Complex gestures and continuous sentence formation are not fully supported
 - Accuracy may decrease with improper hand alignment or occlusion
- 6. Discussion:** Overall, the system successfully achieves its objective of bridging the communication gap between hearing/speech-impaired individuals and normal users. The integration of real-time gesture recognition with a learning module makes it a practical and impactful solution. While there are some limitations, the system provides a strong foundation for further enhancements such as advanced machine learning models, continuous gesture recognition, and mobile-based deployment.

Home Page:

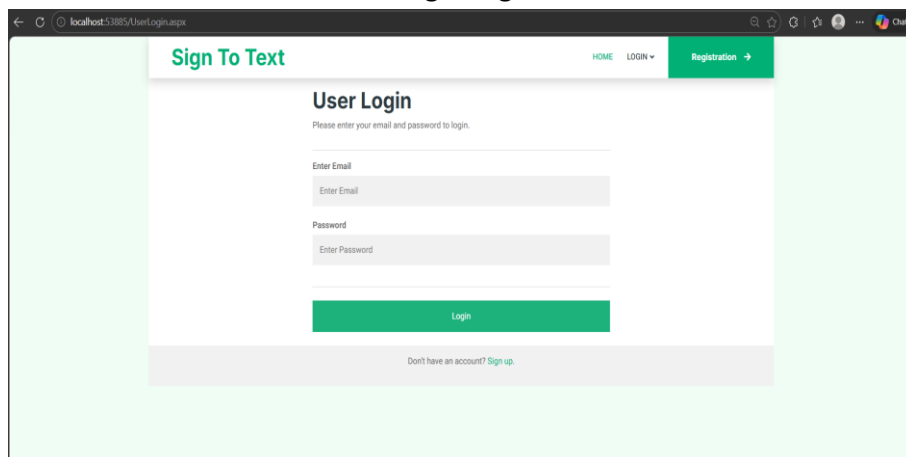


Signup Page



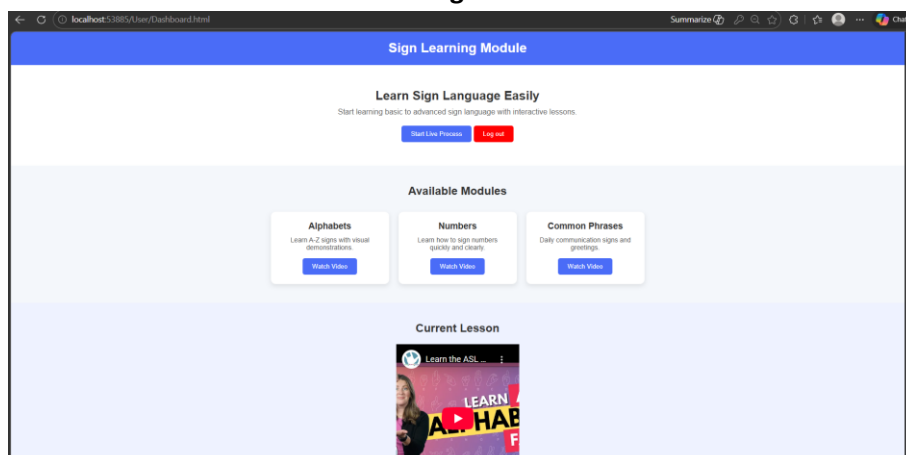
The screenshot shows a web browser window with the URL 'localhost:5385/Registration.php'. The page has a green header with 'Sign To Text' and navigation links for 'HOME', 'LOGIN', and 'Registration'. The main content is a 'Register' form with the instruction 'Please fill in this form to create an account.' The form includes input fields for 'Full Name', 'Email', 'Mobile', 'Password', and 'Repeat Password', each with a placeholder 'Enter [field name]'. A green 'Register' button is at the bottom, and a link 'Already have an account? Sign in.' is at the bottom right.

Login Page

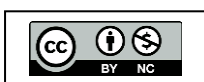


The screenshot shows a web browser window with the URL 'localhost:5385/UserLogin.php'. The page has a green header with 'Sign To Text' and navigation links for 'HOME', 'LOGIN', and 'Registration'. The main content is a 'User Login' form with the instruction 'Please enter your email and password to login.' The form includes input fields for 'Email' and 'Password', each with a placeholder 'Enter [field name]'. A green 'Login' button is at the bottom, and a link 'Don't have an account? Sign up.' is at the bottom right.

Learning Module

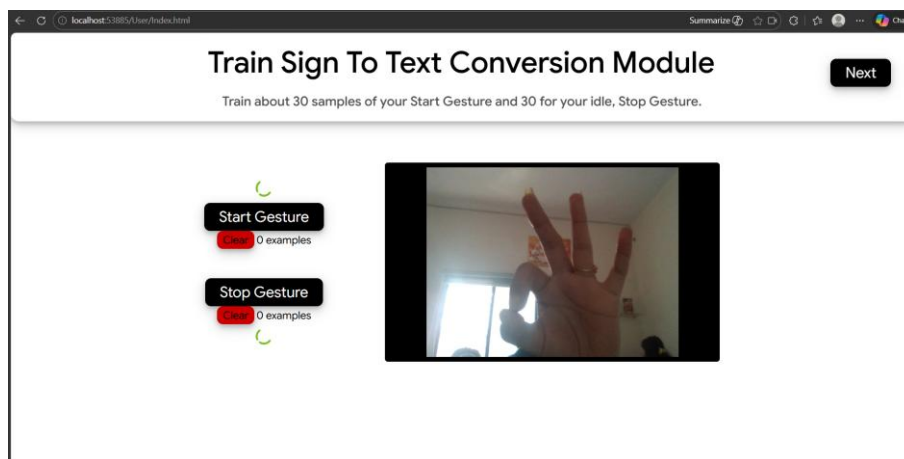


The screenshot shows a web browser window with the URL 'localhost:5385/User/Dashboard.html'. The page has a blue header with 'Sign Learning Module'. Below the header, there is a section 'Learn Sign Language Easily' with the instruction 'Start learning basic to advanced sign language with interactive lessons.' and buttons for 'Start Live Classes' and 'Log out'. The 'Available Modules' section contains three cards: 'Alphabets' (Learn A-Z signs with visual demonstrations), 'Numbers' (Learn how to sign numbers quickly and clearly), and 'Common Phrases' (Daily communication signs and greetings). Each card has a 'Watch Video' button. The 'Current Lesson' section features a video player with the title 'Learn the ASL' and a thumbnail showing a person signing.





Process Start

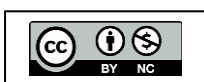


V. CONCLUSION

The proposed sign language recognition system successfully addresses the communication challenges faced by hearing and speech-impaired individuals by converting hand gestures into text and speech in real time. By utilizing a vision-based approach with a standard webcam, the system eliminates the need for expensive and specialized hardware, making it both cost-effective and easily accessible.

The integration of user registration and login ensures secure access, while the inclusion of a learning module enhances usability by helping users understand sign language through educational videos on alphabets, numbers, and common phrases. The real-time gesture recognition module, supported by image processing and computer vision techniques, effectively identifies hand gestures and provides accurate text and audio output.

Overall, the system achieves its primary objective of bridging the communication gap between deaf and non-deaf individuals. It promotes accessibility, independence, and social inclusion, improving the quality of life for hearing and speech-impaired users. Although certain limitations exist, the system provides a strong foundation for future enhancements and wider real-world applications.



**REFERENCES**

- [1] Chaithraj and Kavana H. R, "Sign Language Converter for Deaf and Dumb People in Two Way Communication for Regional Languages," Dept. of ISE, NIEIT, Mysuru, India, 2019. A vision-based system using image processing to convert sign language into text and speech for effective two-way communication.
- [2] S. Bhavsar, D. Dhondge, S. Khande, S. Zend, and M. D. Sanap, "Sign Language Learning Application for Deaf and Dumb People," International Journal of Creative Research Thoughts (IJCRT), vol. 11, no. 5, May 2023. A mobile-based application providing interactive modules and real-time feedback to enhance sign language learning and accessibility.
- [3] V. Priya A. K, J. S., S. V., S. V., and T. K., "Two Way Sign Language for Deaf and Dumb using Deep Convolution Neural Network," International Journal for Research in Applied Science & Engineering Technology (IJRASET), vol. 11, issue IV, Apr. 2023. A deep learning-based system using CNN and OpenCV for real-time two-way sign language translation.
- [4] R. V., S. M. C., T. H. C., S. C., and S. V., "Empowering Deaf and Mute Students through Multilingual Sign Language Learning," International Journal of Research Publication and Reviews (IJRPR), 2023. An AI-based multilingual system integrating CNN, LSTM, and NLP for inclusive sign language learning and communication.
- [5] Harshitha C, Sendil Vadivu D, and Narendran Rajagopalan, "A Survey on Machine and Deep Learning Approaches in Sign Language Recognition: Techniques and Future Trends," Procedia Computer Science, vol. 218, pp. 143–152, 2023.
- [6] Arun Singh, Ankita Wadhawan, Usha Mittal, Ahmed Al Ahdal, Manik Rakhra, and Shambhu Kumar Jha, "Indian Sign Language Recognition using Dynamic Signs," Journal of Ambient Intelligence and Humanized Computing, vol. 14, pp. 3351–3364, 2022.
- [7] Shashidhar R, Ankit Priyesh, Surendra R. Hegde, A. S. Manjunath, Chinmaya K, and Arunakumari B. N, "Indian Sign Language to Speech Conversion using Convolutional Neural Network," International Journal of Engineering Research & Technology (IJERT), vol. 10, no. 6, pp. 1–6, 2021.
- [8] Nidhi Chandarana, Nidhish Chhajer, Shreya Manjucha, Monica G. Tolani, Priyansi Chogale, and Mani Roja M. Edinburgh, "Indian Sign Language Recognition with Conversion to Bilingual Text and Audio," International Research Journal of Engineering and Technology (IRJET), vol. 9, no. 4, pp. 1452–1458, 2022.
- [9] Marinee Devi, Anusha, Ankitha, Ishwarya, and Kaviya, "Learning App for Deaf-Mute using Sign Language English/Gujarati Converter," International Journal of Innovative Research in Computer and Communication Engineering (IJIRCCCE), vol. 10, no. 5, pp. 2156–2163, 2022.
- [10] Soumen Das, Saroj Kr. Biswas, and Biswajit Purkayasth, "Occlusion Robust Sign Language Recognition System for ISL using CNN," IEEE Transactions on Emerging Topics in Computational Intelligence, vol. 7, no. 2, pp. 435–446, 2023.

