International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 09 Issue: 04 | April - 2025 SJIF Rating: 8.586 ISSN: 2582-3930

AI Sign Language Detection for Disabled People & Chatbot

Chaitali Mane[1], Soham Matkar[2], Vaishali Kakade[3], Vrushabh Udeg[4],Dr. Deepali Joshi

[1,2,3,4] *B.E. Students Department of Computer Science Engineering,* [5]HOD, Department of Computer Science Engineering, Bharat College of Engineering, Opp. Gajanan Maharaj Temple, Kanhor Road, Badlapur (West), Thane, Maharashtra - 421503

Abstract - *This project presents an intelligent, multi-functional system designed to empower and support individuals with disabilities, especially those with hearing or speech impairments. The solution integrates* ***real-time Sign Language Detection*** *with an AI-powered assistant to facilitate seamless communication, access to essential services, and daily digital interactions. Built using* ***HTML, CSS, JavaScript, and machine learning techniques****, this innovative platform bridges the communication gap between differently-abled users and the digital world.*

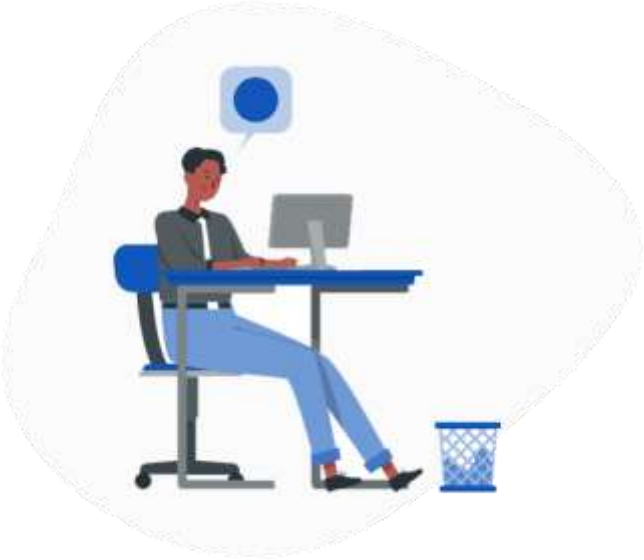
The system uses computer vision models to recognize ***sign language gestures****, particularly the English alphabet, enabling users to communicate through hand signs. The recognized signs are then translated into text or voice using* ***Text-to-Speech (TTS)*** *modules. To extend usability, this feature is integrated into a* ***user-friendly graphical interface*** *that allows users to interact with the system visually and audibly.*

A major highlight of the project is its ***Jarvis-inspired voice assistant****, which responds to the wake word "Hey Jarvis." Once activated, the assistant can perform various tasks such as* ***opening websites****,* ***fetching real-time information*** *(e.g., weather, news, etc.), and responding to queries using a* ***smart chatbot module****. The chatbot fetches accurate responses from the* ***Google Search API*** *to ensure up-to-date and contextually relevant answers.*

1. INTRODUCTION

Communication is a fundamental aspect of human interaction, yet millions of individuals across the globe face significant challenges due to speech and hearing impairments. Among the various modes of alternative communication, ***sign language*** *stands as a vital tool that allows the deaf and hard-of-hearing community to express themselves effectively. However, the barrier arises when others are not familiar with sign language, leading to a communication gap that isolates differently-abled individuals from mainstream interactions in education, healthcare, workplaces, and daily activities.*

In recent years, advances in ***Artificial Intelligence (AI)****,* ***Machine Learning (ML)****, and* ***Computer Vision*** *have opened new possibilities for assistive technologies that can detect, interpret, and translate sign language into text or speech. This project takes a step forward in that direction by introducing a* ***real-time sign language detection system*** *combined with a* ***multi-functional AI assistant*** *that aims to bridge the communication gap and enhance digital accessibility for disabled users.*



1.1 Purpose

To bridge the communication gap between the hearing/speech impaired and the general population by detecting and interpreting sign language gestures in real-time, especially focusing on the English alphabet.

To enhance user independence through a multi-functional AI assistant (Jarvis) capable of understanding voice commands, performing automated tasks, and enabling hands-free control of digital environments.

To provide an intelligent chatbot that retrieves accurate and up-to-date information from the internet using APIs, thereby helping users get real-time answers to their queries without the need for typing or complex

1.1.1 Enhancing Security:

To ensure user privacy and data protection, the system incorporates basic **authentication mechanisms** and **input validation** to prevent unauthorized access and misuse of features like messaging and voice commands. Future enhancements will include **end-to-end encryption** for communication modules and **secure API handling** to safeguard sensitive user interactions and personal data.

1.1.2 Coding Skills & Logical Thinking:

The development of this project required strong **coding skills** in HTML, CSS, JavaScript, and machine learning frameworks, along with a solid foundation in **logical thinking and problem-solving**. These skills were crucial for designing algorithms, managing real-time input/output, and integrating multiple technologies into a seamless, user-friendly system.

1.1.3 Real-Time Performance Evaluation and code Optimization:

To ensure smooth and responsive user interactions, real-time performance evaluation was conducted throughout the development process. The code was continuously optimized by minimizing computational overhead, reducing latency in gesture recognition.

1.1.4 Collaboration and Discussion forums:

A strong **community-driven approach** can significantly improve learning outcomes. The system includes a **discussion forum** where users can: 1. Share insights and alternative, 2. Discuss problem-solving strategies, 3. Seek guidance from mentors and experienced programmers.

1.1.5 Regulatory Compliance:

Different regions have laws mandating organizations to protect personal data and maintain secure communication practices. Implementing robust spam detection helps organizations comply with these regulations by preventing unauthorized access, reducing the risk of data breaches, and ensuring that communication remains secure, trustworthy, and aligned with legal requirements.

1.1.6 Reducing Legal Liabilities:

Effective spam detection helps organizations minimize legal risks associated with data breaches, phishing scams, and violations of anti-spam laws. Properly managing spam ensures compliance with regulations, enhances security, and reduces the likelihood of facing legal consequences due to unauthorized access or fraudulent communications**.**

1.2 Scope

The scope of this project encompasses the development of an assistive technology platform that combines **sign language detection**, **voice-command functionality**, and **AI-based chatbot interaction** to enhance communication and accessibility for people with disabilities. It allows real-time translation of hand gestures into text or speech, voice-activated task execution, and scheduled messaging via WhatsApp. The system is designed to support applications in areas such as **education, healthcare, online services, and daily communication**. The platform offers a **user-friendly UI** and supports multi-modal input methods including gesture, voice, and text. It also aims to ensure **data privacy and secure communication**. The modular architecture makes it highly scalable for future improvements such as support for full sign language sentences, additional language packs, IoT integration, and personalized AI behavior. This project thus lays the foundation for a more **inclusive, intelligent** etc.

Aims

1.3.1 Enhance User Experience and Learning:

The system is designed with a focus on **ease of use**, providing an intuitive interface that allows users to interact through gestures, voice, or text seamlessly. By integrating real-time feedback and multi-modal interaction, the platform encourages **self-paced learning** and improves digital confidence for users with disabilities. This enhances both the **user experience and educational value**, promoting inclusivity in tech-based environments.

1.3.2 Global Collaboration:

This project holds strong potential for global collaboration, as sign language and accessibility challenges are universal concerns.

By open-sourcing parts of the system and using widely adopted web technologies and **APIs**, developers and researchers across the world can contribute to enhancing gesture recognition, expanding language support, and improving **AI chatbot intelligence.**

It also opens doors for collaboration with non-profit organizations, accessibility advocates, and educational institutions to co-create solutions tailored to diverse user needs.

1.3.3 Improving Security and Accessibility:

The project emphasizes both **security and accessibility** by implementing input validation, secure API usage, and user-friendly UI components that support gesture and voice interaction. Future enhancements will include **authentication features**, **data encryption**, and **adaptive design** to ensure safe, seamless access for users with diverse abilities and needs.

Accessibility is enhanced through a responsive interface designed for desktops, tablets, and mobile devices.

2. LITERATURE SURVEY

Previous research has explored **sign language recognition** using computer vision and deep learning techniques, demonstrating successful gesture-to-text translation. Additionally, studies on **AI-powered virtual assistants** have shown promise in integrating voice recognition and natural language processing to enhance accessibility for users with disabilities.

2.1 Architecture of Project:

The architecture of the project is designed around a **multi-layered approach** to integrate sign language recognition, voice assistance, and real-time data processing. It consists of the following main components:

1) *User Interface*: *This is the front-end layer where users interact with the system.*
2) *Execution Engine*: A secure environment (e.g., virtual machines, containers) that runs the submitted code.
3) *Sign Language Detection Module*
4) *Voice Recognition and command processing*

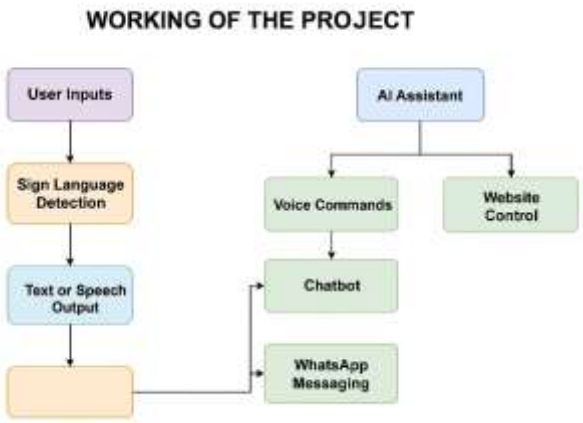


Fig. 1: AI Sign Language Detection

2.2 Security Concerns in RCE System:

Security concerns in this project include the protection of **user data**, especially during voice recognition, gesture processing, and messaging features. To mitigate risks, the system will implement **encryption**, **authentication protocols**, and **secure API handling** to safeguard sensitive information and prevent unauthorized access.

2.3 Future Direction:

Refinement of Deep Learning

Integration of Non-Manual Features

Real-Time Recognition System

Multimodal Data Analysis

3. SYSTEM ARCHITECTURE AND DESIGN

AI SLD systems generally follow a client-server architecture where users submit picture to a the model for tarning.

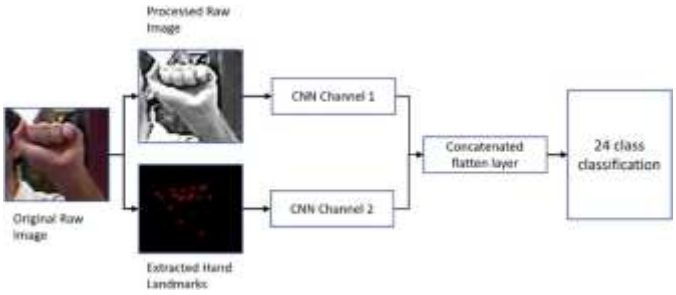


Fig. 2: AI SLDFDP

3.1 Hardware Components

Processors (CPUs):

Efficient and high-performance processors are crucial for handling complex tasks such as analyzing emails, running spam filters, processing large datasets, and ensuring accurate, real-time spam detection for improved cybersecurity.

Memory (RAM):

Maximum RAM is useful for storing and processing email data, algorithms, and filters.

Storage (Hard Disk/SSD):

High storage capacity is required to store email in databases, spam lists, and other necessary data.

Network Infrastructure:

A strong network infrastructure, including routers and switches, is essential for managing large volumes of email traffic while ensuring efficient delivery and effective filtering.

4. PROPOSED SYSTEM & IMPLEMENTATION

The investigation began by collecting data for training the CNN models. Then the data cleansing process involved using hashing to identify and remove duplicate images from the dataset which results to a clean dataset. This dataset then split into a training set and a test set. Data preprocessing techniques are applied to enhance data quality and suitability for training. Data normalization has been performed to prevent biases due to data distribution variations. The CNN model was developed using the Adam optimizer, categorical cross entropy loss function and accuracy as the assessment criteria. The model was trained with a batch size of 64 and 40 epochs, with 20% of the data used for the validation during training .After training, the model's performance has evaluated on a

separate test dataset to assess its predictive capabilities.

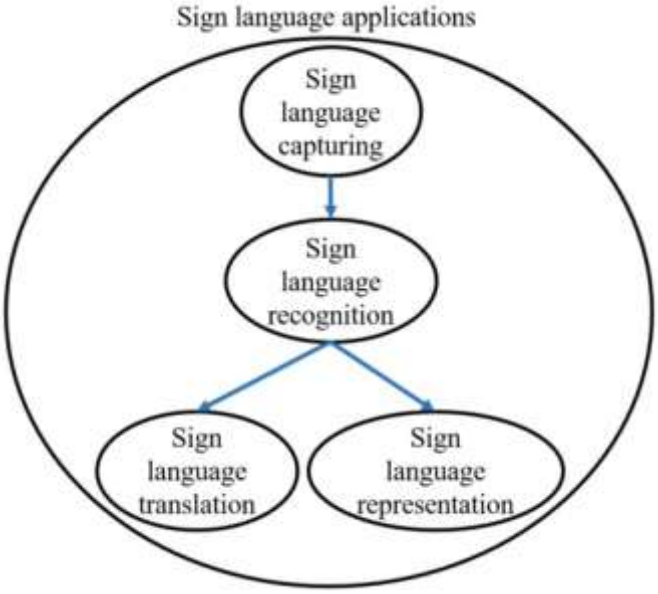


Fig. 3: Workflow

This system architecture consists of three features

- User Interface
- Sign detection
- Chatbot and voice command

4.1 User Authentication & Authorization

Fig. 4: User Authentication & Authorization

In the Ai Sign Language Detection user authentication ensures that only registered and authenticated users can

access the platform, solve problems, and save their progress. Firebase Authentication is used for handling the user sign-up, login, and session management processes.

The sign-up process allows users to create an account using their email and password through Firebase. After successful registration, additional user data (e.g., username, progress) is saved in Firestore or Realtime Database.

The login process allows existing users to authenticate themselves using their email and password. Firebase's signInWithEmailAndPassword() method is used to verify the user's credentials.

4.2 Problem Management & Code Execution

Fig. 5: Problem Management & Code Execution

This The Remote Code Execution System stores DSA problems in Firebase Firestore, where each problem includes attributes such as problem statement, input format, output format, constraints, difficulty level, and tags. Problems are categorized by difficulty to help users progressively improve their problem-solving skills. Firebase Database ensures efficient retrieval and storage of problems, allowing administrators to add, modify, or delete problems as needed. Users can browse through available problems and attempt solving them using the in-built code editor.

4.3 Result Analysis

Fig. 8: Result Analysis

The Remote Code Execution System evaluates user-submitted code by running it against predefined test cases stored in Firebase. Each problem has a set of sample test cases for basic validation and additional hidden test cases to ensure robustness. The system checks the code's output against the expected output for each test case. If all test cases pass successfully, the submission is marked as correct. Otherwise, the system identifies which test cases failed and provides detailed feedback to help the user improve their solution.

5. CONCLUSION

The successful completion of this project marks a significant step towards building an inclusive and intelligent assistant system that can enhance the lives of differently-abled individuals. By integrating sign language detection, voice command recognition, chatbot functionalities, and accessibility-focused features such as shopping, banking, and educational support, this project demonstrates the potential of combining AI and ML with assistive technologies.

Through this system, users can communicate using gestures, access essential services via voice interaction, and receive real-time information from the web. The addition of WhatsApp messaging, voice-triggered actions ("Hey Jarvis"), and gesture-based website access further adds to the usability and practicality of the application.

This project not only showcases technical competence but also aims to bridge the communication gap for individuals with disabilities, making technology more accessible.

ACKNOWLEDGEMENT

I would like to express my heartfelt gratitude to all those who supported me throughout the course of this project. It gives me immense pleasure to acknowledge the valuable guidance, encouragement, and support provided by everyone involved in making this project a success.
First and foremost, I would like to thank my project guide, **[Guide's Name]**, for their constant support, insightful suggestions, and expert guidance throughout the development of this project. Their motivation and feedback helped me stay focused and continuously improve.
I am also thankful to the **Department of Computer Science and Engineering, [Your College Name]**, for providing the necessary facilities and resources to carry out this project smoothly.
I extend my sincere thanks to all the faculty members and lab assistants who helped me directly or indirectly during the course of this project.
A special thanks to my family and friends for their unwavering support and encouragement throughout this journey.
Lastly, I would like to acknowledge all the online communities and resources that played a significant role in solving technical challenges during the development of this project.

REFERENCES

[1] • Virtual Assistant With Sign Language Authors: Not specified Publication Date: Approximately 5 months ago Summary: This article presents a technique for generating a sign language dataset using a camera and training a TensorFlow model through transfer learning to create a real-

time sign language recognition system. ResearchGate+2ResearchGate+2Financial Times+2JETIR+1ResearchGate+1

[2] • Advanced AI-Powered Voice and Display Assistant System Using IoT Authors: Not specified Publication Date: Approximately 6 months ago Summary: This paper discusses a system that employs speech-to-text and sign language recognition technologies to enable voice assistants to convert spoken language into text or visual sign language, facilitating communication for the deaf. IJCNIS

[3] • Innovative Study of an AI Voice-Based Smart Device to Assist Deaf People Authors: Not specified Publication Date: Approximately 5 months ago Summary: This research aims to develop AI voice-based smart devices that utilize current technology to assist individuals with hearing difficulties, enhancing their ability to interact and communicate effectively. ResearchGate

[4] • Artificial Intelligence Technologies for Sign Language Authors: Not specified Publication Date: Not specified Summary: This survey provides a comprehensive review of state-of-the-art methods in sign language capturing, recognition, translation, and representation, discussing their advantages, limitations, and applications. MDPI

BIOGRAPHIES

DR. Deepali Joshi
[5] HOD, Department of Computer Science Engineering, Bharat College of Engineering, Opp. Gajanan Maharaj Temple, Kanhor Road, Badlapur (West), Thane, Maharashtra - 421503

Chaitali Mane
Pursuing B.E in Computer Science from the Department of computer at Bharat College of Engineering Badlapur, Thane, Maharashtra

Soham Matkar
Pursuing B.E in Computer Science from the Department of computer at Bharat College of Engineering Badlapur, Thane, Maharashtra

Vaishali Kakade
Pursuing B.E in Computer Science from the Department of computer at Bharat College of Engineering Badlapur, Thane, Maharashtra

Vrushabh Udeg
Pursuing B.E in Computer Science from the Department of computer at Bharat College of Engineering Badlapur, Thane, Maharashtra