International Journal of Engineering Science and Advanced Technology (IJESAT)
Vol 26 Issue 03(March),2026
Received: 11-02-2026 Accepted: 20-03-2026 Published: 26-03-2026

Hand Sign Detection (ASL) Using AI and Image Processing

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Abstract: **The increasing need for accessible communication for the hearing-impaired community has led to advancements in technology, particularly in the field of Hand Sign Detection for American Sign Language (ASL). This project explores the development of an AI-driven hand sign detection system using image processing techniques in Python. By leveraging convolutional neural networks (CNNs) and machine learning algorithms, the system is capable of recognizing and interpreting ASL gestures from live video streams or static images. The model is trained on a dataset of ASL hand signs, using Python libraries such as OpenCV for image preprocessing and TensorFlow or Kera's for building and training the neural network. The system processes input images, identifies hand gestures, and maps them to their corresponding ASL letters or words, providing real-time feedback. This project aims to bridge communication gaps by offering a tool that can be used for learning ASL or assisting in daily interactions between the hearing and hearing-impaired communities. The proposed system has applications in educational tools, assistive technologies, and real-time translation services. With further training and optimization, it has the potential to improve the quality of life for individuals who rely on sign language as their primary mode of communication.**

Index Terms**: American Sign Language (ASL), Hand Sign Detection, Image Processing Convolutional Neural Networks, Machine Learning, Deep Learning, Computer Vision.**

I. INTRODUCTION

A "flag" is any change or movement of a body part, like a hand or arm, used to communicate. In sign language recognition systems, techniques from image processing and computer vision help interpret these movements accurately. Python is often used to turn the recognized signs into speech, making it possible for machines to speak what someone signs. This technology helps bridge the gap between people and machines, allowing natural interaction without physical contact or control. For individuals who are unable to hear or speak, sign language—comprising gestures and body movements—serves as a vital means of communication. When talking or writing isn't an option, sign language often becomes the main way to connect with others in this community. In daily life, many people use gestures or signs when they can't speak. But for the deaf and mute, sign 56 language is usually their main way to communicate. Sign language uses visual gestures to pass on the same meaning as spoken words. Different signs are used around the world, such as American Sign Language (ASL) and Indian Sign Language (ISL), though there are local variations. Sign language can involve one or both hands to make gestures. Sign language recognition can be broadly categorized into two types: static recognition, which identifies stationary hand gestures, and dynamic recognition, which interprets gestures involving motion over time. Isolated recognition involves identifying single signs or words. Continuous recognition involves understanding a string of signs that form full sentences. This project focuses on recognizing separate ASL signs, mainly those that stand for individual words. People find many ways to communicate, such as speaking, using hand gestures, or showing facial expressions. However, those with hearing or speech issues often depend on sign language and hand signals to communicate. Sign language is a visual system that helps them express thoughts and feelings clearly. Although it works well for its users, many people outside the deaf community might not understand it well. This can create a communication gap between hearing and non-hearing people. Sign language is an important way of talking for people who are deaf or hard of hearing. It is the sixth most 36 used languages worldwide. This method uses hand signs, facial expressions, and body movements to share ideas and emotions. Like spoken languages, different regions have their own sign languages. For example, 77 52 American Sign Language (ASL) and Indian Sign Language (ISL) are made for their specific cultures and languages. By 2005, around 62 million people in the world were deaf—about twice the population of California.

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In North America, many deaf people mainly use ASL. Some people with partial hearing loss and even some hearing individuals also use it to communicate. ASL includes hand signs, facial expressions, and body movements to send messages. It helps the deaf community talk with others who do not know sign language. But not everyone understands how to perform the signs correctly. Learning ASL takes time and practice. Some problems has been the lack of simple tools to recognize sign language easily. Recent advances in artificial intelligence and machine learning are making it possible to build systems that can spot and interpret signs. These new tools make automatic sign language recognition much more practical today. Our main focus is creating a system that can recognize hand movements and combine them to form complete 51 words. Then, it can turn those signs into spoken words. The picture below shows a few example gestures used in this process.

II. METHODLOGY

Requires a large data set for training and CNN models. Utilizes a deep learning approach with a combination of CNN and long short-term memory networks for accurate and robust hand gesture recognition. Used ORB feature extraction for efficient and accurate gesture recognition.

III. BLOCK DIAGRAMS

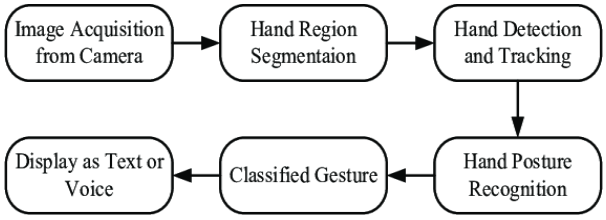

Fig 1: Converting SIGN TO TEXT/SPEECH

This diagram shows how sign language is recognized step by step.

First, the camera captures the hand image, which is then separated and tracked. Next, the system identifies the hand posture and classifies gesture. Finally, the gesture is shown as text or voice for easy understanding.

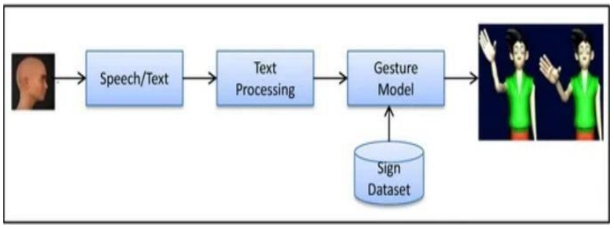

Fig 2: Converting SPEECH TO SIGN&TEXT

The system takes speech or text as input from a user. It processes the input and sends it to a trained gesture model. Using a sign language dataset, the model selects the right gestures. These gestures are then animated to visually convey the message.

IV. RESULTS & DISCUSSIONS

EXAMPLES:

- Okay
- Peace
- Thumbs up

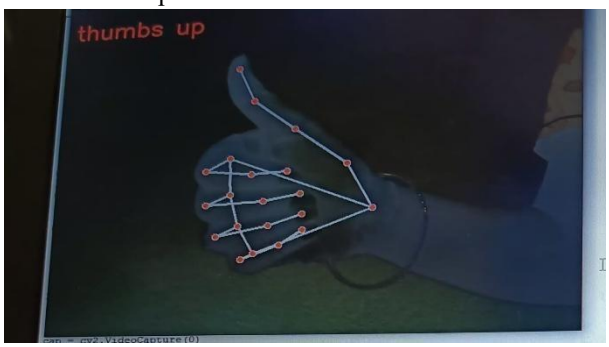

Fig 3: Result of HAND SIGN TO SPEECH/TEXT

EXAMPLES:

- Are you hungry
- do you want some water
- Be careful
- Are you bus

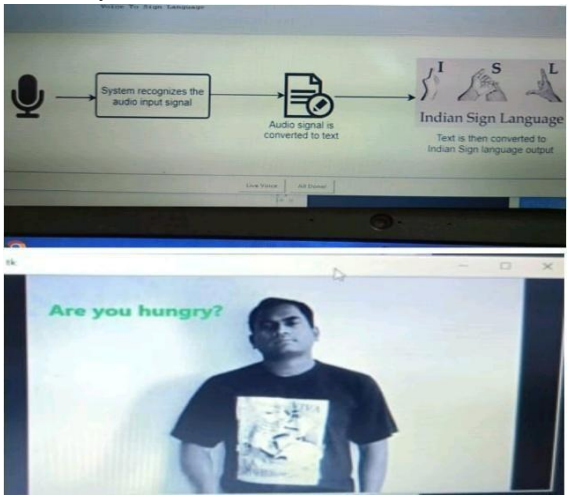

Fig 4: Result of SPEECH TO SIGN/TEXT

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V. FUTURE SCOPE

- Expand vocabulary and improve model accuracy.
- Integrate voice synthesis for spoken ASL translation.
- Use larger dataset for complex sentences recognition

VI. ADVANTAGES

Enhanced communication:

- Facilities real time communication between deaf and hearing individuals, bridging gaps in understanding and interaction.

Accessibility:

- Improve accessibility for the deaf and hard-of-hearing communities in various settings such as education, healthcare and customer service.

Automation:

- The translation process, reducing the reliance on interpreters and enabling immediate responses is conversions

VII. APPLICATIONS

- Education: ASL learning and training.
- Assitive Technology: Support for deaf and dumb communication
- Translation Services: Real-Time ASL to text Conversion

VIII. CONCLUSION

- Summary of Findings: Recap the importance of ASL recognition systems and the advancements made in the field.
- Call for Collaboration: Encourage interdisciplinary efforts to enhance the effectiveness of ASL recognition systems.
- This survey provides a foundational understanding of hand sign detection for ASL using AI and image processing. By analyzing current techniques, challenges, and trends, researchers and developers can build more effective systems that enhance communication for the deaf and hard-of-hearing community.

IX. ACKNOWLEDGMENT

R.MAHITHA, T.AKHILRAJ, SUKANYA , V .SANTOSH we acknowledge for her patience checking in Manuscript and Result Validations to G. BHARGAVI

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