IJARETY

International Journal of Advanced Research in Education and TechnologY (IJARETY)

Volume 12, Issue 3, May-June 2025

Impact Factor: 8.152

www.ijarety.in editor.ijarety@gmail.com

International Journal of Advanced Research in Education and TechnologY(IJARETY)

IJARETY 94-2975 | www.ijarety.in| | Impact Factor: 8.152| A Bi-Monthly, Double-Blind Peer Reviewed & Refereed Journal |

|| Volume 12, Issue 3, May-June 2025 ||

DOI:10.15680/IJARETY.2025.1203039

Sign Language Detector and Translator using Action Recognition with OpenCV and Deep Learning

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ABSTRACT: Hand gesture recognition is a vital component of human-computer interaction, enabling intuitive and seamless communication between users and digital systems. This project leverages OpenCV and deep learning techniques to develop a real-time gesture recognition system. The system follows a structured pipeline involving image acquisition, hand region segmentation, feature extraction, and gesture classification, with deep learning models enabling accurate recognition of predefined gestures. To enhance accessibility for sign language users, the system integrates a chatbot that converts recognized gestures into text and speech. Additionally, YOLOv8 is used for sentiment analysis, detecting facial expressions and hand cues to interpret emotional states such as happiness, sadness, or anger. The chatbot then processes this data and delivers appropriate responses, making the entire interaction more human-like and responsive.

KEYWORDS: OpenCV, Computer vision, Hand gesture recognition, Real-time processing, Deep Learning, YOLO v8, NLP.

I.INTRODUCTION

Sign language serves as a vital communication tool for individuals with hearing and speech impairments, enabling them to convey complex thoughts, emotions, and intentions through structured hand gestures, facial expressions, and body movements. However, despite its significance, there exists a communication gap between sign language users and individuals who do not understand it. This often leads to challenges in day-to-day interactions, especially in public, educational, or professional environments where interpreters may not always be available.

To overcome this barrier, a sign language detection and translation system can be developed using action recognition and deep learning techniques. The goal of such a system is to automatically recognize sign language gestures and translate them into spoken language (speech) or written text in real time, making communication more natural and inclusive. This system eliminates the dependency on human interpreters and allows for instant translation, thus promoting independence for sign language users. By translating recognized gestures into audible speech or displayed text, the system enables smoother and more intuitive interactions between sign language users and non-signers.

II.SYSTEM MODEL AND ASSUMPTIONS

The system is designed to facilitate seamless communication for individuals with hearing and speech impairments by translating sign language gestures into text and speech using computer vision, deep learning, and natural language processing. The core of the system revolves around real-time hand gesture recognition, which begins with capturing video input through a standard webcam. This input is processed through a series of stages including image preprocessing, hand region segmentation, feature extraction, and gesture classification. Convolutional Neural Networks (CNNs) or lightweight models like Mobile Net are employed to classify predefined gestures with high accuracy. Once the gesture is recognized, it is converted into text and speech. To make interactions more human-like, the system also incorporates a sentiment analysis module powered by YOLOv8, which detects emotional cues from facial expressions and gender.

The system operates under a few key assumptions to maintain reliability and accuracy. The system is trained on a predefined set of gestures, and its accuracy may be influenced by the user's gesture consistency, hand shape, and positioning. Then the chatbot then processes this data and delivers appropriate responses, making the entire interaction more human-like and responsive.

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III.EFFICIENT COMMUNICATION

Efficient communication is the cornerstone of the proposed sign language recognition system, aiming to bridge the gap between hearing-impaired individuals and those unfamiliar with sign language. This system achieves seamless interaction by recognizing hand gestures using a standard webcam and processing them through a structured pipeline involving image segmentation, feature extraction, and classification using deep learning models like Convolutional Neural Networks (CNNs) and Mobile Net. Once a gesture is accurately classified, it is translated into meaningful text and passed to a Natural Language Processing (NLP) based chatbot.

To further enhance the quality of communication, the system incorporates a sentiment analysis module using YOLOv8, which detects facial expressions and hand movements to determine the user's emotional state. Emotions such as happiness, sadness, or anger are recognized in real-time and influence the chatbot's response, making the interaction more empathetic and natural.

By combining gesture recognition, emotional analysis, and intelligent text generation, the system ensures fast, accurate, and emotionally aware communication, thus promoting inclusivity and accessibility in various social, educational, and professional settings.

IV.SECURITY

Security is a vital component of the software development process and plays a critical role in safeguarding the system against unauthorized access and data breaches. In the context of a gesture and emotion-based sign language recognition system, security ensures the confidentiality, integrity, and availability of user data and system resources.

This includes the implementation of technical methods, formal code reviews, and adherence to development standards. Moreover, security testing is conducted to verify that the system remains protected under various use conditions and can prevent exploitation of its resources.

This includes enforcing secure login mechanisms, encrypting sensitive data, monitoring access logs, and ensuring that all modules follow best practices in data handling. Through continuous monitoring, regular updates, and vulnerability assessments, the system can maintain a robust security posture, ensuring safe and trustworthy communication for users who rely on the system for sign language recognition and real-time interaction.

V. RESULT AND DISCUSSION

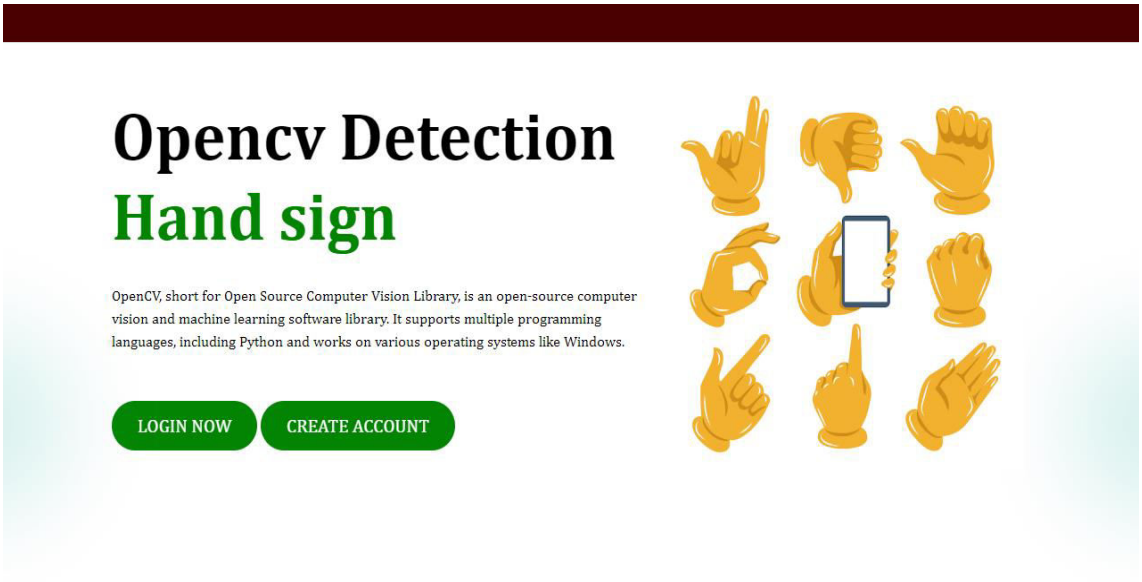

Fig.5.1 Landing page

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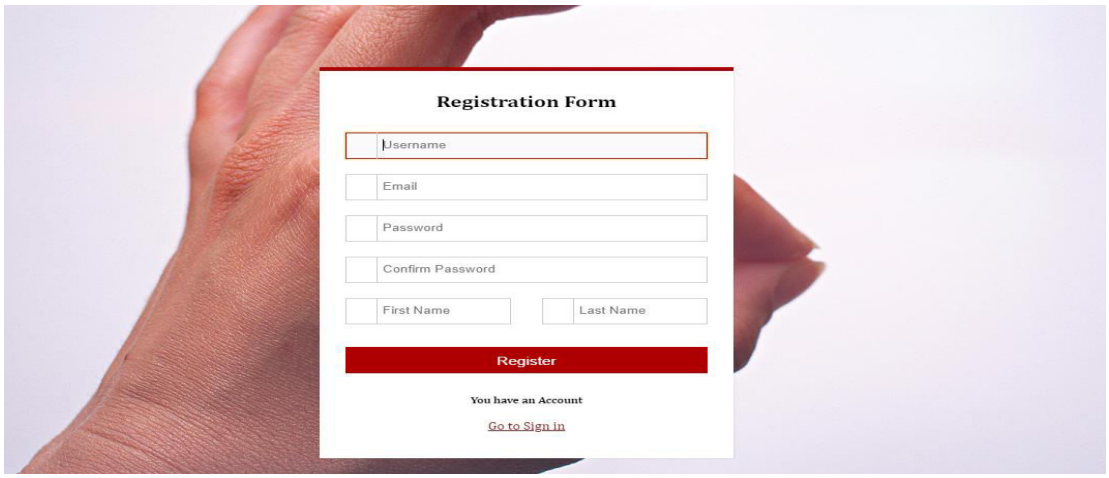

Fig.5.2 Registration page

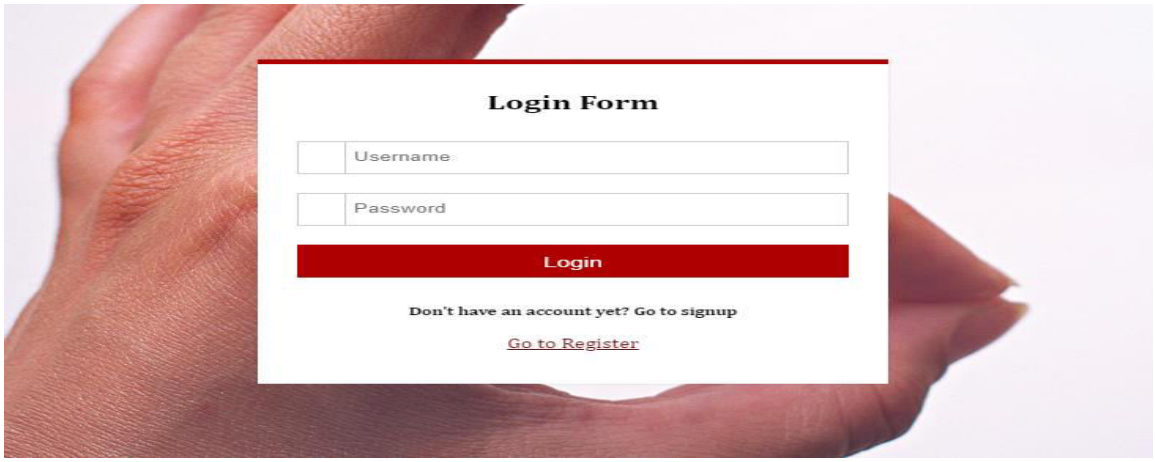

Fig.5.3 Login page

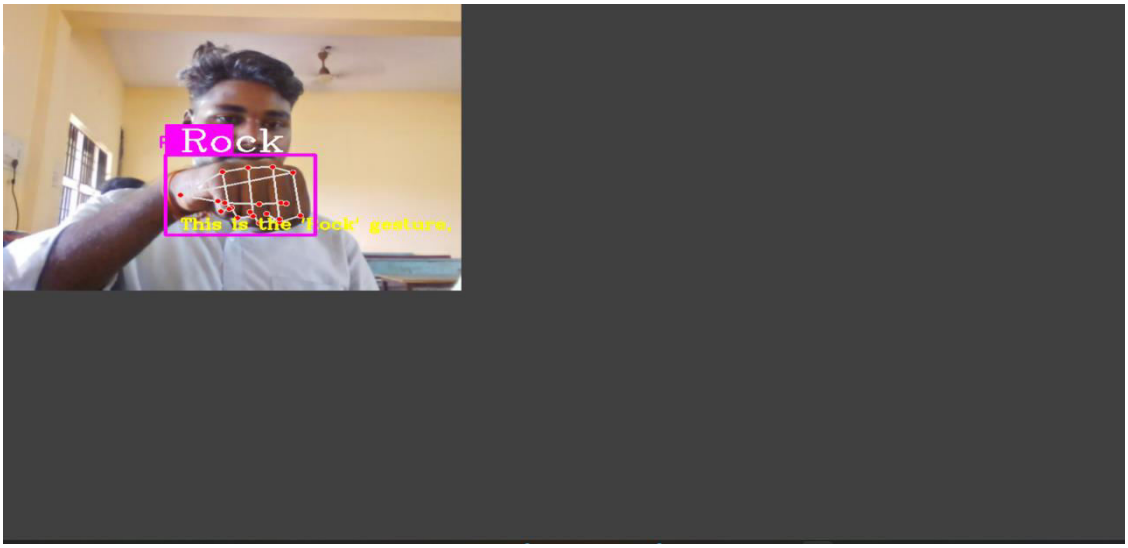

Fig.5.4 Gesture detection

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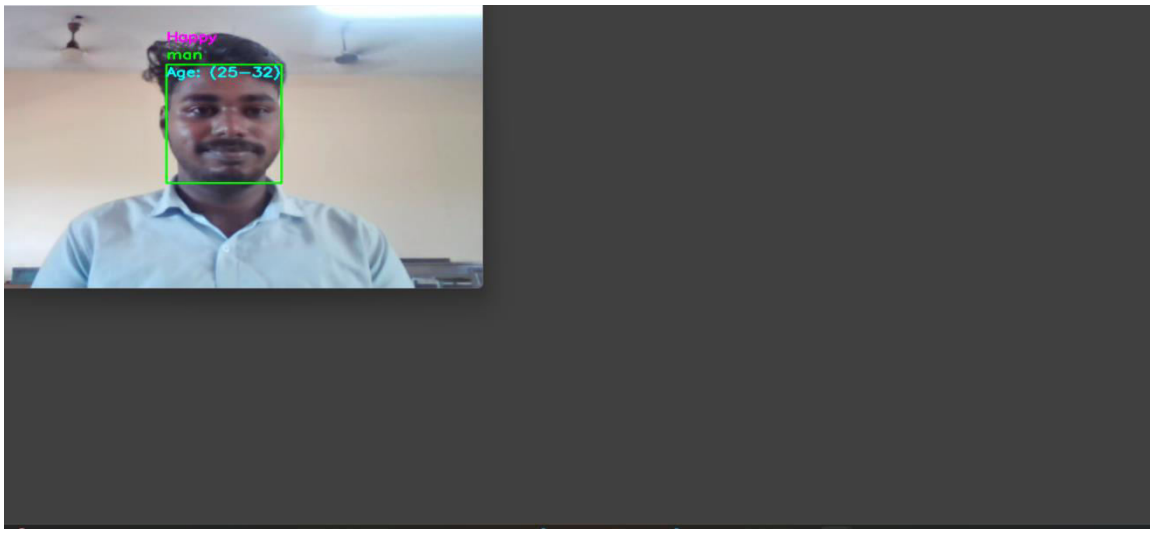

Fig.5.5 Sentiment analysis

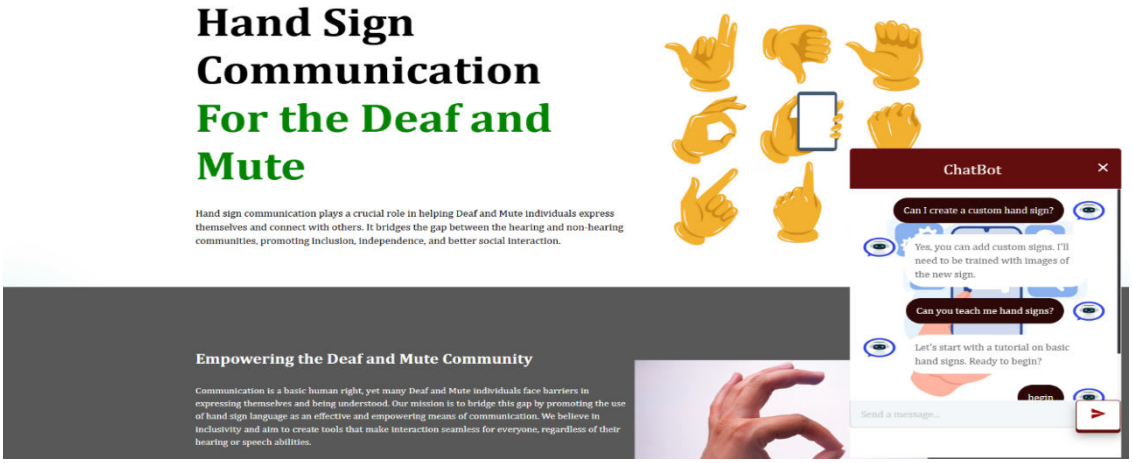

Fig.5.6 Chatbot

VI.CONCLUSION

The integration of deep learning for hand sign detection, followed by AI-powered gender, age, and emotion detection, demonstrates a robust and scalable system for real-time human-computer interaction. The use of Convolutional Neural Networks (CNNs) for accurate recognition of hand gestures ensures precise identification, while the subsequent analysis of facial attributes enhances user engagement. By connecting the model with Django, the system enables seamless deployment, making it accessible for real-world applications. This approach can be highly beneficial in areas such as assistive technologies, interactive systems, and human behavior analysis, showcasing the potential of AI-driven automation in various domains.

REFERENCES

[1] Fatma M. Najib"A multi-lingual sign language recognition system using machine learning" Multimedia Tools and Applications, Spinger ISSN: 11042-024-20165, volume –3, 2024

[2] Ahmed Kasapbasi, Ahmed Eltayeb, Ahmed Elbushr, Omar Al-Hardanee, Arif Yilmaz," DeepASLR: A CNN based human computer interface for American Sign Language recognition for hearing-impaired individuals" Computer Methods and Programs in Biomedicine, Elsevier doi.org.2021.100048 , 2021.

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[3] Mehul Singh Negi "Hand Gesture Detection using C++ and OpenCV" International Research Journal of Modernization in Engineering Technology and Science, ISSN: 2582-5208, volume-4, 2022.
[4] G. Ram Sankar, G. Ananda Kumar, R. Anurag Upadhyay, and R. Ranjith "Hand Gesture Recognition System Using OpenCV, Machine Learning" International Journal of Innovative Research in Technology, ISSN: 2349-6002, volume-10, 2024 .
[5] Fatma M. Najib" Sign language interpretation using machine learning and artificial intelligence" Neural Computing and Applications, doi.org: s00521-024-10395, volume- 9, 2024.
[6] S.Tripathi, S. Kadam, "Real-Time Gesture and Emotion Recognition Using Computer Vision and Deep Learning," International Journal of Advanced Computer Science and Applications, Vol. 13, , 2022.
[7] Camgoz, N.C.: **"**Sign language transformers: joint end-to-end sign language recognition and translation**."** In: Proceedings of the IEEE/CVF Conference on Computer Vision And Pattern Recognition, DOI:10023–10033 (2020).
[8] Premaratne, P., Nguyen, Q., Premaratne, M.: "Human computer interaction using hand gestures." Huang, D.-S., McGinnity, M., Heutte, L., Zhang, X.-P. (eds.) ICIC 2010. CCIS,vol. 93, pp. 381–386. Springer, Heidelberg (2010). https://doi.org/10.1007/978-3-642-14831-6_5112.
[9] Wozniak, M.; Wieczorek, M.; Silka, J.; Polap, D. "Body pose prediction based on motion sensor data and recurrent neural network".IEEE Trans. Ind. Inform. 2021,17, 2101–211
[10] Al-Hammadi, M.; Muhammad, G.; Abdul, W.; Alsulaiman, M.; Bencherif, M.A.; Alrayes, T.S.; Mekhtiche, M.A". Deep learning-based approach for sign language gesture recognition with efficient hand gesture representation". IEEE Access2020,8, 192527–192542
[11] Wozniak, M.; Wieczorek, M.; Silka, J.; Polap, D." Body pose prediction based on motion sensor data and recurrent neural network."IEEE Trans. Ind. Inform. 2021,17, 2101–211
[12] A. Das, S. Gawde, K. Suratwala, and D. Kalbande, "Sign Language Recognition Using Deep Learning on Custom Processed Static Gesture Images," 2018 International Conference on Smart City and Emerging Technology (ICSCET). IEEE, Jan. 2018. doi: 10.1109/icscet.2018.8537248.
[13] A.K. Sahoo, "Indian Sign Language Recognition Using Machine Learning Techniques," Macromolecular Symposia, vol. 397, no. 1. Wiley, p. 2000241, Jun. 2021. doi: 10.1002/masy.202000241.

International Journal of Advanced Research in Education and Technology

ISSN: 2394-2975 Impact Factor: 8.152

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