IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 5, Issue 4, May 2025
Impact Factor: 7.67

Gesture Language Recognition for Inclusive Communication

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Abstract: *Communication is a fundamental human need, yet the deaf and hard-of-hearing communities continue to face challenges due to the lack of widespread sign language literacy among the general population. This paper proposes a real-time gesture language recognition system aimed at reducing this communication barrier through the use of computer vision, deep learning, and Natural Language Processing (NLP). The system captures live hand gestures using a standard webcam and processes them using a Convolutional Neural Network (CNN), which has been trained to recognize a wide variety of static and dynamic hand gestures representing sign language. Once recognized, these gestures are translated into meaningful outputs such as readable text and audible speech, thus enabling effective one-way communication from the deaf to the hearing individuals. To further enhance inclusivity and allow for two-way interaction, the system also integrates a speech-to-text module that converts spoken words into text, making them accessible to deaf users. This multimodal communication approach—gesture-to-text, gesture-to-speech, and speech-to-text—ensures a seamless and real-time interaction environment that supports inclusivity in daily life scenarios such as classrooms, hospitals, workplaces, and public services. The proposed system is designed to be user-friendly, cost-effective, and hardware-independent, requiring only a basic webcam and standard computing hardware. The model achieves high accuracy, precision, and real-time responsiveness, with experimental results indicating over 91% classification accuracy across multiple gesture classes. By leveraging deep learning and NLP, the system intelligently understands and delivers grammatically correct outputs, ensuring natural and coherent communication. This research contributes significantly to the field of inclusive technology, offering a practical, scalable, and efficient solution for gesture-based communication. Future enhancements such as support for regional sign languages, mobile deployment, and facial expression recognition can further expand the impact of this system and make it an essential tool for accessible human-computer interaction.*

Keywords: Sign Language Recognition, Gesture Recognition, Convolutional Neural Network (CNN), Speech-to-Text, NLP, Inclusive Communication, Real-Time System, Deaf Accessibility, Human-Computer Interaction, Deep Learning

DOI: 10.48175/IJARSCT-26477