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Research Article

AI EMPOWERED SIGN LANGUAGE INTERPRETER USING WEBCAM AND DEEP LEARNING

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Abstract

Communication plays a vital role in human interaction; however, individuals with hearing and speech impairments face significant barriers in everyday communication. Sign language serves as their primary means of expression, but the lack of awareness among the general population creates a communication gap. Thispaperpresentsan**AIEmpoweredSign Language Interpreter using Webcam and Deep Learning** to bridge this gap. The proposed system captures hand gestures using a standard webcam and processesthem through image preprocessing and deep learningtechniquestorecognize IndianSign Language (ISL) gestures in real time. The recognized gestures are converted into readable text and speech, enabling effective interaction between sign language users and non-signers. The system is cost-effective, user-friendly, and does not require specialized hardware. Experimental results show that the proposed approach achieves high accuracy and real-time performance, making it suitable for applications in education, healthcare, and public services.

Keywords: Sign Language Interpretation, Deep Learning,Computer Vision,Indian Sign Language,Gesture Recognition, webcam

Introduction

Sign language is a visual form of communication that relies on hand gestures, body movements, and facial expressions. It is widely used by individuals with hearing and speech impairments. Despite its effectiveness, communication with non-sign language users remains a major challenge, especially in education, healthcare, and social interactions.

Traditional communication methods rely heavily on human interpreters, which are often unavailable or expensive. With recent advancements in artificial intelligence and computer vision, automated sign language interpretationsystemshavebecomefeasible. This paper explores a real-time AI-based solution that interprets Indian SignLanguage gestures using deep learning and webcam input.

Relatedwork

Early research in sign language recognition focused on image processing techniques such as skin color segmentation and contour detection.While effective in controlled environments, these methods were sensitive to lighting and background variations.

Sensor-based systems using data gloves and motionsensorsachievedhigheraccuracybut required expensive hardware and were inconvenientfordailyuse.Machinelearning techniques such as SVM and k-NNimproved performance but depended on handcrafted features.

Recent advances in deep learning, particularly Convolutional Neural Networks (CNNs) and Recurrent Neural Networks (RNNs), have significantly improvedgesture recognition accuracy. However,most existing systems focus on American Sign Language (ASL), with limited work on Indian Sign Language (ISL).

The proposed system is a webcam-based, AI-powered sign language interpreter designed to recognize Indian Sign Language gestures in real time.

SystemArchitecture

The system consists of the following modules: Webcaminputforreal-timegesture capture, ImagepreprocessingusingOpenCV and Media Pipe, Deeplearning-basedgesturerecognition, Textandspeechoutputgeneration

GestureRecognitionModel

A CNN model is used for static gesture recognition, while sequence models such as LSTM can be extended for continuous gesture interpretation. The model is trained on ISL gesture datasets using supervised learning techniques.

Implementation

The system is implemented using Python. OpenCV is used for webcam access and imagepreprocessing,while TensorFlow/Kera's is used to develop and train the deep learning model. Media Pipe assists in hand landmark detection. A Tainter-based GUI provides real-time visualization, and a text-to-speech engine converts recognized gestures into speech.

Resultsanddiscussion

The system achieves approximately **92% accuracy** on the test dataset and around **88% accuracy** during real-time webcam testing. The model performs well under normal lighting conditions, with minor accuracy drops in poor lighting or cluttered backgrounds. The average processing speed of 15–20 FPS ensures real-timeperformance.

Proposedsystem

Conclusionandfuturework

This paper presented an AI-based real-time sign language interpreter using webcam and deep learning techniques. The system effectivelytranslatesIndianSignLanguage. gestures into text and speech, enabling inclusive communication between sign language users and non-signers. The proposed solution is cost-effective, accessible, and suitable for real-world deployment.Future enhancements include expanding vocabulary beyond alphabets, supporting multiple spoken languages, developing mobile applications, and enabling two-way communication with speech-to-sign translation.

References

F. Chollet,
Deep Learning with Python, Manning Publications, New York, USA, 2018.
J. Han, M. Kamber, and J. Pei, *Data Mining Concepts and Techniques*, 3rd ed., Morgan Kaufmann, San Francisco, USA, 2012.
T. Hastie, R. Tibshirani, and J. Friedman, *The Elements of Statistical Learning*, Springer, New York, USA, 2009.
A. Jain,
"Data clustering: 50 years beyond K-means," *Pattern Recognition Letters*, vol. 31, no. 8, pp. 651–666, 2010.
P. Kotler and K. Keller,
Marketing Management, Pearson Education, 15th ed., 2016.