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Kannada Sign Language Detection using Artificial Intelligence

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Abstract: *Communication barriers faced by hearing- and speech-impaired individuals make sign language recognition an important area of research. Kannada Sign Language, being region-specific, has limited technological support compared to other widely used sign languages. This paper presents an artificial intelligence–based system for the discovery and recognition of Kannada Sign Language gestures with computer vision and deep learning techniques. The proposed system captures hand gesture images through a camera and processes them using image preprocessing methods such as resizing and normalization. A convolutional neural network (CNN) model is employed to extract significant features and accurately classify the gestures corresponding to Kannada alphabets. The system is trained on a custom dataset containing various hand gesture samples under different conditions to improve robustness and accuracy. Experimental results demonstrate that the proposed model achieves reliable performance in recognizing Kannada sign gestures, thereby enabling effective communication assistance. This work aims to bridge the communication gap between the hearing-impaired community and the general public, and it can be further extended to real-time translation and sentence-level recognition in the future.*

Keywords: Kannada Sign Language, Artificial Intelligence, Deep Learning, Convolutional Neural Network, Computer Vision

I. INTRODUCTION

Sign language serves as a primary means of communication for hearing- and speech-impaired individuals, enabling them to express thoughts and emotions through structured hand gestures and movements. However, communication between sign language users and the general public remains a significant challenge due to the lack of widespread understanding of sign languages. This communication gap often restricts social interaction, education, and access to essential services for differently abled individuals.

In India, regional sign languages play an important role, and Kannada Sign Language is widely used by the hearing-impaired community in Karnataka. Despite its importance, limited research and technological solutions are available for Kannada Sign Language recognition when compared to more commonly studied sign languages such as American Sign Language. Variations in hand shapes, orientations, lighting conditions, and background complexity further increase the difficulty of accurate sign detection and recognition.

Recent advancements in artificial intelligence, particularly in the fields of computer vision and deep learning, have shown promising results in gesture and pattern recognition tasks. Convolutional Neural Networks (CNNs) have demonstrated strong capability in extracting meaningful features from images, making them suitable for sign language recognition applications. By leveraging these techniques, it is possible to develop intelligent systems that can automatically recognize hand gestures with improved accuracy and reliability.

This paper proposes an artificial intelligence–based approach for detecting and recognizing Kannada Sign Language gestures using image processing and deep learning techniques. The system captures hand gesture images, preprocesses them to enhance relevant features, and employs a CNN model to classify gestures corresponding to Kannada alphabets. The proposed solution aims to assist in bridging the communication gap between hearing-impaired individuals and society, while also providing a foundation for future real-time and sentence-level sign language translation systems.

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II. PROBLEM STATEMENT

Communication between hearing- and speech-impaired individuals and the general public is limited due to the lack of automated tools that support regional sign languages such as Kannada Sign Language (KSL). Most existing sign language recognition systems focus on international signs and do not effectively handle region-specific gestures or real-time usage. The absence of trained interpreters further increases the communication gap in everyday scenarios. Hence, there is a need for an AI-based Kannada Sign Language recognition system that can accurately detect and classify hand gestures in real time, improving accessibility and communication for the hearing- and speech-impaired community.

III. METHODOLOGY

The proposed system is designed to detect and recognize Kannada Sign Language gestures using artificial intelligence and deep learning techniques. The overall methodology involves data acquisition, image preprocessing, feature extraction, gesture classification, and output generation. The workflow of the system is illustrated through a structured sequence to ensure accurate and efficient sign recognition.

A. Data Collection

A custom dataset of Kannada Sign Language hand gestures was created for training and testing the proposed model. The dataset consists of images corresponding to different Kannada alphabets captured using a standard camera. To improve the robustness of the system, gesture images were collected under varying lighting conditions and backgrounds. Multiple samples were recorded for each gesture to ensure diversity and reduce overfitting during training.

B. Image Preprocessing

Image preprocessing is an essential step to enhance the quality of input images and remove unnecessary variations. The captured images are resized to a fixed dimension to maintain uniformity across the dataset. Noise reduction techniques are applied to minimize background disturbances. Additionally, image normalization is performed to scale pixel values, which helps in faster convergence of the deep learning model and improves classification accuracy.

C. Feature Extraction Using CNN

Convolutional Neural Networks (CNNs) are employed for automatic feature extraction and classification of hand gestures. The CNN architecture consists of multiple convolutional layers followed by pooling layers, which extract spatial features such as edges, shapes, and patterns from gesture images. These layers are followed by fully connected layers that interpret the extracted features and perform gesture classification. The use of CNN eliminates the need for manual feature engineering and improves recognition performance.

D. Gesture Classification

The extracted features are passed through the classification layer of the CNN, where each input image is categorized into its corresponding Kannada sign class. The model is trained using labeled gesture images and optimized using appropriate loss functions and optimization techniques. During testing, the trained model predicts the gesture class for unseen images based on learned feature representations.

E. System Output

The final output of the system is the recognized Kannada sign corresponding to the input hand gesture. The system displays the predicted alphabet, enabling effective communication assistance for hearing- and speech-impaired individuals. The proposed methodology can be extended to real-time applications and integrated with text or speech generation modules in the future.

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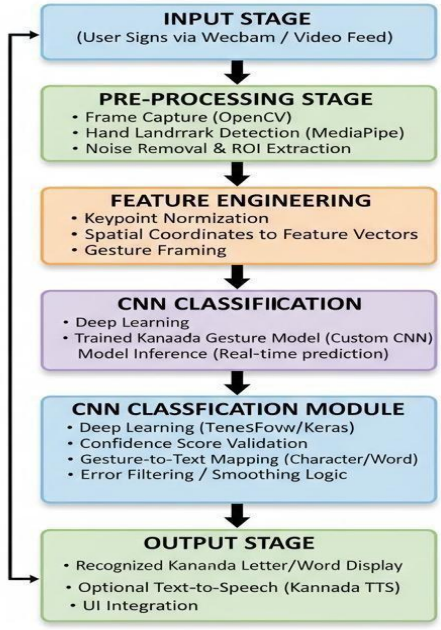

Fig. 1. System Architecture of the proposed system

IV. RESULTS AND DISCUSSION

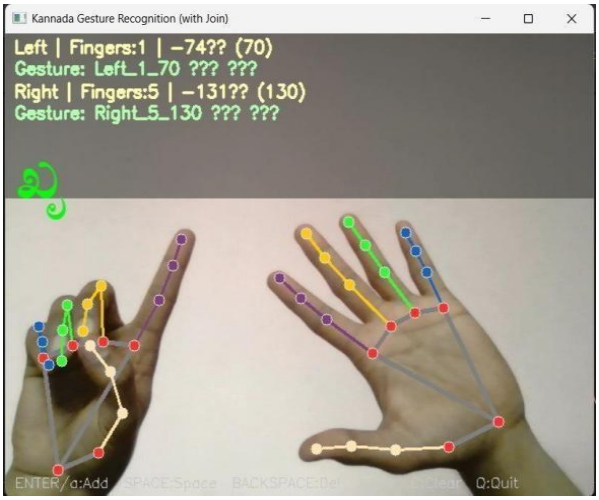

Fig. 2. Sample Input gesture and corresponding recognition output

The performance of the proposed Kannada Sign Language recognition system was evaluated using the custom dataset collected during the project implementation. The dataset was divided into training and testing sets to assess the effectiveness of the CNN-based model. The training process enabled the model to learn distinctive features of different Kannada hand gestures through multiple convolution and pooling layers.

The experimental results demonstrate that the proposed system is capable of accurately recognizing Kannada sign gestures under controlled conditions. Image preprocessing techniques such as resizing and normalization played a significant role in improving the consistency of input data, which contributed to better classification performance. The CNN model effectively extracted spatial features from gesture images, allowing accurate differentiation between similar hand shapes.

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During testing, the system successfully classified most of the input gestures corresponding to Kannada alphabets. Minor misclassifications were observed in cases where gestures had similar visual patterns or when lighting conditions varied significantly. However, overall performance remained satisfactory, indicating the robustness of the proposed approach.
The results confirm that deep learning–based methods are suitable for Kannada Sign Language recognition. Compared to traditional machine learning approaches, the CNN-based system reduces the dependency on manual feature extraction and improves recognition accuracy. The obtained results validate the effectiveness of the proposed methodology and highlight its potential for real-time communication assistance applications.

V. CONCLUSION

This paper presented an artificial intelligence–based approach for the detection and recognition of Kannada Sign Language gestures using deep learning techniques. The proposed system utilized image preprocessing methods and a Convolutional Neural Network (CNN) model to effectively extract features and classify hand gestures corresponding to Kannada alphabets. By training the model on a custom dataset, the system demonstrated reliable performance in recognizing sign gestures under controlled conditions.
The experimental results indicate that deep learning methods, particularly CNNs, are well suited for sign language recognition tasks due to their ability to automatically learn discriminative features from gesture images. The proposed approach reduces the dependency on manual feature extraction and improves recognition accuracy compared to traditional methods. This system can serve as a useful communication aid for hearing- and speech-impaired individuals by bridging the interaction gap with the general public.
In the future, the proposed system can be extended to support real-time gesture recognition, sentence-level translation, and integration with speech synthesis modules. Further improvements can also be achieved by increasing the dataset size, incorporating dynamic gestures, and deploying the system on mobile or embedded platforms to enhance accessibility and usability.

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