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Sign Language Recognition Using Deep Learning

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ABSTRACT: -

Hand gestures are an essential component of sign language, a form of non-verbal communication primarily used by individuals who are deaf or have speech impairments. Sign language enables them to communicate effectively with others who share the same language. While various sign language systems have been developed by different communities worldwide, some challenges remain in terms of adaptability and cost-effectiveness for end users. To address these challenges, a software prototype has been developed to automatically recognize sign language. This system aims to assist deaf and speech-impaired individuals in interacting more successfully with each other and with the broader population. Often, individuals who are not familiar with sign language find it difficult to communicate with speech-impaired individuals, leading to limited social interaction for the latter. While visual communication or the presence of an interpreter can be used, these options are not always practical or readily available. Sign language serves as the primary mode of communication within the deaf and speech-impaired community. However, the complex syntax and numerous gestures that constitute sign language make it challenging for the average person to understand its meaning and structure. Consequently, individuals who rely on sign language often rely on their families and the deaf community for communication.

By leveraging technology to automatically recognize sign language, the software prototype aims to bridge the communication gap and provide a more accessible means of interaction for speech-impaired individuals. It offers a promising solution that can enhance inclusivity and facilitate better communication between speech-impaired individuals and the wider society.

Key Words— ***Hand gesture, Sign language, Communication , OpenCV, ANN, .LSTM***

I. Introduction

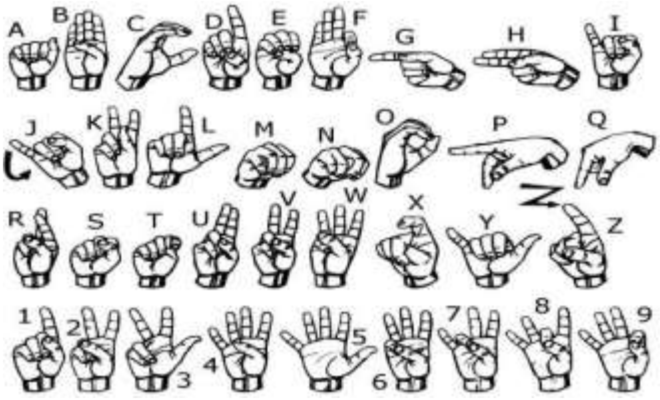
Sign language utilizes various visual means of communication, including facial expressions, hand gestures, and body movements, to convey meaning. It serves as an invaluable tool for individuals who have difficulties with hearing or speaking. The recognition of sign language involves translating these gestures into words or alphabets of spoken languages that already exist. By employing algorithms or models to convert sign language into words, the communication gap between individuals with hearing or speech disabilities and the rest of society can be narrowed. Researchers in computer vision and machine learning are currently engaged in extensive research on image-based hand gesture identification. The goal is to create simpler and more natural human-computer interaction (HCI) without the need for additional devices. This area of research has gained significant attention, as it has the potential to revolutionize how people interact with computers and technology. For this purpose, vision-based hand gesture interfaces require fast and highly accurate hand detection, as well as real-time gesture recognition. Sign language recognition, which is used by the deaf community, is a particularly powerful form of human communication with numerous potential applications.

By advancing the field of sign language recognition, researchers aim to create systems that can understand and interpret sign language, thereby enabling seamless communication between individuals who use sign language and the wider society. The main objective is to develop systems that can recognize specific gestures and utilize them to transmit information or control devices. It's important to note that hand postures represent the static structure of the hand, while gestures involve dynamic movements of the hand, requiring spatial and temporal description. Two main methods are commonly used for hand gesture recognition: vision-based methods and data glove methods. In the context of sign language recognition, the focus is on developing a vision-based system capable of real-time recognition. Vision-based approaches are preferred as they provide a more intuitive and natural form of communication between humans and machines. The human hand is a significant tool for communication in daily life, and advancements in image and video processing techniques have contributed to the progress in this field. Sign language is considered the most natural form of communication for individuals who are deaf, but they often face challenges when interacting with those who can hear. Sign languages have vocabularies of signs, similar to spoken languages' vocabulary of words. However, it's important to note that sign language grammar can vary from country to country and lacks standardization or uniformity.

OBJECTIVES

The objectives of the Sign Language Recognition Prototype are as follows:

1. To evaluate the feasibility of a vision-based system for real-time sign language recognition using the American Sign Language alphabet shown in Figure 1.



2. To assess and select hand traits that can be effectively applied in real-time sign language recognition systems using machine learning algorithms.

The adopted approach for the prototype is based on the following assumptions and constraints:

1 The system uses a single camera and relies on the input captured from that camera.

2 The user needs to be within a predefined perimeter area and positioned in front of the camera for optimal recognition.

3 The user must be within a specified distance range to account for camera limitations and ensure accurate hand pose detection.

4 Hand poses are defined with bare hands and should not be occluded by any other objects.

5 The system is designed for indoor use as the selected camera may not perform well under direct sunlight conditions.

These objectives and assumptions provide a foundation for developing and evaluating the Sign Language Recognition Prototype, focusing on real-time recognition of sign language using computer vision techniques and machine learning algorithms..

Data Acquisition, Pre-processing, and Feature Extraction Module:

This module is responsible for capturing the data from the input source, performing necessary pre-processing steps, and extracting relevant features from the acquired data. It involves the following steps:

Data Acquisition: The system collects input data, which may include video footage or images of hand gestures performed in sign language. This data is obtained through the camera or input device.

Pre-processing: The acquired data undergoes pre-processing techniques to enhance the quality and remove any noise or unwanted artifacts. This may involve procedures such as noise reduction, image enhancement, or background removal to isolate the hand region.

Feature Extraction: Relevant features are extracted from the pre-processed data to represent the hand gestures effectively. These features could include hand shape, finger positions, motion trajectories, or any other discriminative characteristics that can help distinguish different sign language gestures.

Sign Language Gesture Classification Module:

This module focuses on the classification of the extracted features into specific sign language gestures. It employs machine learning algorithms or pattern recognition techniques to recognize and classify the gestures based on the extracted features.

Training: A training phase is conducted using a dataset that includes pre-labeled examples of sign language gestures. The machine learning algorithm learns from this training data to recognize the patterns and associations between the extracted features and corresponding gestures.

Classification: Once the training is complete, the system can classify unseen or real-time input data into different sign language gestures. The learned model or algorithm is applied to the extracted features to determine the most probable gesture or a set of potential gestures.

By combining the data acquisition, pre-processing, feature extraction, and gesture classification modules, the proposed system architecture aims to enable real-time recognition and classification of sign language gestures. It allows for the translation of hand gestures into corresponding textual or spoken language, facilitating effective communication between individuals using sign language and others who may not be familiar with it.

3. Literature Survey :

The existing research in the field of sign language recognition has predominantly focused on glove-based technology. Glove-based systems involve attaching sensors, such as potentiometers and accelerometers, to each finger to capture hand movements and gestures. Christopher Lee and Yangsheng Xu developed a gesture recognition system based on gloves that can recognize 14 letters of the alphabet. Their system is capable of learning new gestures and updating the recognition system in real-time. Over the years, advanced gloves such as Sayre Gloves, Dexterous Hand Master, and Power Gloves have been developed. However, one of the main challenges with glove-based systems is the need to recalibrate the finger positions for each new user before accurate recognition can be achieved. In contrast, the proposed project implements sign language recognition using image processing techniques. This approach offers several advantages, including the ability to work with various backgrounds without the need for a specific black background. The system also eliminates the need for glove installation, enhancing convenience and usability. The project emphasizes the use of biometrics for identification and security purposes. Biometrics can be broadly categorized into physiological and behavioral characteristics. Physiological biometrics encompass physical traits like iris patterns, palm prints,

Deaf Mute Communication Interpreter [1]: In summary, the literature survey highlights the prevalence of glove-based technology in sign language recognition research. However, the proposed project offers advantages in terms of image processing, versatility with backgrounds, and eliminating the need for glove installation. The survey also covers different communication methodologies used by deaf-mute individuals, focusing on wearable devices and online learning systems. The three mentioned methods (glove-based systems, keypad methods, and Handicom touch-screen systems) utilize various sensors, including accelerometers, micro-controllers, text-to-speech conversion modules, keypads, and touch-screens. However, the need for an external device can be eliminated by using the second method, the online learning system. This system encompasses different methods such as the SLIM module, TESSA, Wi-See Technology, SWI_PELE System, and WebSign Technology, which enable real-time sign language recognition and communication without the need for additional devices.

An Efficient Framework for Indian Sign Language Recognition Using Wavelet Transform [2]: The proposed ISLR system consists of two modules: feature extraction and classification. It utilizes Discrete Wavelet Transform (DWT) for feature extraction and a nearest neighbor classifier for sign language recognition. Experimental results demonstrate a high classification accuracy of 99.23% using the cosine distance classifier.

Hand Gesture Recognition Using PCA [3]**:** (Mandeep Kaur Ahuja, Dr. Amardeep Singh)The authors propose a database-driven hand gesture recognition system for applications in human robotics and similar domains. The system utilizes a skin color model approach and thresholding in the YCbCr color space to segment the hand region. The foreground and background are separated using thresholding. Recognition is achieved through a template-based matching technique incorporating Principal Component Analysis (PCA). This approach proves effective in recognizing hand gestures and can be applied in various applications.

Hand Gesture Recognition System For the Dumb People [4]**:** The authors introduce a hand gesture recognition system based on digital image processing. Their approach focuses on static hand gestures and employs the Scale-Invariant Feature Transform (SIFT) algorithm to extract the hand gesture feature vector. Specifically, the SIFT features are computed at the edges, providing invariance to scaling, rotation, and the presence of noise. This methodology enables robust recognition of static hand gestures for effective communication.

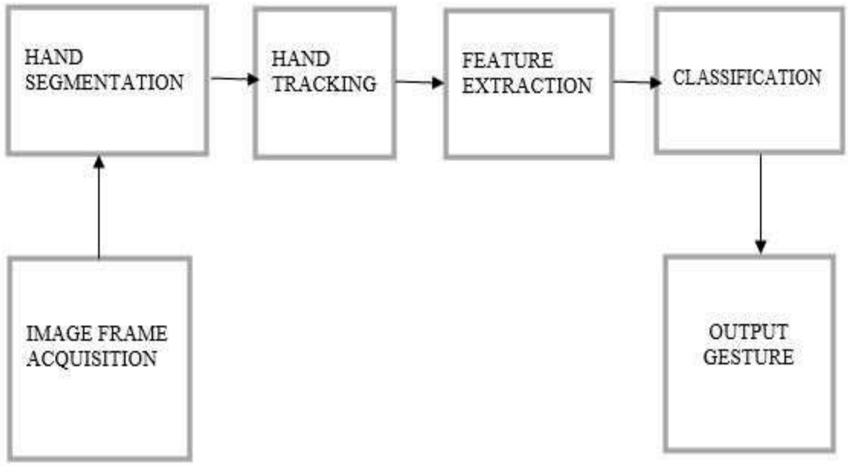
An Automated System for Indian Sign Language Recognition [5]: This paper presents a method for automatic sign recognition based on shape-based features. The hand region is segmented using Otsu's thresholding algorithm, which optimizes the threshold to minimize within-class variance. Hu's invariant moments are calculated as features for the segmented hand region and fed to an Artificial Neural Network for classification. The system's performance is evaluated based on Accuracy, Sensitivity, and Specificity.

Hand Gesture Recognition for Sign Language Recognition [6]**:** The authors discuss different methods of hand gesture and sign language recognition previously proposed by researchers. They highlight that sign language serves as the primary means of communication for deaf and dumb individuals, allowing them to express their emotions and thoughts to others despite their physical impairments.

Real-Time Detection and Recognition of Indian and American Sign Language Using Model Training [7]**:** this paper presents a real-time system for the detection and recognition of ISL and ASL gestures using model training approaches. The system demonstrates high accuracy and efficiency in recognizing hand gestures, making it suitable for various applications involving sign language communication. The proposed methodology can be further enhanced and extended to support additional sign languages and gestures, contributing to improved accessibility and inclusivity for individuals with hearing impairments.

IV.METHODOLOGY

The proposed system is a vision-based approach where sign language gestures are represented using bare hands, eliminating the need for artificial devices for interaction.



A. DATASET GENERATION

To create a proper database for sign language gestures, the following steps were followed using the OpenCV library:

1.Image Capture: Around 800 training images and 200 testing images were captured for each symbol in American Sign Language (ASL). Frames were captured using the webcam.

2.Region of Interest (ROI): A region of interest was defined in each frame, represented by a blue bounded square, to extract the relevant area for gesture recognition.

3.Conversion: The ROI was converted from RGB to grayscale to simplify processing.

4.Gaussian Blur: A Gaussian blur filter was applied to the grayscale image to enhance feature extraction.

By following these steps, a dataset was created with captured and preprocessed images for training and testing purposes in sign language recognition

B. GESTURE CLASSIFICATION

Our approach for this project involves two algorithm layers to predict the user's intended symbol:

Algorithm Layer 1:

We have studied with 600 alphabetic and arithmetic images for creating dataset.

Algorithm Layer 2:

We identify different sets of symbols that produce similar detection results. Classifiers specific to each symbol set are used to classify and distinguish between the detected sets. By implementing these two algorithm layers, we enhance the accuracy and robustness of symbol recognition in the sign language system.

C. TRAINING AND TESTING

In our approach, we preprocess the input images by clicking 600 or more dataset .After preprocessing, the images are fed into the model for training and testing. These operations mentioned above are applied to ensure effective input representation and enhance the performance of the system.

D. CHALLENGES FACED

During the project, we encountered several challenges. Firstly, the availability of a suitable dataset was a challenge, as we needed raw square images for training a CNN model in Keras. To overcome this, we created our own dataset. Another challenge was selecting an appropriate filter to extract relevant features from the images for input to the CNN model. After experimenting with various filters, we found that the Gaussian blur filter yielded satisfactory results.

Additionally, we faced issues related to the accuracy of our trained model in the initial phases. To address this, we made improvements by increasing the input image size and enhancing the dataset. These modifications helped enhance the performance and accuracy of our model.

V. CONCLUSION

In application the application of deep learning in sign language recognition has shown promising results in improving communication for individuals who use sign language. By utilizing deep learning algorithms, accurate and efficient systems can be developed to recognize and interpret sign language gestures in real time. Deep learning models, such as convolutional neural networks (CNNs) and recurrent neural networks (RNNs), have proven effective in extracting relevant features and capturing the temporal dynamics of sign language gestures. This enables improved recognition performance by effectively handling the spatial and temporal aspects of the gestures. One notable advantage of deep learning-based sign language recognition is the ability to learn directly from raw data, eliminating the need for manual feature engineering. This allows the system to adapt and generalize well to different sign languages and variations within a sign language. Despite these advancements, challenges remain in dealing with variations in hand shapes, viewpoints, and lighting conditions. Further research and development are required to address these challenges and enhance the robustness and accuracy of sign language recognition systems. Overall, sign language recognition using deep learning holds great potential for facilitating effective communication between deaf or hard-of-hearing individuals and the hearing community. It opens up opportunities for the development of assistive technologies, educational tools, and inclusive communication systems that bridge the communication gap between sign language users and non-sign language users.

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