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American Sign Language Recognition

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ABSTRACT: Communication between deaf or mute individuals and people who do not understand sign language can be challenging. To address this problem, a Sign Language Recognition (SLR) system is developed to recognize hand gestures and convert them into readable alphabets. This project focuses on recognizing American Sign Language (ASL) alphabets using machine learning and deep learning techniques. Only 24 alphabets are considered because the letters J and Z involve motion and are difficult to detect using static images. Dimensionality reduction techniques such as Principal Component Analysis (PCA) and manifold learning are applied to reduce data size and improve processing speed. Several machine learning algorithms including Random Forest, K-Nearest Neighbors, Gaussian Naïve Bayes, Support Vector Machine, and Stochastic Gradient Descent are used for classification. Grid Search is applied to optimize SVM parameters. Experimental results show that PCA improves performance for most algorithms, while deep learning models such as CNN and DNN achieve higher accuracy in recognizing sign language gestures.

I. INTRODUCTION

Communication is a basic human need, yet millions of people around the world are unable to communicate effectively due to disabilities. According to the World Health Organization, 285 million people are blind, 300 million are deaf, and 1 million are mute, demonstrating a strong global need for accessible communication tools. Sign language serves as the primary communication medium for deaf and mute individuals, but most people without hearing disabilities do not understand it. With the rapid development of Artificial Intelligence (AI) and image recognition technologies, there is a strong motivation to use machine learning and deep learning models to automatically recognize sign language gestures and convert them into text. Such systems can significantly improve communication, reduce social barriers, and enhance the independence of individuals with disabilities.

II. EXISTING SYSTEM

It is well known that sign language is widely used in communication between deaf and dumb people. Although there are lots of study of natural language applied by people with normal hearing and vision ability, there are few applications for mute to transfer sign language to words to communicate with others. In existing machine learning methods are applied to recognize and classify American Sign Language With the help of SDG algorithm with the accuracy rate of 60%. There are different sign languages in this data set presents some sample images in the collected Sign Language dataset. Results are not up to the mark with the low accuracy rate. SGD performs not well in both original data and dimension- reduction data Training requires high time and requires large memory SDG algorithm.

III. PROPOSED SYSTEM

Machine learning and deep learning methods are applied to recognize and classify American Sign Language (ASL), and only 24 English letters are classified because letter J and Z require fingers to move. First, Principal Component Analysis (PCA) and manifold algorithms are used to do dimension reduction to accelerate the training of machine learning and visualize it. Second, various machine learning methods such as Random Forest Classification (RFC), K-Nearest Neighbor (KNN), Gaussian Naïve Bayes (GNB), Support Vector Machine (SVM), and Stochastic Gradient Descent (SGD) are applied to classify the pattern. Since the SVM algorithm has several hyperparameters, this study uses the Grid Search method to find the best combination of hyperparameter which lead to predicting more accurately. Since the SVM algorithm has several hyperparameters, this study uses the Grid Search method to find the best combination of hyperparameter which lead to predicting more accurately. Random Forest Classification (RFC), K-Nearest Neighbor (KNN), Gaussian Naïve Bayes (GNB), Support Vector Machine (SVM), and Stochastic Gradient (SGD).

IV. METHODOLOGY**i. Data Collection**

In this module, the dataset containing images of American Sign Language alphabets is collected. The dataset includes hand gesture images representing different alphabets which are used for training and testing the machine learning models.

ii. Image Preprocessing

The collected images are processed before training the model. This step includes resizing images, normalization, background cleaning, and converting images into suitable formats so that the machine learning algorithms can process them efficiently.

iii. Feature Extraction

In this module, important features are extracted from the images to help the model understand gesture patterns. Dimensionality reduction techniques such as Principal Component Analysis (PCA) and Manifold Learning are used to reduce the number of features while preserving important information.

iv. Model Training

Different machine learning and deep learning algorithms are used to train the system. These include Random Forest, K-Nearest Neighbor, Gaussian Naïve Bayes, Support Vector Machine, Stochastic Gradient Descent, Deep Neural Networks, and Convolutional Neural Networks.

v. Gesture Recognition

The trained model predicts the alphabet corresponding to the hand gesture provided as input. The system analyzes the image and classifies it into the correct sign language alphabet.

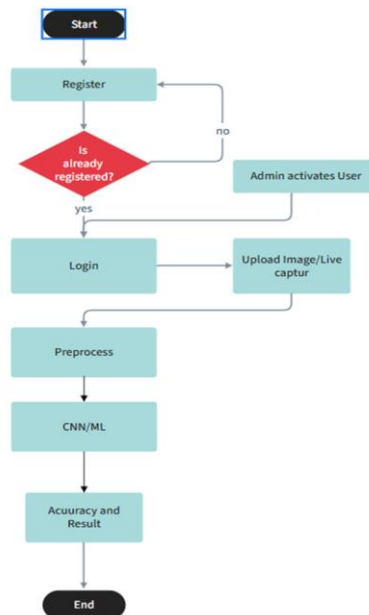
vii. Output Display

After recognition, the predicted alphabet is displayed on the screen as text output, allowing users to understand the meaning of the sign gesture.

V. SYSTEM ARCHITECTURE

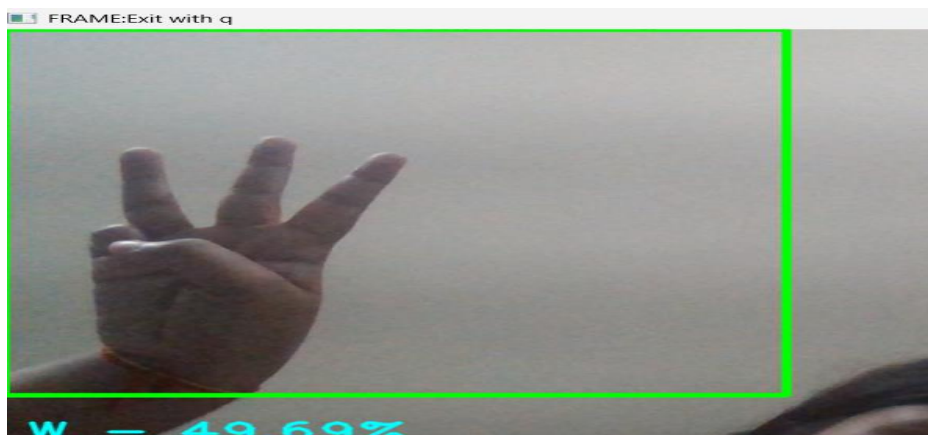
The proposed system architecture is designed to recognize American Sign Language (ASL) hand gestures using machine learning and deep learning techniques. The process begins with the user registering in the system by providing basic details such as username and password. After registration, the administrator verifies and activates the user account to ensure that only authorized users can access the system. Once the account is activated, the user logs into the system using valid credentials. After successful login, the user provides the input gesture either by uploading an image or capturing a live hand gesture through a webcam.

The input image is then passed to the preprocessing stage where image resizing, normalization, noise removal, and background cleaning are performed to improve the quality of the image for analysis. The processed image is then given to the machine learning or convolutional neural network (CNN) model, which extracts important features from the gesture and classifies it into the corresponding sign language alphabet. Finally, the system displays the predicted result along with the recognition accuracy, allowing the user to understand the detected sign gesture.

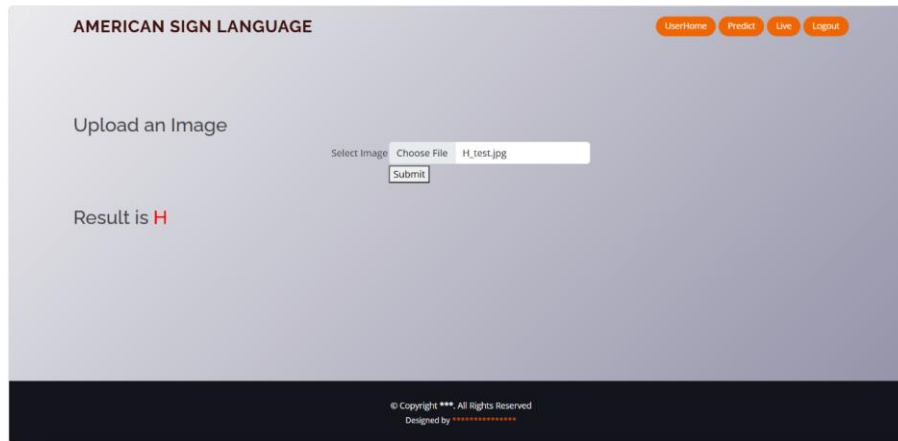


VI. RESULTS AND OUTPUT

i. Live output



ii. Predicted Output



VII. CONCLUSION

In this project, an American Sign Language Recognition system was developed to assist communication between deaf or mute individuals and people who do not understand sign language. The system uses machine learning and deep learning techniques to recognize hand gestures corresponding to American Sign Language alphabets.

The proposed system captures hand gesture images through a webcam or input images and performs preprocessing, feature extraction, and classification to identify the corresponding alphabet. Various algorithms such as Random Forest, K-Nearest Neighbor, Gaussian Naïve Bayes, Support Vector Machine, and Stochastic Gradient Descent were evaluated for gesture classification. In addition, Deep Neural Networks (DNN) and Convolutional Neural Networks (CNN) were used to improve recognition performance.

Dimensionality reduction techniques such as Principal Component Analysis (PCA) and Manifold Learning were applied to reduce the complexity of the dataset and speed up the training process. Experimental results show that deep learning models, particularly CNN with data augmentation, achieve higher accuracy compared to traditional machine learning algorithms. Overall, the developed system demonstrates that Artificial Intelligence and computer vision technologies can effectively recognize sign language gestures and convert them into readable output, helping bridge the communication gap between hearing-impaired individuals and the general public. This project highlights the potential of intelligent systems in creating inclusive technologies for people with disabilities.

VIII. FUTURE SCOPE

The proposed sign language recognition system can be further improved by incorporating advanced deep learning models and larger datasets to increase recognition accuracy. In the future, the system can be extended to recognize not only alphabets but also complete words and sentences in sign language. Real-time gesture recognition using mobile devices and embedded systems can also be implemented to make the system more accessible. Additionally, integrating text-to-speech technology can help convert recognized gestures into spoken language, enabling better communication between deaf and hearing individuals. The system can also be enhanced to support multiple sign languages used in different countries, making it more versatile and widely applicable in educational, healthcare, and assistive communication systems.

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