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RECOGNITION OF SIGN LANGUAGE USING MACHINE LEARNING

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Abstract: When persons who are deaf or dumb are unable to communicate with other people in regular ways, sign language emerges. New algorithms are being developed by researchers to make communication easier for the deaf and dumb people. K-Nearest Neighbor (KNN), Convolution Neural Network (CNN), Recurrent Neural Network (RNN), Principle Component Analysis (PCA), and Histogram of Oriented Gradients (HOG) are a few of the current approaches. In this paper, a technique for hand gesture recognition using the open-source MediaPipe framework and SVM algorithm is provided. 80% accuracy is attained.

Keywords—Machine Learning (ML), Support Vector Machine (SVM), K-Nearest Neighbors (KNN), MediaPipe, OpenCV

I. INTRODUCTION

Deaf and dumb persons utilize sign language, often known as finger spelling, as a form of physical communication. It makes use of finger, arm, and hand motion. It is a very old language that was in use long before speech developed. A physician from Italy named Geronimo Cardano devised sign language, which was first used in the late 16th century.

The World Health Organization (WHO) estimates that 5% of the population has a hearing impairment, which results in a significant communication gap with others around them. Recognizing sign language is a difficult undertaking because it is not a universal language. There are about 300 different sign languages in use today, each spoken or signed differently in various nations.

The Researches carried out in past were sensors-based and gloves-based sign recognition system. These methods were not economical and were quite discomfortable. The recent works proves that the computer vision-based technologies can recognize the sign with bare hands without use of any hardware. The results thus came out are economical, easy to use and much more efficient.

The computer vision-based technology deals with feature extraction, background subtraction, estimation of hand shapes. The proposed methodology involves the use of MediaPipe, the open-source framework and Machine Learning algorithm which is faster, simpler, economical and easy to deploy.

The structure of this paper is as follows: the third part provides examples of the suggested technique; section four presents the empirical findings and provides an assessment of them. The work is summarised in section 5. At the conclusion, the references are completed.

II. RELATED WORK

The literature survey carried out helps to understand the various algorithms used to recognize the signs. There are two types in which vision-based recognition can be achieved they are static and dynamic recognition. They have used the combination of CNN and Re-current neutral network (RNN) [3] to capture the spatial and temporal features. The evolution of CNN [6] which deals with concerns of hand-tracking, illumination, orientation but there is an accuracy of 90%. Binarized Neural Network (BNN) [8] used for recognition of Indian Sign Language supports two hand gestures. BNN architecture has bitwise operations which reduces the complexity computation based on skin color segmentation achieving an accuracy around 93-95%. The conversion of hand gestures in Indian Sign Language (ISL) [9] for numbers (from 1 to 9), English letters, and a few English words into text that can be understood. The algorithms used here are CNN, RNN and SVM. The better approach was SVM classifier with K-means clustering for gesture recognition with an accuracy of 89%. The classification algorithms like SVM, KNN [10] to maintain datasets of hand gestures and classify them individually to convert them to text which gives the accuracy of 85%.

III. METHODOLOGY

The proposed system recognises the sign language with bare hands. Colour and shape features are used to help the system to recognize the signs.

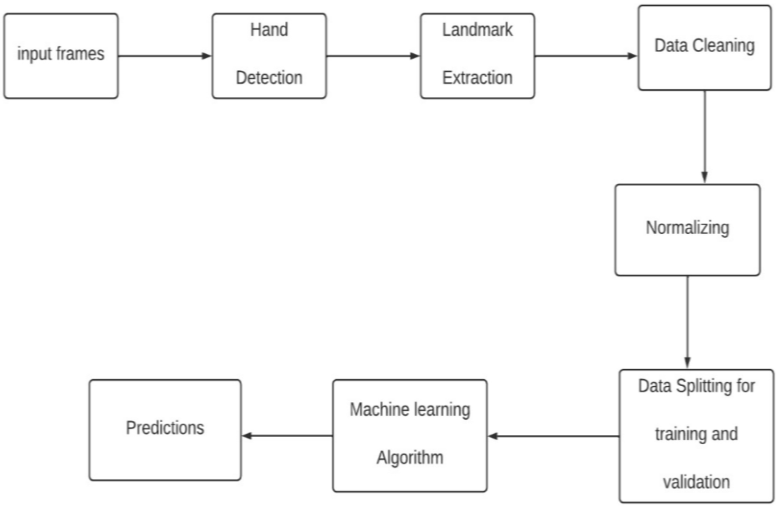

Fig. 1. Architectural Design

Fig. 1 depicts the architecture of the sign language recognition system, which begins by collecting the photos for the pre-defined data. The system recognises the hand when the user makes the sign, extracts landmarks from the hand, and then does image processing operations such data cleaning, normalisation, and data splitting for training and validation in the following step. Finally, a machine learning technique is used to anticipate the sign.

A. Input Collection

This is the first module implemented according to the architectural design. This module is used for collection of input data. Here the hand signs are captured as an input image. An individual class is created for each input sign and exactly 100 images are captured for each sign using the in-built webcam, a sample image set is shown in Fig. 2. An error message of "Cannot open camera!" is displayed in case of any failure in opening the webcam. These 100 images are utilized in the further modules to obtain the data and train the model for predicting the signs. In this module OpenCV library is used to capture the image, set the frame for the image and to save the image for each sign from A-Z.

Fig. 2. Input Dataset

B. Data analysis and interpretation

In this module, the collected images from the dataset are processed and analyzed. Image processing here includes reading the static image from the dataset, converting BGR to RGB to match the pixel orderings and flipping the image in Y-axis. These steps use the functions of OpenCV library.
The next step in data analysis involves the setting up of 21 landmarks for each image and detect the X-axis, Y-axis and Z-axis co-ordinates for the recorded images. This step uses MediaPipe framework of Python. These landmarks help in interpreting the signs made and the landmarks for all the signs are saved in the dataset.csv file and successful creation of this .csv file is confirmed by "Dataset created successfully!" message in the output terminal after displaying the contents of the file.

(i) MediaPipe

MediaPipe is an open-source framework applied for Machine Learning pipelines which are used by the developers to build multi-model(image/videos) cross-platform. MediaPipe has large collection of human body detection and vast dataset from google. The hand tracking system of the MediaPipe has two models in Machine Learning pipeline namely palm detection and landmark setting model. Both of them work dependently. MediaPipe is well trained that it detects and sets the landmarks even to the partially visible hands. Fig 3. shows the landmarks of the hand.

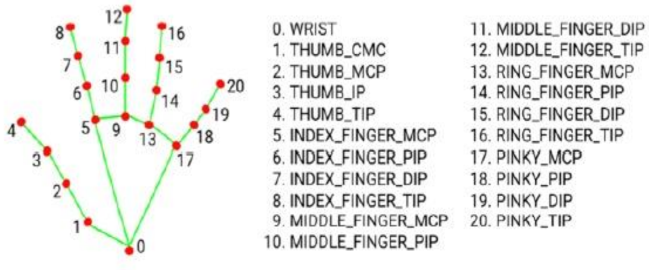

Fig. 3. Landmarks

C. Training the model

The first phase in machine learning is model training, which produces a functional model that can subsequently be validated, tested, and deployed. How well a model performs during training ultimately determines how well it will perform when it is implemented in an application for end users. The end-use scenario is the primary factor that influences the algorithm selection. However, there are always additional aspects to take into account, such as the complexity of the algorithm model, performance, interpretability, resource requirements, and speed. Selecting algorithms can be a time-consuming and challenging procedure due to the need to balance off these diverse needs. Here Support Vector Machine (SVM) algorithm is used as it works with better accuracy in the image classification process than any other Machine Learning algorithms. This algorithm is expected to give minimum accuracy of around 80%. Libraries such as Pandas, Scikit and Seaborn are used to train the model.

(ii) Support Vector Machine (SVM)

The first phase in machine learning is model training, which produces a functional model that can subsequently be validated, tested, and deployed. Support Vector Machine is a type of supervised machine learning method that may be used for both regression and classification. Finding a hyperplane in N-dimensional space that categorises the two points of the datasets is the primary goal of the SVM method. SVM operates slowly even if it offers great accuracy because of its computational cost.

D. Sign recognition and display of the output

This is the last module where the signs made by the user is recognised and the predicted output is displayed in text format. The user gives the input sign to the model through in-built webcam and if unable to open the camera an error message is displayed saying "Unable to open the camera!". The model collects the image and digital image processing techniques are applied. The landmarks of the images are detected. The total of 63 landmark components are detected (21 landmarks * 3 co-ordinates) for the sign made. The trained model on observing all the landmark components of different signs in dataset.csv file displays the sign class that seems to be more related to the present input sign. The user can exit the output window by pressing 'q' and stop the sign recognition process.

IV. EXPERIMENTAL RESULT

The experimental result demonstrates the digital image processing techniques to recognise letters from A-Z. The output is illustrated as below.

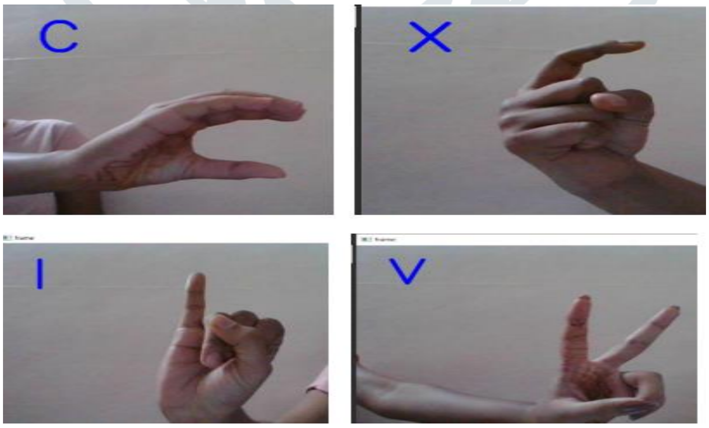

Fig. 4. Output

The number of correct responses out of 5 times of testing of each sign is shown in the Table 1 and Fig. 5 depicts the output analysis graph.

signs	Number of correct prediction out of 5	Prediction %
A	5	100
B	2	40
C	4	80
D	5	100
E	4	80
F	5	100
G	5	100
H	4	80
I	5	100
J	3	60
K	3	60
L	5	100
M	5	100
N	4	80
O	5	100
P	5	100
Q	2	40
R	3	60
S	2	40
T	3	60
U	5	100
V	2	40
W	4	80
X	4	80
Y	4	80
Z	5	100

Table 1. Output analysis

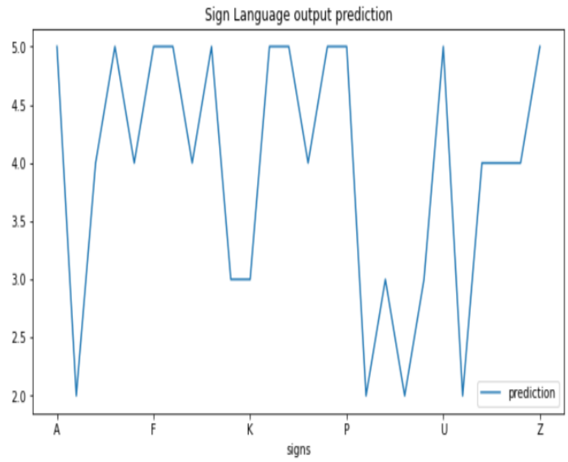

Fig. 5. Output analysis graph

Average Recognition Rate = (Number of correct responses)/ (Total samples) *100

V. CONCLUSION

An overall accuracy of 80% and 92.3% at centre of the window is obtained by using MediaPipe, OpenCV and SVM algorithm. Training and testing with different dataset of sign languages gives efficient and accurate outputs using MediaPipe framework. This work gives faster real-time detection of the signs.

In future, words and sentences can also be detected by giving input in form of images as well as videos using MediaPipe framework.

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