ISSN No : 2454-4221(Print)
ISSN No : 2454-423X(Online)
International Journal of Research in Advanced Computer Science Engineering
A Peer Reviewed Open Access International Journal
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A Real-Time Application For Road Traffic Signs Recognization Using Opencv

Suvvari syamala, Menda Sowmya, Ronanki Venkata Sai Deepika, Potnuru Sai Tarun, Mallapu Kishor
B.Tech UG Students, Dept. of CSE, AITAM, Tekkali, AP, India.
syamalasuvvari89823@gmail.com sowmyamenda362@gmail.com deepikaronanki@gmail.com
saitarunpotnuru@gmail.com Mallapukishor143@gmail.com

ABSTRACT:

Real-time traffic sign recognition is a difficult topic with numerous use cases in autonomous driving and advanced driver assistance systems using OpenCV, a well-known open-source computer vision library, we suggest a real-time traffic sign recognition system in this paper.

Because of their accuracy and robustness, convolutional neural networks (CNNs) are frequently used for recognizing traffic signs on roads. In this work, we proposed a CNN sequential model for identifying traffic signs on the road. We compare a CNN model's performance with the Support Vector Machine (SVM) model, a more established machine learning approach for image categorization. Both models are trained and tested using the German traffic sign recognition benchmark (GTSRB) dataset, and their accuracy, and precision are evaluated. After comparison it shows that the CNN sequential model is a promising approach for identifying traffic signs on the road. Therefore, we used the CNN model with OpenCV to recognize the road traffic signs.

KEYWORDS: Traffic sign recognition, SVM, CNN, deep learning, OpenCV

INTRODUCTION:

Road safety, intelligent transportation systems, and autonomous vehicles are just a few of the practical uses of a real-time application for road traffic sign recognition, which is a fast-expanding subject. It is now possible to effectively detect and classify traffic signs using cameras and classification algorithms due to developments in computer vision and deep learning techniques. For drivers, understanding traffic signs is an essential skill. These days, a large number of traffic accidents and hundreds of fatalities occur as a result of an incomplete understanding of road signs. Everyone must be well knowledgeable of traffic signs if they want to prevent these fatalities. No one is unaware that there are several traffic sign boards on the roadways, despite the fact that everyone is aware of them. These days, both technology and the intelligence transportation system are evolving quickly. So, everyone may readily comprehend how to read traffic signs. To comprehend road signs, several machine learning methods have been created. Nevertheless, the focus of this effort is on improving traffic sign recognition precision.

Cite this article as: Suvvari syamala, Menda Sowmya, Ronanki Venkata Sai Deepika, Potnuru Sai Tarun, Mallapu Kishor, "A Real-Time Application For Road Traffic Signs Recognization Using Opencv", International Journal of Research in Advanced Computer Science Engineering, (IJRACSE), Volume 8 Issue 11, April 2023, Page 1-12.

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Over the years, numerous research papers have been published on this topic, and significant progress has been made in developing robust and accurate algorithms for traffic sign recognition. Early approaches to traffic sign recognition involved the use of handcrafted features and traditional machine learning algorithms, such as classifiers and decision trees. However, these methods often struggled with real-world variations in lighting, weather conditions, and occlusions. In recent years, deep learning techniques, such as convolutional neural networks (CNNs), have shown great promise in improving the accuracy and robustness of traffic sign recognition systems. In this paper, the recognition of road traffic signs is done by deep learning algorithm.

LITERATURE SURVEY:

[1] Traffic Sign Recognition and Classification using CNN

Thunga Saiteja, et Al proposed a paper "Traffic Sign Recognition and Classification using CNN". This paper explains the importance of traffic sign recognition and classification and describes their CNN architecture, which includes multiple convolutional layers, pooling layers, and fully connected layers. They trained and tested their CNN on the GermanTrafficSignRecognition Benchmark (GTSRB) dataset, achieving an accuracy of over 95%. By using GUI they upload a traffic sign then it gives the name of the sign.

[2] A Novel SVM Network Using HOG Feature For Prohibition Traffic Sign Recognition

Yang Liu,et al proposed a paper " A Novel SVM Network Using HOG Feature For Prohibition Traffic Sign Recognition ".The study proposes a novel SVM network for recognizing prohibition traffic signs using a histogram of oriented gradient (HOG) features. It uses a hierarchical structure consisting of multiple SVM classifiers to improve recognition accuracy. The proposed network is evaluated on a publicly available traffic sign dataset and outperforms other state-of-the-art methods in terms of recognition accuracy.

[3] Detection And Classification Of Road Signs In Natural Environment

Yok-Yen Nguwi, et al proposed a paper " Detection And Classification Of Road Signs In Natural Environment". The authors propose a system to detect and classify road signs in natural environments, using image pre-processing, feature extraction, and classification. They use techniques such as contrast enhancement, median filtering, and edge detection to enhance the images and reduce noise. They used a neural network-based classifier to classify the road signs based on the extracted features, with an overall accuracy of 95.6%.

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[4]Detection and Recognition of Traffic Signs Based on HSV Vision Model and Shape features

Yixin Chen, et al proposed a paper “Detection and Recognition of Traffic Signs Based on HSV Vision Model and Shape features”. The proposed method is based on the HSV color model, which is more robust to lighting changes. It pre-processes the input image by segmenting the ROI and using the circular Hough transform to detect circular traffic signs. To recognize the signs, the authors extract shape features using a Gabor filter and use a support vector machine (SVM) classifier to classify them. They used The results show that the proposed method outperforms other state-of-the-art methods in terms of detection and recognition accuracy. They implemented the algorithms using the MATLAB programming language.

[5]Real-Time Detection and Recognition of Road Traffic Signs using MSER and Random Forests

Kuang Xianyan, et al proposed a paper "Real-Time Detection and Recognition of Road Traffic Signs using MSER and Random Forests". The paper presents a real-time traffic sign detection and recognition system that uses a combination of Maximally Stable Extremal Regions (MSER) and Random Forests algorithms. The authors evaluated the proposed system on two publicly available traffic sign datasets, the German Traffic Sign Recognition Benchmark (GTSRB) and the Chinese Traffic Sign Recognition Evaluation (CTSR-E). The experimental results showed that the proposed system achieved high detection and recognition rates, outperforming several state-of-the-art methods.

[6]A Review of Deep Machine Learning

Benuwa Bright Ben,et al proposed a paper "A Review of Deep Machine Learning”. The article gives a general description of deep machine learning, a branch of machine learning that employs neural networks with numerous layers. It discusses the development of deep learning and how it has been used in a variety of industries, including computer vision, speech recognition, natural language processing, and autonomous cars. Also, it discusses the various deep learning designs, including deep belief networks, recurrent neural networks, and convolutional neural networks. Also covered are the difficulties with deep machine learning, including overfitting, computational complexity, and interpretability, as well as the solutions, including fully - connected layers, dropout, and transfer learning.

[7]An Automatic Traffic Sign Detection and Recognition System Based on Colour Segmentation, Shape Matching, and SVM

Wali, et al proposed a paper "An Automatic Traffic Sign Detection and Recognition System Based on Colour Segmentation, Shape Matching, and SVM". The primary objective of the study is the creation of an automatic traffic sign detection and identification system based on three key elements: color segmentation, shape matching, and support vector machines (SVM). To extract areas of

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interest (ROIs) from the input picture, the color segmentation approach is utilized. The retrieved ROIs are compared to templates for predefined traffic signs using the shape-matching method. To categorize the detected traffic signs into several groups, the SVM classifier is lastly trained. 97.3% accuracy was attained by the suggested system in detecting and identifying traffic signs, according to the testing data. Moreover, the authors' approach exceeds other systems currently in use in terms of accuracy and efficiency, as demonstrated by this comparison.

[8]Robust Chinese traffic sign detection and recognition with deep convolutional neural network

Qian, et al proposed a paper "Robust Chinese traffic sign detection and recognition with deep convolutional neural network". The system is made to be robust to a wide range of variables that may impact the detection and recognition of traffic signs. It is divided into three primary stages: post-processing, traffic sign identification, and traffic sign detection. A CNN-based object detection technique is used in the traffic sign detection step, followed by a CNN-based algorithm in the traffic sign recognition step. The authors also suggested a multi-stage recognition method to increase the efficiency of traffic sign recognition.

[9]Comparative Survey on Traffic Sign Detection and Recognition

Safat B. Wali,et al proposed a paper "Comparative Survey on Traffic Sign Detection and Recognition". They provide a comprehensive review of various methods and techniques for traffic sign detection and recognition. The authors present a comparative analysis of the strengths and weaknesses of different approaches and highlight their key features.

[10]Traffic Sign Detection using Convolution Neural Network: A Novel Deep Learning Approach

G.Bharath Kumar, et al proposed a paper "Traffic Sign Detection using Convolution Neural Network: A Novel Deep Learning Approach"The proposed method uses a CNN to extract features from input images and classify them into different traffic sign categories. The authors designed a custom CNN architecture for traffic sign detection, which includes several convolutional and pooling layers followed by fully connected layers for classification.

To train and evaluate the proposed system, the authors used a large dataset of traffic sign images, including various types of signs and different lighting and weather conditions. They compared the performance of their system with other state-of-the-art approaches, including traditional computer vision methods and other deep learning techniques.

The results showed that the proposed CNN-based approach outperformed other methods in terms of accuracy and speed, demonstrating the effectiveness of deep learning for traffic sign detection tasks. The authors also discussed the limitations and future directions of their approach, such as the need for more diverse datasets and the potential for transfer learning to improve performance in different scenarios.

Overall, this paper presents a promising approach for traffic sign detection using a CNN-based deep learning method. The proposed system has practical applications in improving road safety and traffic management in various settings.

PROPOSED METHODOLOGY:

There are limits to the current technologies, despite the fact that they can be used to identify traffic signs. There is a great deal of scope for the system's performance to be improved. To improve the system's performance and accuracy in order to recognize the traffic signs in the dataset, the proposed method is based on Deep Learning.

There have been some promising results in the recognition of traffic signs using machine learning approaches like Random Forest, Support vector machines, and image processing techniques like HOG Feature Extraction and HSV vision models. Moreover, the Suggested System faces a number of obstacles and constraints that must be overcome.

In the proposed model, we train our model using the GTSRB dataset utilizing the two techniques CNN and SVM architectures. Among these, the CNN algorithm gives higher traffic sign recognition accuracy. So, the OpenCV vision model receives input from our CNN model to recognize various traffic signs.

The model is used to take pictures of the boards with a camera. This acquired image will be subjected to analysis, processing, and identification of the signboard. When a signboard is discovered, the name and probability of the signboard are displayed. This paradigm suggests a system that classifies various traffic sign types in real-time.

DATA SET:

We used the GTSRB (German Traffic Sign Recognition Benchmark) dataset from Kaggle, which is divided into two major folders: "myData" and "label.csv". The "train" folder contains a set of 43 subfolders, one for each class of traffic sign. Within each subfolder, there are a varying number of training images of that particular class. The total number of training images in the "myData" folder is 39,209. The images in the "myData" folder are used to train machine learning models to recognize traffic signs.

The "labels.csv" file contains the class names and corresponding class IDs for the traffic signs in the dataset. The CSV file has two columns: "ClassId" and "Sign Name." The "ClassId" column contains the numeric class ID for each traffic sign from 0 to 42, while the "SignName" column contains the name of each traffic sign. Using this CSV file, you can map the class IDs in the training and testing data to their corresponding traffic sign names.

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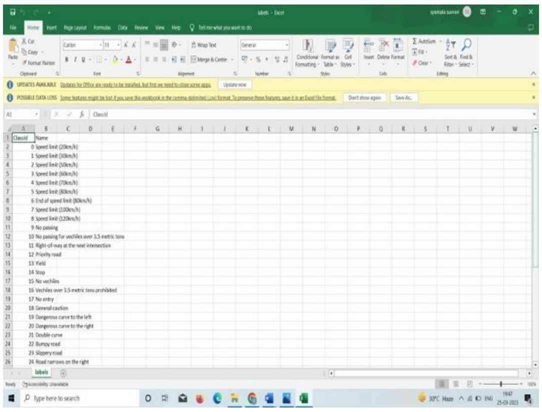

fig: example of images from the dataset

Fig:labels.csv file

SYSTEM ARCHITECTURE:

The Steps involved in the Architecture are:

- **Data Collection**
- **Data Pre-Processing**
- **Train, Test & Validation**
- **Recognition**

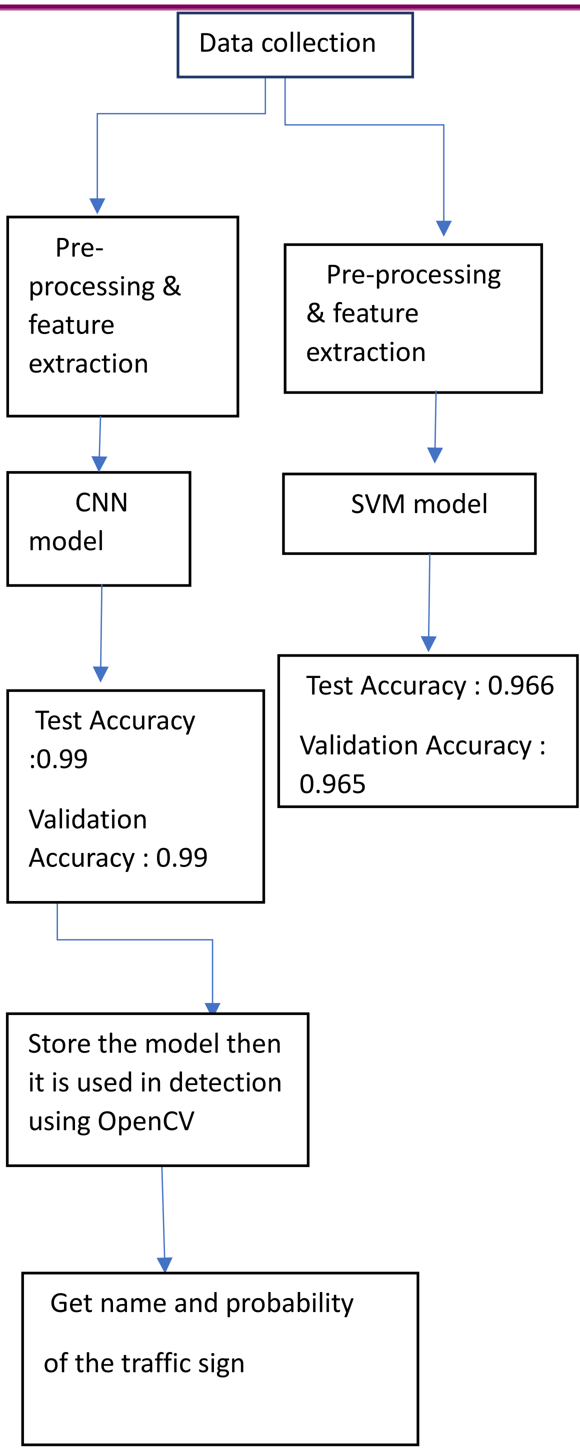

Fig: flow chart

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1.DATA PRE-PROCESSING:

When applying the CNN and SVM algorithms to recognize traffic signs, data pre-processing is a crucial step. In order for the data to be used by the algorithms, it must first be prepared and cleaned. The following are some typical data preparation methods for identifying traffic signs:

1. The first step in pre-processing is to convert the input image to a grayscale. This is done using the cv2.cvtColor() function, which converts an image from one color space to another. Converting the image to grayscale simplifies the subsequent image processing steps, as it reduces the amount of data that needs to be processed and eliminates any color variations that may affect the accuracy of the recognition algorithm.
2. The next step is to perform histogram equalization on the grayscale image. This is done using the cv2.equalizeHist() function, which enhances the contrast of the image by spreading out the intensity levels of the pixels.
3. After histogram equalization, the pixel values of the image are normalized to a range between 0 and 1. This is done by dividing the pixel values by 255, which is the maximum value that a pixel can have in an 8-bit grayscale image. Normalization helps to standardize the input data and makes it easier to train and compare different recognition models.
4. Data augmentation is a technique used to artificially expand the size of a dataset by creating new variations of existing data. This is done by applying a series of transformations to the original data, such as flipping, rotation, cropping, scaling, and color manipulation. By generating additional examples of the data, data augmentation can help to improve the accuracy and robustness of machine learning models.

2.CNN MODEL:

CNN, or Convolutional Neural Network, is a widely used deep learning technique for image classification tasks like recognizing traffic signs.

In order to create a set of features that may be used to make predictions, the input image is processed through a number of layers that forms the architecture of a CNN. Convolutional, pooling, and fully connected layers are the main types of layers utilized in a CNN.

Convolutional layers are responsible for learning a set of filters that can be used to extract features from the input image. Each filter is applied to a small section of the image at a time, and the output of the filter is then pooled together to create a feature map.

Pooling layers are used to reduce the spatial size of the feature map by down sampling it. This helps to reduce the number of parameters in the model and makes it more computationally efficient. Common pooling

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operations include max pooling and average pooling.

Finally, fully connected layers are used to classify the features extracted from the image. These layers are similar to the layers used in traditional neural networks and are used to learn a mapping between the input features and the output classes.

The model architecture you provided is an example of a CNN, consisting of multiple convolutional layers, pooling layers, and fully connected layers. It is designed to take a 28x28 pixel image as input and output a prediction for one of 43 possible traffic signs. The model has a total of 378,023 parameters, all of which are trainable.

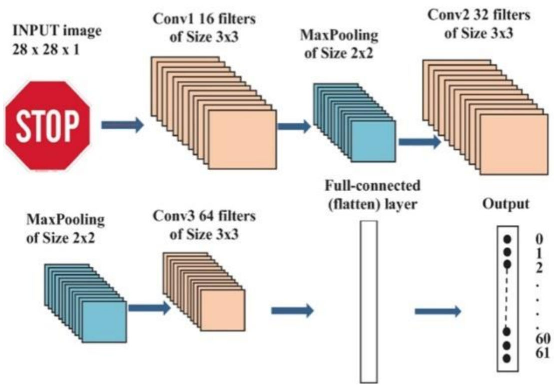

fig:cnn model architecture

3.SVM MODEL:

SVM (Support Vector Machine) is a supervised machine learning algorithm that is used for classification and regression analysis. In the context of image
classification, SVM can be used to classify based on the features extracted from them.

The path to the directory containing the photos, the file path for the labels, and a number of hyperparameters, including the test ratio, validation ratio, and image size, are configured in this section.

Read labels and images: Using the cv2.imread() method from the OpenCV library, this step reads labels and images from the provided directory. Using cv2.resize(), the photos are shrunk to the required dimensions and saved in a NumPy array. Labels are kept in their own NumPy array.

Create train, validation, and test sets of data: This stage divides the data into three sets: train, validation, and test using the train test split() method from the scikit-learn library. The size of the test and validation sets in relation to the train set is calculated using the test ratio and validation ratio.

Data reshaping for SVM: Using the reshape() function, this section converts the images from a 3D NumPy array (height x width x channels) to a 2D NumPy array (samples x features). SVMs want a 2D input, hence this is required.

4.TRAINING THE MODEL:

To train the CNN model, we have used an Adam optimizer with batch size 50 and a number of epochs is 10. We followed a simple approach and ran only 10 epochs
of the training and observed the validation error trying to set it on a minimum level and also due to the limitation of computational power. It is very important to consider mainly validation errors while improving the model. Decreasing

only the error with respect to training data can easily lead to unwanted model overfitting. After training the model up to 10 epochs with each epoch containing a batch size of 937 we are getting around 98% accuracy and low loss of 0.2.

Train SVM: This section creates an SVM model using the SVC() function from the scikit-learn library with a linear kernel and fits the model to the training data using the fit() method.

5.TESTING THE MODEL:

To test and validate the CNN model, 20% data will be given for testing and 20% data will be given for validating. the accuracy obtained on the test set is also a very good sign that of a good model performance.

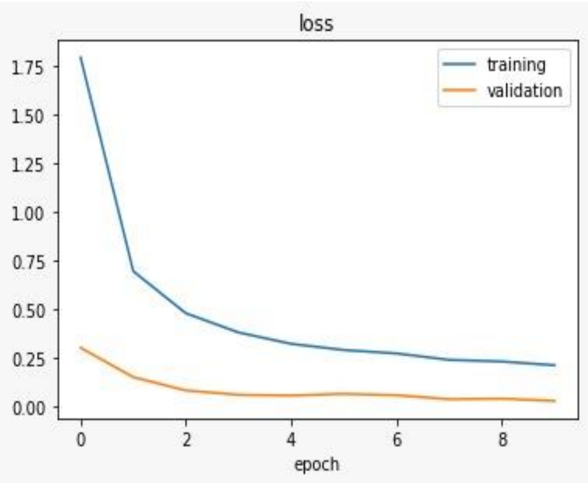

Fig: trained and validation loss

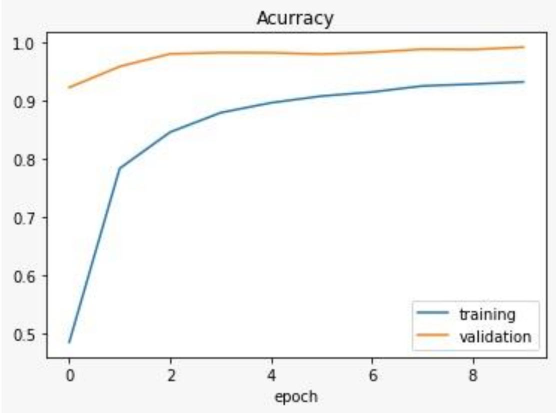

Fig: train and validation accuracy

SVM evaluation using validation set: The predict() method of the SVM model is used in this section to make predictions on the validation set. The accuracy and confusion matrices are then computed using the scikit-learn library's accuracy score() and confusion matrix() algorithms.

SVM evaluation using test data: The predict() method of the SVM model is used in this part to generate predictions on the test data. The accuracy and confusion matrices are then computed using the scikit-learn library's accuracy score() and confusion matrix() algorithms.

6.COMPARISION OF CNN AND SVM MODELS:

we are comparing both CNN and SVM models based on the performance metrics like Accuracy, Precision, F1 score, Recall.

The test accuracy resulted by CNN model is 0.98 and validation accuracy of CNN model is 0.99.

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The test accuracy of SVM model is 0.966 and the validation accuracy of SVM model is 0.965

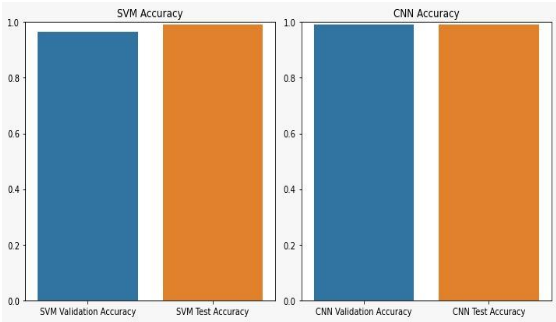

Fig: bar graph of CNN and SVM test, validation accuracy

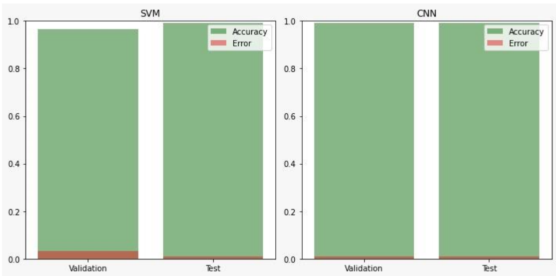

Fig: bar graph of CNN and SVM test, validation error

As comparing both the models the CNN model gives the better performance than the SVM model with less loss.

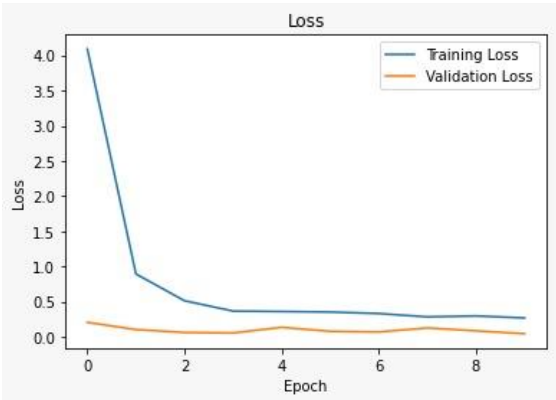

Fig: comparision graph of CNN and SVM loss

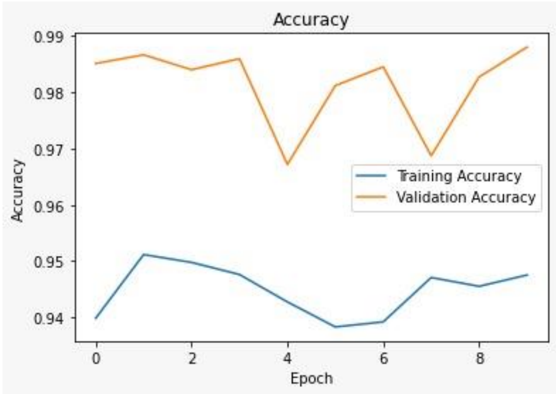

Fig: comparision graph of CNN and SVM Accuracy

Therefore, we fed the CNN model to the OpenCV vision model to recognise the traffic signs.

RESULT:

With a camera, real-time object recognition and categorization may be accomplished using the OpenCV and numpy packages. It takes video frames from the camera, pre-processes them, and then categorises them using an image classification model that has been developed.

The script initially initialises the camera and sets its settings, including the brightness, frame width, and frame height. It then moves into an endless while loop where it constantly reads and analyses each frame received from the camera.

Each frame is pre-processed by the script by being resized to (32, 32), utilising the pre-processing() function to do further operations, and then being reshaped to fit the input shape of the model. The model's predict() method is then used to predict the class of the picture, and

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the estimated class and probability are then displayed on the window using putText() function of OpenCV

Fig: recognising traffic sign image using webcam

CONCLUSION:

A promising method for automatic traffic sign identification and recognition uses OpenCV and CNN in a real-time application for road signs. We have discussed how traffic sign classification using deep learning can be accurate. Our model's accuracy was 98%. This innovation has the potential to significantly reduce the number of collisions and fatalities caused by traffic violations and make driving safer for all users of the road.

FUTURE ENHANCEMENT:

Future work could focus on developing algorithms that can run in real-time on low-power devices such as smartphones or embedded systems. We can improve the accuracy potentially by incorporating deep learning techniques. We can add voice system to the previous model. Cloud-based processing could be used to improve the performance of the system. The system could send images to the cloud for processing, allowing for more advanced algorithms to be used without requiring high-end hardware on the vehicle. Integration with GPS - The system could be integrated with GPS technology to provide location-based warnings to the driver. For example, if the system detects a "stop" sign ahead, it could alert the driver to slow down and prepare to stop

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