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Traffic Sign Detection Using CNN Networks

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ABSTRACT: Task automation simplifies almost everything we do in today's world. Drivers often miss traffic signs and try to keep their attention on the road, which is dangerous for themselves and others. This problem could be avoided if there was a quick way to alert drivers without distracting them. Road sign detection is essential for autonomous driving, traffic monitoring and road safety. In this paper, we propose a method for detecting and recognizing road signs using a convolutional neural network (CNN) for sign recognition. Due to CNN's high recognition rate, it is very suitable for various computer vision tasks. To implement CNN, TensorFlow is used. In training and testing, we get over 95% sign recognition accuracy on the GTSRB dataset.

KEYWORDS: GTSRB, CNN, Tensorflow, Computer vision, CNN

I. INTRODUCTION

In the era of artificial intelligence, people are increasingly dependent on technology. Thanks to advances in technology, multinationals like Google, Tesla, Uber, Ford, Audi, Toyota, Mercedes-Benz, etc. are working on car automation. Their goal is to develop more accurate self-driving or self-driving vehicles. You may have heard of self-driving cars, where the vehicle acts as a driver, driving on the road without human intervention. While driving on the road, you will come across many traffic signs such as traffic lights, left and right turn, speed limit, no heavy vehicles to overtake, no entry, children crossing the road, etc., and must be obeyed to drive safely.

Likewise, self-driving cars must read these signals and make decisions based on them. Decision making is the process of determining which class a traffic sign belongs to in order to arrive at an accurate classification of traffic signs. Traffic sign recognition is an important aspect of intelligent transportation systems because it prevents drivers from missing traffic signs through inattention. In the 1970s, traffic sign recognition became popular. With the rapid development of technology, it quickly caught on, caught the attention of automakers, and put it into production.

However, current traffic sign recognition systems can only recognize a limited number of sign types. Traffic sign recognition is a difficult problem in the real world due to multiple factors such as weather, camera angle, occlusion, and other variables. Traditional traffic sign recognition systems first extract the artificial features, such as edge distance, oriented gradient feature histogram and Haar features, etc. These methods then select a support vector machine or other classifier to solve the traffic sign recognition problem. Some functionality was lost due to human intervention in the first stage, highlighting the need for excellent image quality in.

Unlike older methods, convolutional neural networks automatically learn attributes from raw data. The results of the traffic sign recognition contest show that CNN's features are more reliable than traditional methods. CNNs work well on traffic sign recognition; however, this requires constant parameter tuning, which is easy to do, to achieve optimal recognition performance. Moreover, CNNs have demonstrated their strengths when dealing with high-dimensional data.

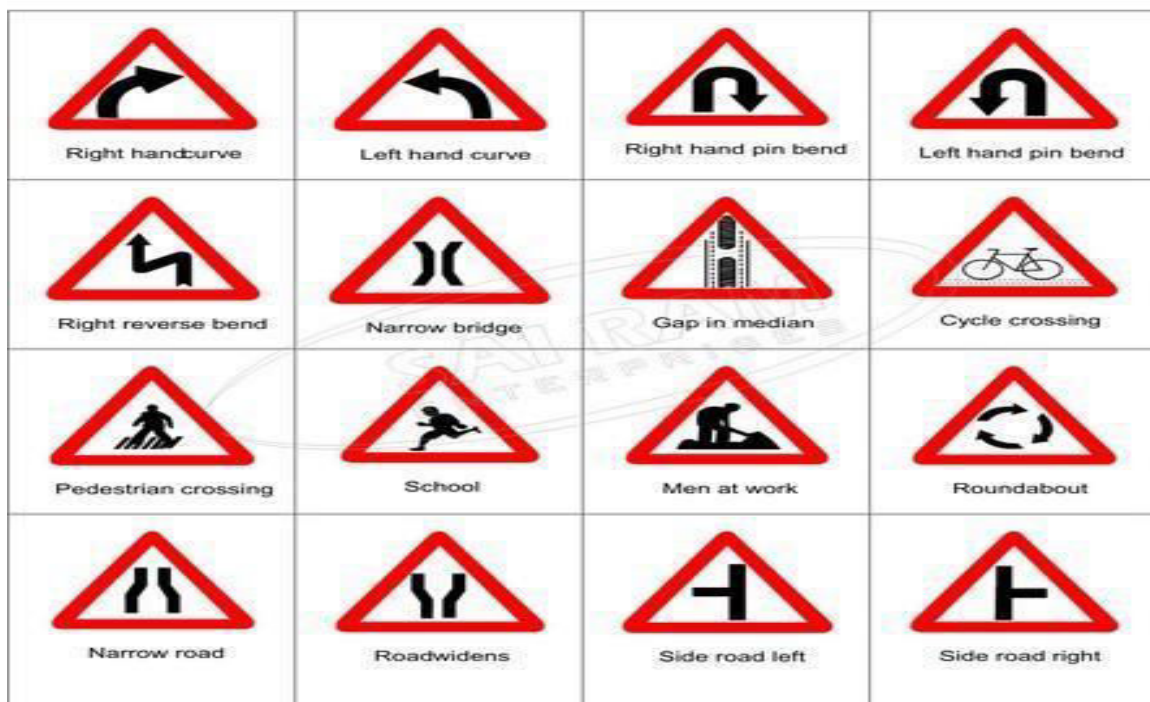
Different Types of Traffic Signs in India

Common traffic signs in India are categorized under three heads -

1. Mandatory Traffic Signs



2. Cautionary Traffic Signs



3. Informatory Traffic Signs



II. LITERATURE REVIEW

There are many studies in the literature dealing with the problem of traffic sign recognition (TSR). The first work on automatic traffic sign detection was presented in Japan in 1984. Various researchers subsequently described various approaches to develop an efficient traffic sign recognition and detection (TSDR) system. The following sections deal with literature related to traffic sign recognition.

Gudiga et al. [1] proposed an automatic traffic sign detection and recognition system (ATSDR), which includes three modules: segmentation, detection and recognition. Regions of interest (ROIs) were extracted using multiple thresholding schemes with novel environment selection strategies. Traffic sign detection is performed using a correlation calculation between the log-polar mapped interior area and a reference model. Finally, the Support Vector Machine (SVM) classifier is used for identification. The system achieves a recognition accuracy of 98.3% and experimental results show that the detection and recognition of traffic signs is robust in real-world scenarios.

J. M. Lillo-Castellano et al. [2] The proposed system is divided into three steps: (1) Segmentation of colored and uncolored scene elements, where two machine learning techniques (k-Nearest Neighbors and Support Vector Machines) are used; (2) After processing, removing regions of no interest, connecting fragmented tokens, and splitting tokens at the same position as ; (3) Classification of symbol shape using Fourier descriptors. Compared to other contour-based methods, has significant advantages, then uses machine learning techniques for pattern recognition.

Hee Seok Lee et al. [3] proposed a traffic sign detection system that uses a convolutional neural network (CNN) to simultaneously estimate the location and exact boundaries of a traffic sign. In this work, the boundary estimation of the traffic sign is formulated as a 2D pose and shape class prediction problem and is efficiently solved by a single CNN. Using the predicted 2D position and shape class of the target traffic sign in the input image, the authors estimate the actual target sign boundary by projecting the boundary of the corresponding model sign image onto the plane of the input image.

Safat B. Wali et al. The technique developed in [4] is invariant to variable illumination, rotation, translation and viewing angle, and has a low computation time of and a low false positive rate. The development of the system is divided into three work steps of image pre-processing, detection and recognition. The system demonstrates the use of RGB color segmentation and shape matching followed by a color classifier. Support vector machine (SVM). The area under the receiver operating characteristics (ROC) curve,, was used to statistically assess recognition performance. Chapter [5] describes a road sign recognition system. The system works in two main phases: detection, and identification. In the detection phase, images are pre-processed, enhanced, and segmented based on drawing characteristics such as color or shape.

The output is a segmented image containing potential regions that can be identified as possible landmarks. In the recognition phase, each candidate is tested against a specific set of characteristics (a pattern) to determine if they are part of the benchmark group, and they are then sorted into different groups based on those characteristics. The shape of the logo plays a central role at this stage, and the logo is divided into different categories such as triangle, circle, octagon, etc. The analysis of the pictograms allows a further classification hours.

Lee et al. [6] proposed a traffic sign detection method by integrating color invariant image segmentation and shape matching of Pyramid Histogram Oriented Gradients (PHOG) features. Extract the color invariants of a given image into a Gaussian color model, then segment the image into different regions by clustering on the color invariants to obtain candidate regions of interest (ROIs). Then adopt PHOG to represent the shape characteristic of ROI and output SVM to recognize traffic signs.

Yang et al. [7] deals with real-time traffic sign recognition, i.e. localizing which type of traffic sign appears in which region of an input image with fast processing time. To achieve this objective, the authors propose a monitoring module. The detection module is based on the extraction and classification of traffic sign suggestions built by the color probability model and the color HOG. A convolutional neural network is used to further classify the detected signs into subclasses within each superclass.

X. Yuan et al [8] proposed a color global and local oriented edge magnitude model (color global LOEMP). It effectively combines color, global spatial structure, global orientation structure and local shape information, and balances the two concerns of uniqueness and robustness of . Since the context frame is established by the shape of the traffic sign, a color angle mode is proposed to provide color discrimination information, and a context frame is established to provide global spatial information. The authors also propose LOEMPs to represent each cell. In each cell, the distribution of directional patterns is described by HOG features, then each HOG direction is represented in detail by the occurrence of local binary pattern histograms for that direction seconds.

Sarti [9] et al. A system is proposed to handle the strong variation in appearance that typically occurs in traffic sign recognition applications, especially in the presence of strong lighting changes and drastic scale changes. The proposed method is specific to three variants, each of which is designed to detect one of three types of traffic signs: mandatory, prohibition and danger signs.

A. Ruta [10] et al. Describes the concept of robust symbolic similarity measures that can be derived from domain-specific data. The authors propose two novel machine learning techniques as frameworks for automatically constructing such measures from pairs of images representing the same or different categories. One is called SimBoost, which is a variation of the AdaBoost algorithm, and the other is based on the Fuzzy Regression Tree framework.

Palavanчу S. For the detection, recognition and classification of GTSRB traffic signals, five efficient transfer learning models are studied, accessible in the Keras library: Xceptionnetwork, InceptionV3 Networks, Residual Networks ResNet50, VGG-16 and EfficientNetB0. The main objective of this research is to use and analyze five state-of-the-art and efficient deep learning algorithms to determine which model can perform well in feature extraction and classification of accessible road sign data . The models were rated based on accuracy, loss, training time, and model parameters. For detection, recognition, and classification of traffic signs, the Xception network has proven to be very effective in terms of accuracy (95.04%), minimum loss value (0.2311), affordable speed and training time, while ResNet50 and EfficientNetB0 achieve good accuracy with fewer model parameters [11].

Li Xingjian et al introduced a regularization strategy to transfer behavior and semantics from the sourcenetwork to the target network by using attention to reduce the difference between the feature maps generated by the convolutional

layers of the source/target network. We create a normalized learning technique called DELTA that models differences between networks in feature maps with attention, an estimate of attention produced by supervised learning [12].

III. PROPOSED SYSTEM

In the previous section, we discussed existing works on TSR. This article aims to recognize all types of traffic signs regardless of their shape and colors. The details of our proposed system are shown below. Libraries to use: - NumPy, Matplotlib, Keras, OpenCV, Scikit-learn, Pickle, OS, Pandas, Random. Input data: - We use the German Traffic Sign Recognition Standard (GTSRB). The input dataset contains 34,799 labeled images and 4,444 images are classified into 43 categories. Figure 1 below details the 43 categories. For training, testing, and validation sets, we divide the total number of frames at 80:20 to get a training-to-trial ratio. From this training set, we again split a total of images in an 80:20 ratio for training at a validation scale set. So, the dataset is divided into three parts, 64% of the dataset is used as the training set, 20% of the datasets are used as the test set, and the remaining 16% of the data set are used as test set. Verification set.

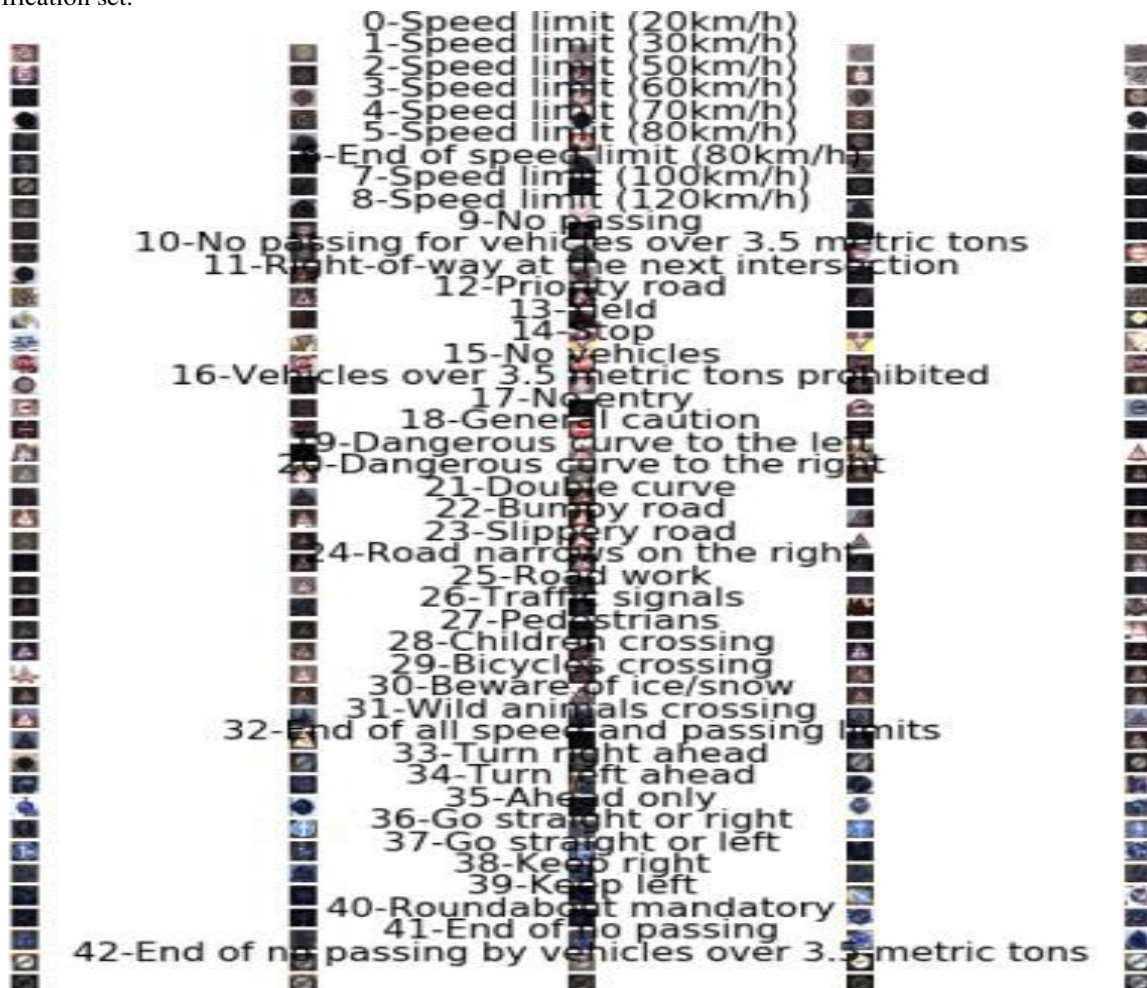


Fig 1: Set of traffic sign images

As a result, 22,271 photos are utilised for training, 6960 images for testing, and 5568 images for validating.

Figure 2 depicts the classification of the input dataset (34,699 photos) into 43 classes. The distribution of the input dataset into 43 classes is determined by the input dataset.

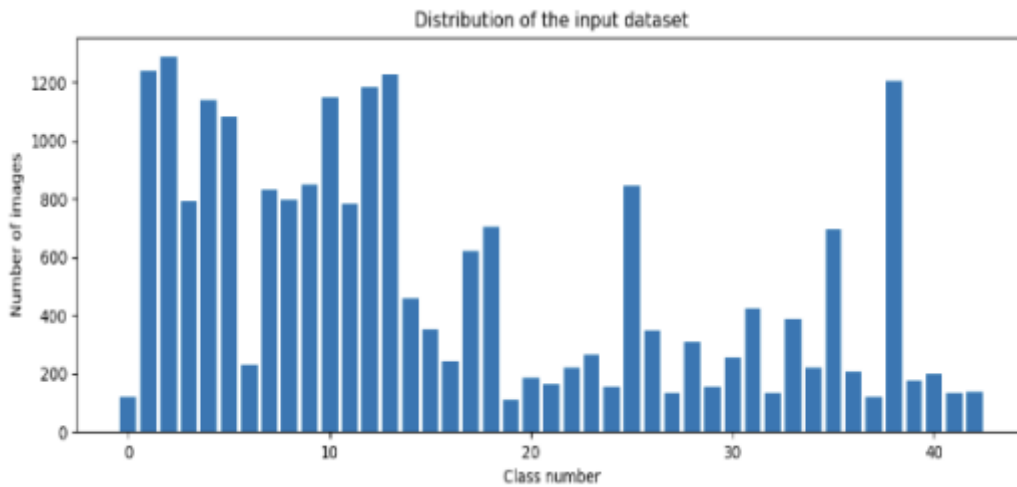


Fig 2: Distribution of Input Dataset (34,799 images)

Preparation: - Data preprocessing is the process of preparing raw data for use in Machine Learning.

The dataset's input pictures are 32x32 in size and include three channels, namely Red-Green-Blue (RGB). NumPy is used to import these pictures and their classes into a matrix. The dataset contains 32*32*3 input photos (where 3 represents the number of channels, i.e., 3 channels = RGB).

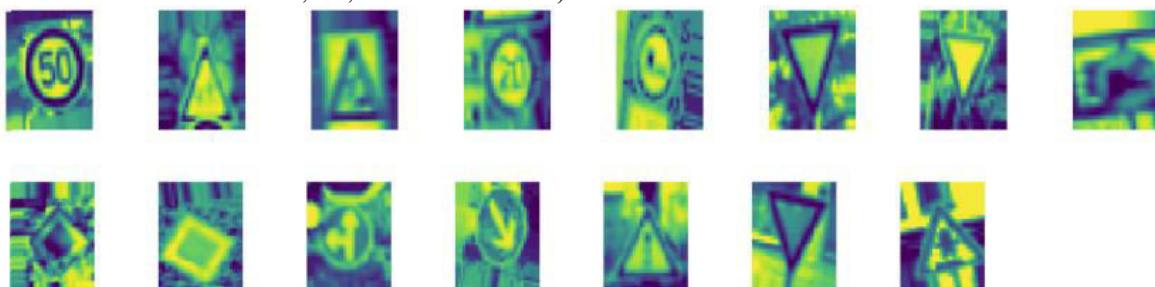


Fig 3: Image Augmentation Technique used on training dataset

We started by converting all of the training photos to grayscale, and then we increased the contrast by equalising the histogram and standardising the data. The pictures are then enhanced (i.e., zoom, rotation, width shifting, height shifting, shearing, and so on), as illustrated in Fig. 3.

Classification: We built a Convolutional Neural Network (CNN) based on Yann LeCun's LeNet-5 architecture. Figure 4 depicts the LeNet-5 system architecture.

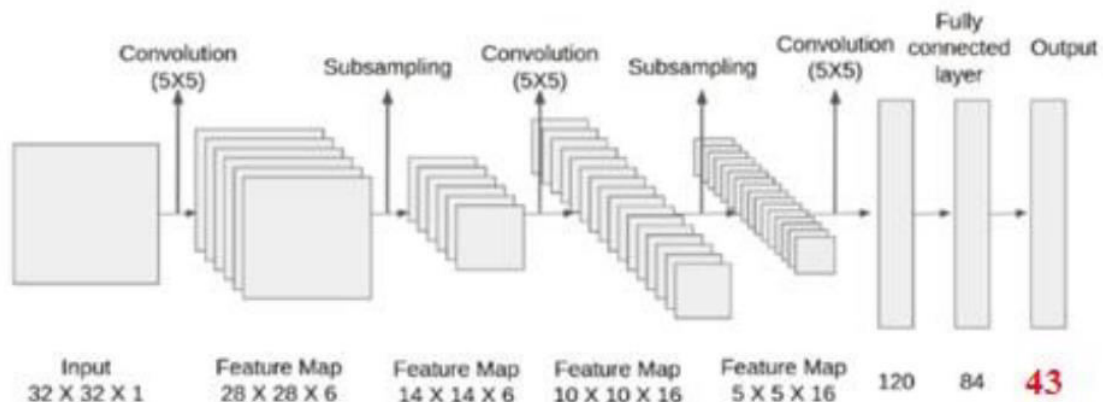


Fig 4: LeNet 5 CNN model

The figure 4 is borrowed from the source , however in this picture we display 43 output classes because there are 43 traffic signs in our dataset that need to be categorised. This model is first implemented, then trained on training data and validated on validation data.

This trained model is saved as a pickle object and utilised in OpenCV. We utilised OpenCV to put our trained model to the test in real-time sign detection.

The configuration of our suggested system is depicted in Fig. 5.

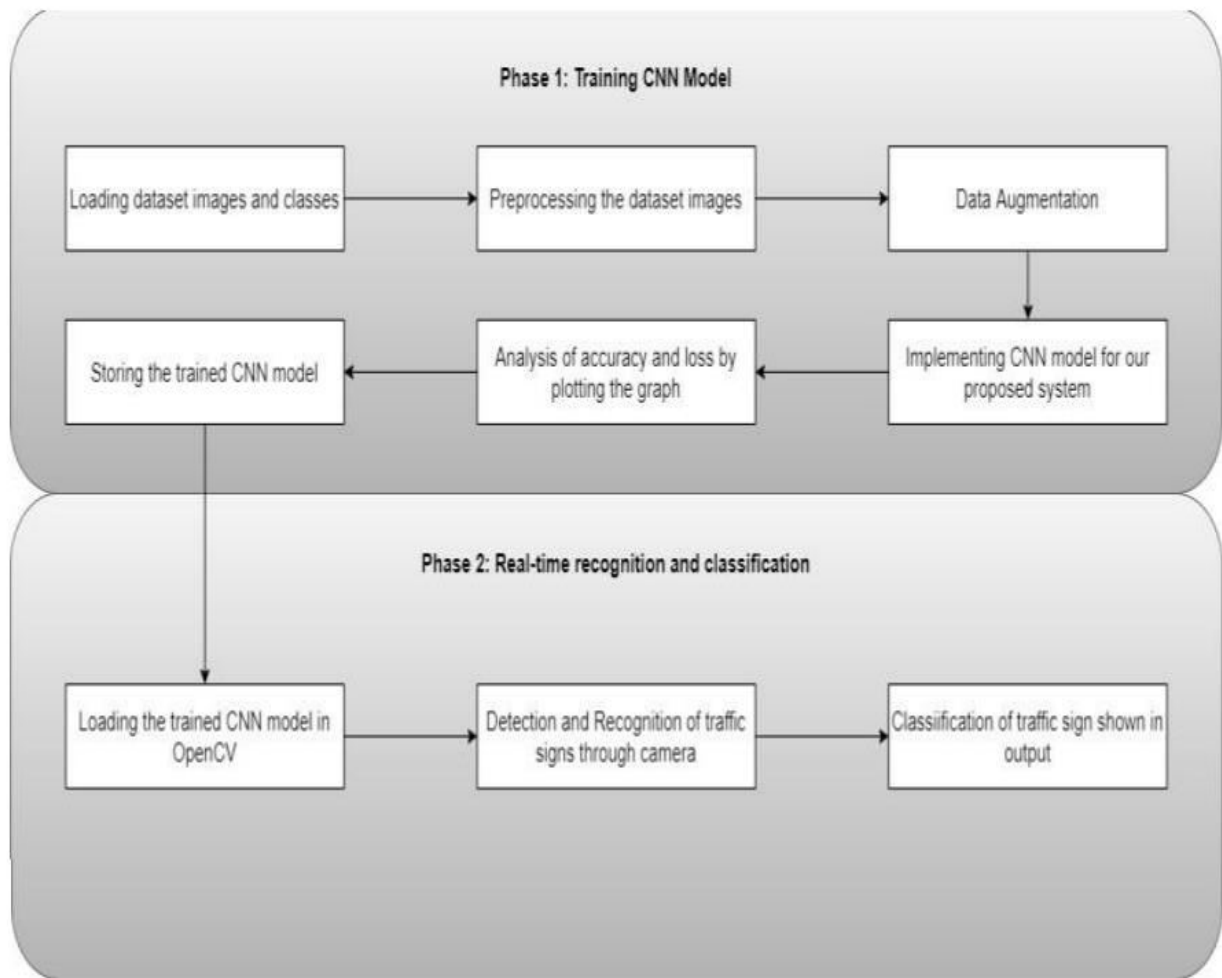


Fig 5: Layout of our proposed solution

IV. CONCLUSION

Our suggested system can identify and categories a set of 43 traffic signs in a variety of situations such as dark lighting, wet weather, and so on. Using the system we presented. We observed an accuracy of approximately 99% and a loss of around 1.3%. The likelihood of correct traffic sign identification is 100% for most signs, but not all signs result in such a high probability, which may be improved by supplying an equally distributed dataset. Our suggested system overcomes numerous limitations of the existing TSR, such as identifying any traffic sign in any lighting condition, and so provides a superior solution.



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