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Real Time Indian Traffic Sign Detection using Image Processing and CNN

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Abstract: *Driver Assistance and Monitoring System plays a very important role in traffic management especially in Indian roads. It eventually reduces the accidents and major injuries. DAMS (Driver Assistance and Monitoring System) give the safety and driving comfort. The main motto of our work is to design the effective methodology for the assistance and driver monitoring system which alerts the driver when it detects the road signs so that driver can take the appropriate action. The proposed methodology detects a road signs which is present in the dataset under cluttered background and different lighting conditions. The proposed work detecting the road sign based on colour and shape. The edge of the road sign is detected using canny edge operator. The images are enhanced and removed the noise using median filters. The images are classified as stop, no entry, speed limit using Convolutional Neural Network (CNN) classifier.*

Keywords: TSR (Traffic Sign Recognition), DAS (Driver Assisting System), Convolutional Neural Network (CNN)

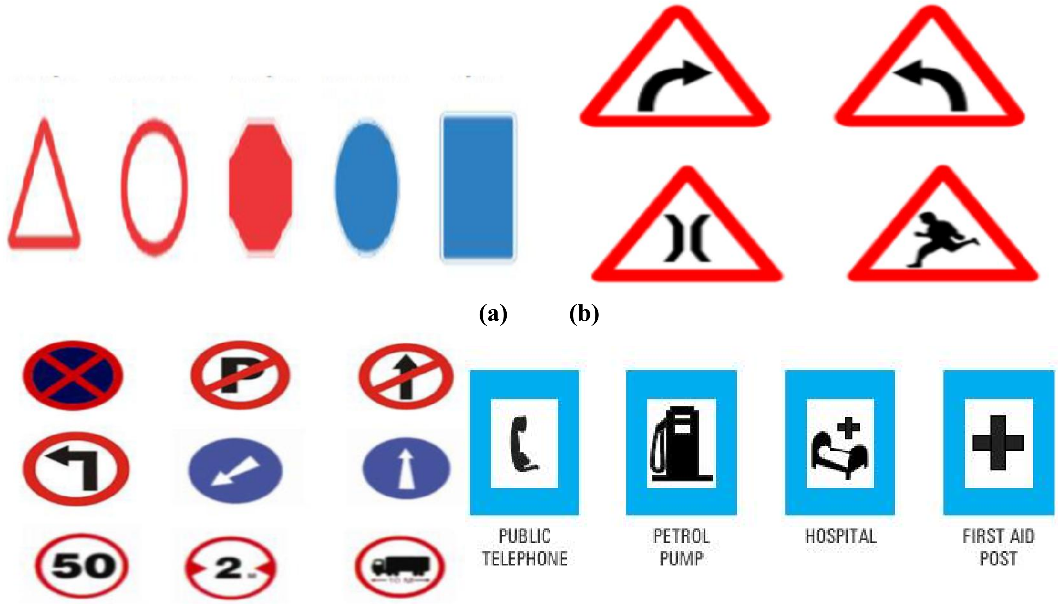
I. INTRODUCTION

According to statistics in India more than 232 000 peoples are killed in road accidents. In order to reduce the number of traffic accidents and, consequently, the number of fatalities, technology can be extremely beneficial. The traffic signs along the sides of the road can be difficult for drivers to see very frequently, and they may occasionally overlook the warning warnings. These warnings may say "bump ahead," "thin bridge," "accident zone," etc. Even more challenging are moments like these and evenings. Drivers may occasionally be unable to read anything due to traffic or poor road conditions. Aim of this work is to employ image processing to develop a resolution to this problem.

Numerous algorithms for the identification and categorization of traffic signs have been created recently. The challenge of autonomous cars as a whole can be regarded to include traffic sign recognition (TSR). Making driving judgments requires an autonomous vehicle system to recognise its surroundings via vision. This vision-based identification system may act as a source of feedback for several controls, including the steering, wheel, the accelerator, and the brake. It may recognise the lane and the road to enable the control system to follow the path of the own vehicle. It may also detect roadside obstacles until the control system avoids them. Additionally, in order to warn the control system of any possible dangers, it may detect approaching cars (using, for instance, side or rear cameras). Finally, it may recognise and interpret traffic signs to provide drivers advice on how to drive safely.

Drivers can learn vital information from traffic signs regarding the state of the road and potential risks. By using an autonomous road sign recognition system to give the driver traffic information, such as details about the road in front of the car, accidents may be avoided. Circles, triangles, rectangles, and octagons are just a few of the diverse forms used for traffic signs. The use of these technologies helps drivers drive safely. They are clearly distinguishable by humans because to their distinctive form and colours. The same actors can assist in developing a TSR system based on vision. The goal of using autonomous vehicle control for safer driving with less mental strain on the driver was one of the three primary work topics that were defined. The goal of the many parts that make up the traffic environment is to control the flow of traffic and ensure that all drivers are following the law in order to offer a safe and secure environment for all parties involved.

The below Figure 1.describes the different shapes and colour of the traffic signs, and some examples for Cautionary, Mandatory/Regulatory and Informatory traffic signs



(a) (b)

(c) (d)

(a) Shapes and Colours of signs (b) Cautionary signs (c) Mandatory/ Regulatory signs (d) Informatory signs **Fig 1:** Some examples of Traffic signs

This study describes a software programme for recognising traffic signs . The application has four stages of operation. The first step in locating regions of interest (ROIs) is to pre-process the image, which involves making it grayscale and applying the Laplacian of Gaussian (LOG) filter to find edges. Next is the possible traffic sign detection, where each form pattern's ROI is evaluated. If each potential traffic sign is confirmed, the third phase, a detection stage using a cross-correlation algorithm, classify the signs according to the traffic sign dataset. Finally, the prior procedures may be managed and controlled via a graphical user interface designed especially for this purpose. The results collected demonstrate the created application's strong performance while taking into consideration the size and contrast requirements of the input image.

II. LITERATURE SURVEY

Today, traffic sign categorization and identification are crucial skills, particularly for unmanned autonomous driving. The identification and categorization of traffic and road signs has been the subject of extensive research.

The programme was created in 2014 by Rubén Laguna et al [1][14] and compares the region of the original picture where the prospective traffic sign is placed to a database that contains normalised traffic signs. The graphical user interface of this programme enables the user to manage each step of the application. Depending on the input image's resolution and ambient factors, the findings produced demonstrate a high success rate. In 2019, Danyah A. Alghmgham et al [2][19] developed an autonomous traffic sign identification of Arabic roads and uses Deep Learning for recognition. The proposed system can capture images of road signs through cameras and analysed by a Deep CNN network. This technology, which is put in cars and is capable of detecting and identifying any road sign, is primarily intended to assist the driver or the self-driving process. Deep learning algorithms may be used with unlabelled data, and the system can automatically extract features without human input. Prof. Chhaya Narvekar et al. [3][9] they proposed device is designed to notify the motorist when traffic signs are present at a specific distance apart. The capacity of this technology to detect, recognises, and infers the road traffic signs would be very advantageous to the driver. The objective of an automatic road sign identification system is to identify and classify one or more road signs from inside real-time, colour pictures that were recorded by a camera. A traffic sign's colour may be clearly distinguished from the colours of the surrounding area. To enhance picture quality, eliminate erroneous pixels, and identify edges, the system employs a variety of image processing algorithms. To locate objects in a picture, utilise the object decompressor. Images are categorised according to their properties using Support Vector Machine (SVM) machine learning method. A speech signal is produced to alert the motorist whether the sign features learned from the video match the already constructed traffic signs. Ying-Chi Chiu et al. [4][25] describes the detection and identification of traffic sign pictures recorded by the vehicle's on-board camera, they provide a two-stage network. They use Faster R-CNN in the detection network to find the locations of the traffic signals. SVM, VGG, and ResNet are used for testing and validating the classification network. In comparison to YOLOv3 and Mask R-CNN, the findings employing Faster R-CNN for detection and VGG17 for classification have shown higher performance. Priyanka A. Nikam et al. [5][20] proposed a method in 2017 this system uses colour information and shape analysis to recognise traffic signs, followed by PCA to classify them (principal component analysis). Road signs are detected by the detection module utilising shape filtering after segmenting the input picture in a YCBCR colour space. Principle Component Analysis is used by the classification module to identify the kind of observed traffic signs (PCA). E. Ramalakshmi et al. [6][13] presently the traffic signs in the video are detected by shape filtering technique. The current classifier module defines the type of road signaling detected by the neural network. Manjunatha H T et al [9] provide the system of Indian road lanes detection based on regression and clustering using video processing techniques this is uses the continuous video streaming is detected and processed gives road lane id detected.

III. METHEDOLOGY

The methodology contains following sections 1.Input traffic signs 2.Pre-processing 3. Feature extraction 4.Feature reduction 5.Detection 6.Classification. The following block diagram figure 2 shows the road sign detection model

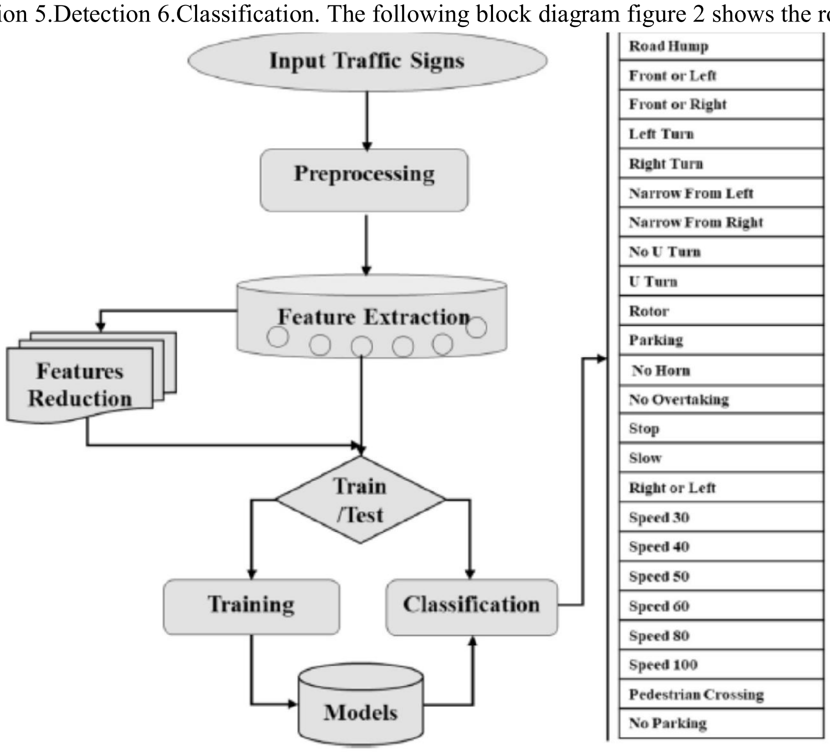


Fig 2: Road Sign Detection Model

3.1 Input Traffic Sign

The traffic sign recognition benchmark is a single-image multilayer classifier consisting of 43 classes with 31,367 training images, 7,842 validated images, and 12,640 test images.

3.2 Pre-processing

Before the photos are put into the CNN network, they must first undergo pre-processing because they are RGB images of varied sizes. The image is shrunk to 30x30 pixels and changed from colour to grayscale.

3.3 Edge Detection

When an edge detector is applied to an image, a group of linked curves that represent object borders, surface marking boundaries, and discontinuities in surface orientation may be produced. Edge detection techniques allow for the preservation of an image's fundamental structural qualities while also dramatically lowering the quantity of data that has to be processed and removing data that could be seen to be of less importance. The subsequent effort of deciphering the information contents in the original image may become considerably easier if the edge detection phase is successful.

A. Image Segmentation

The term image segmentation refers to the division of a digital image into many fragments (sets of pixels also known as image objects). Segmentation works to make an image's representation more useful and understandable by simplifying and altering it. Image segmentation is the process of naming every pixel in a visual so that pixels with the same label have same image properties. Figure 3 shows the sample sign that are pre-processed through different steps.

Fig 3: Pre-processed image

3.4 Feature Extraction

This system is ability to differentiate between traffic signs and background pictures using the colour, size, and orientation of segmented images is its most precise feature. Then, utilising correlation, homogeneity, homogeneity, variance, standard deviation, accuracy, and ultimately mean, the datasets are compared to this sign.

3.5 Feature Reduction

The feature reduction technique used in this system is PCA (Principal Component Analysis). This is the tool for statistical analysis allows exploration, coding, and grouping of data. To make it simpler to work with the data and generate predictions, PCA reduces a large number of associated (interrelated) variables to a smaller number of uncorrelated variables (principal components), while keeping the maximum degree of variation. PCA, on the other hand, is a technique for spotting patterns in data and presenting the data to highlight both its similarities and differences. PCA is a helpful tool for data analysis since huge dimension data may be challenging to discover patterns in when the luxury of graphical representation is not accessible.

3.6 Detection

The detection module's primary job is to extract picture edges and get the image ready for the following stage. Simply put, the contour is a curve that connects all of the continuous points along the border that share the same colour. Sketching is a valuable tool for examining shapes and recognizing objects. For best results, binary images are used. There are geometrical mathematical structures formed by joining points of similar magnitude or colour. We will use this concept for edge detection in the pre-processing step. This will help find the outlines or objects in the image. By varying the similarity value associated with the circle, we obtain different shapes. By applying a value of 0.7, one gets the maximum accuracy for the circle of the shape and one takes the coordinates of the contours.

3.7 Classification

The neural network classification method is incredibly effective and trustworthy. Road sign identification and categorization are good applications for neural networks. One of the main advantages of using a neural network is that the input image does not need to be translated into a different representation space. Second, the classification result is influenced by the relationship between the network's weights and initial selection. The need for a sizeably huge training data picture is the fundamental drawback of employing a multilayer neural network. This turned out to be a disadvantage

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because there isn't a common database for traffic signs in India. Consequently, the database must initially be established using either manual input, aggregated data, or a combination of the two. With 31,367 training photos, 7,842 validation images, and 12,640 test images, the symbology classifier has 43 classes.

This study's objective is to present a method for removing the traffic sign from the background image utilising a variety of edge detection and filtering approaches. The YCBCR conversion technique was used to compare the datasets and the identified image. Feature selection extraction is used to extract the precise symbol from the matched pictures. The first three stages of the proposed system are segmentation, form detection, and identification. To extract ROIs in the first stage, we want to partition the pictures. In the second, we determine the desired shapes, colours, and interior elements using the ROIs. The final stage is identifying the data included in the traffic signs that have been identified.

IV. EXPERIMENTAL RESULTS

The traffic sign recognition benchmark is a single-image multilayer classifier consisting of 43 classes with 31,367 training images, 7,842 validated images, and 12,640 test images. The dataset contains reliable field data thanks to semi-automatic annotation. The dataset also ensures that instances of real-world traffic symbols are unique in the dataset, i.e. each traffic sign appears only once. When discussing images and their format, each image contains only one traffic sign. The actual traffic sign is surrounded by a border on the image that is at least 5 pixels wide and at least 8% tall. This makes edge-based methods of detection and identification possible. Image sizes range from 15*15 to 250*250 pixels but the image doesn't have to be square as this ensures no deviation in image size or resolution. The annotations are provided in a separate CSV file and include the bounding box height and width as well as the coordinates of the upper left and lower right corner of the sign is bounding box. The below table 4.1 shows the efficiency of different methods and our method

Author	Method Used	Efficiency
Danyah A. Alghmghama [2]	K Clustering Algorithm	92.6%
Prof. Chhaya Narvekar [3]	Fusion of camera and lidar data	95.87%
Ying-Chi Chiu1 [4]	Using video as input and then applying feature extraction	95%
Our System	Convolution Neural Network	98 to 99%

Table 4.1: Results of other existing System

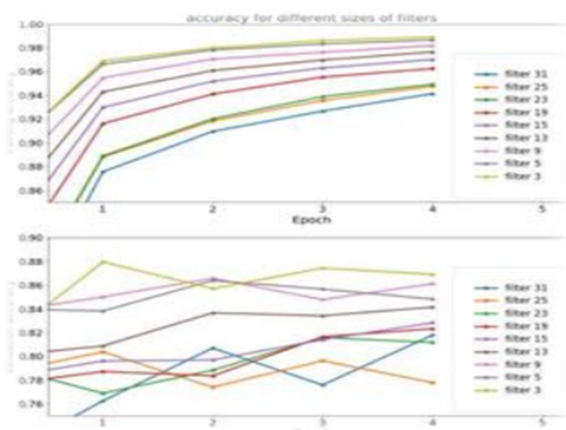
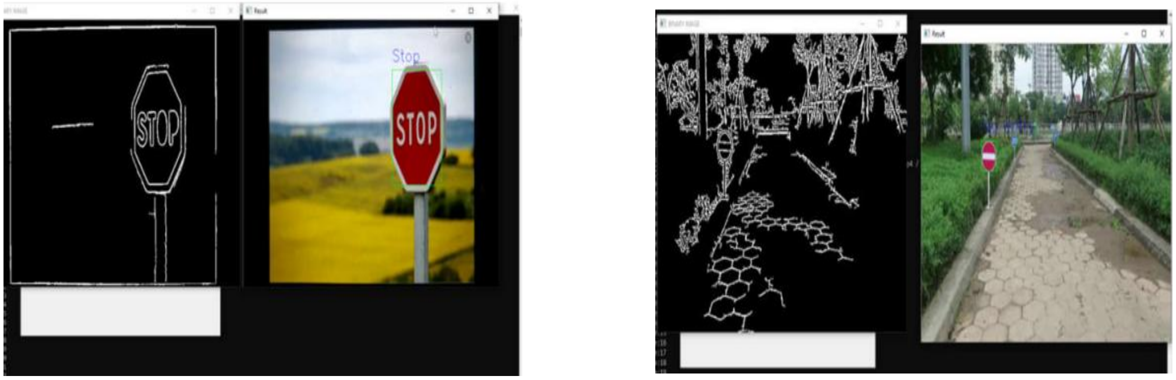


Fig 4: Accuracy Graph for size classes



(a) Detection of stop sign (b) Detection of No Entry sign

Fig 4: Detection of traffic sign after image processing

V. CONCLUSION

This model will help us get closer to developing the ultimate Advanced Driver Assistance System (Autonomous Car) or perhaps a fully driverless system although there is still much improvements to be made. For traffic sign detection, this method depends on shape and colour of traffic sign. A high efficacy is obtained by using CNN algorithm and the drawbacks which give improper detection include impaired colour, shape of the sign or reflections on the sign. The detection in the night can only be achieved using infrared camera. Combining text to speech module in this system can ease the driving and it also elevates the concentration of driver on road than that of on the traffic signs thus may prevent accident.

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