SMART VEHICLE – TRAFFIC SIGN BOARD DETECTION SYSTEM

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Abstract.
The traffic problem is one of the major problems in the world. Machine learning (ML), a sub field of artificial intelligence (AI), allows computers to learn and adapt to new rules. With ML algorithms, the machine can process and recognize different samples of observations, figures and other data, which helps to identify and describe the model. Using the pre-processed data, the system can identify different kinds of traffic signboards. The traffic signboard detection process depends on two phases: Detection phase and Recognition phase. In the Detection phase, the image of the sign board is captured using a camera, then shape analysis and color segmentation of that captured signboard is done. At the detection phase, a road sign is extracted from the signboard. In the Recognition phase, the extracted sign is used for features values, classification and validation. At the end, the system gives an alert to the user (driver) about detected traffic sign boards. The system can deliver output with overall 98% accuracy.

Keywords—Traffic sign board recognition, Traffic sign detection.

INTRODUCTION

Many people get injured due to road accidents caused by road traffic. The traffic signboards play a very important role in controlling the traffic, and to prevent any kind of accidents, ensuring the safety of the people. Certain rules are required to follow while driving vehicles on the road. The different forms of traffic signboards are no entry, speed limits, left or right, school ahead, heavy vehicles not allowed, traffic signals, etc. Traffic signboards are designed in a specific shape and colors such that they can be easily recognized or detected.

In order to design a traffic sign board detection system that can read and comprehend different traffic signs and assist the vehicles in which they are installed in choosing and adhering to these laws, neural networks may be used. The goal of this work is to train and create a neural network-supported model that can recognize various traffic signs and make an appropriate judgment when imported into a car, in other words, such a neural network model can assist in preventing accidents brought on by driver inattention or over speeding.

RELATED WORK

Mohammad A. Khan, Sarfraz F. Khan, Taher Alawi Taher Barham Ba Omar, Abdul Rahman Mohammed Aqeel Ba Omar, et al. [1] Development & Implementation of Smart Vehicle Over Speeding Detector using IoT. In this paper, an IOT based solution is given for over speeding vehicles to avoid accidents. The system automatically detects over speeding vehicles and reports them to competitive authorities.

Anju Manjooran, Anphy Varghese, Annmariya Seby, Krishnadas J, et al. [2] Traffic Sign Board Detection and Voice Alert System Along with Speed Control. The paper gives information about how captured images by camera undergoes for image processing using SURF algorithm.

Muhammad A. Panhwar, Saleemullah Memon, Sijjad A. Khuhro, et al. [3] Signboard Detection and Text Recognition Using Artificial Neural Networks. The paper provides information about an AI and ML algorithms for detecting text from captured signs boards.

Abidha Pandey, Manish Puri and Aparna S. Varde, et al. [4] Object Detection with Neural Models, Deep Learning and Common Sense to Aid Smart Mobility. In this paper, explored the application of Common-Sense Knowledge (CSK) in object detection using neural networks and deep learning, highlighting the significance of CSK in capturing human intuition.

Agnes Asmy P T, Aiswarya C A, et al. [5] Real Time Traffic Light and Sign board Detection. The paper explores how to detect the Real-time autonomous driving depends on the condition of traffic lights, sign boards, and their interactions.

Raghavan Srinivasan, Martin Parker, et al. [6] Expert System for Recommending Speed Limits in Speed Zones. The paper gives different solutions to reduce the accidents occurring due to over speeding at various places such as schools, hospitals, markets, etc.

Pooya Najaf, et al. [7] A Macro-Level Analysis of Traffic and Pedestrian Safety in Urban Areas. The paper provides information to investigate how urban characteristics at the city level, such as urban shape and trip-generation factors, affect traffic safety generally and pedestrian safety specifically.

Aparna A. Dalve, Sankirti S. Shiravale, et al. [8] Real Time Traffic Signboard Detection and Recognition from Street Level Imagery for Smart Vehicle. In this paper, a solution is given for road sign board detection and recognition to assist the driver to ensure safe travel.

Jagdish Pimple, Payal Charpe, Harshita Dakhode, Chandani Gajbhiye, et al. [9] Design and Implementation of Sign Board Detection & Recognition for Self-Driving Vehicle. In this paper, a solution is provided for smart vehicles which can detect the direction of the road sign and recognize it.

METHODOLOGY

Our system uses a camera to detect the traffic sign boards. The system detects the shape of the sign boards of various shapes like triangles, circles, etc. and recognizes the various colors used in traffic signs such as the red-colored border of sign boards black colored instructions and white colored background. The shape and color detection of the system will finalize whether the given picture is of the signboard or not. If the picture is not of the signboard, system will ignore it and if the picture is of the signboard, the system will compare the picture with the database, giving the result to display and alert the user.

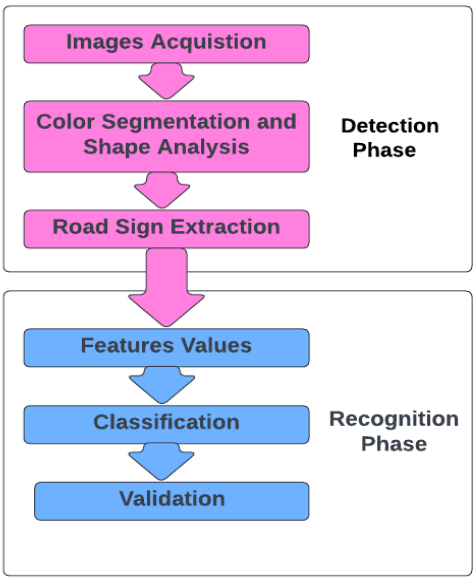


FIGURE 1. Methodology

The system should detect the image in various conditions like high sunlight, night, foggy weather, and blurry images.

A process is introduced for detecting and recognizing road sign boards that includes following three phases:

- **Color segmentation:** The colors of road sign boards are separated from the actual images using HIS (Hue, Saturation and Intensity) color closure method with chromatic signals. In additions, white markers from images are distinguished by using the achromatic color decay process.
- **Shape design:** Road sign conditions are divided into four different patterns by adding a value: restrictive, warning, informative and compulsory.
- **Signal recognition from signboards:** Road signage signals are detected by comparing the dimensions of the area – Area, template values and Perimeter Measurements. Value of templates depends on standard colorless images.

Color Segmentation:

Human color sensitivity and the HSI color spaces are closely connected. Using fixed values of thresholds, the elements like saturation and hue are sufficient to bring out the colors of the road signs. The imaginary colors represented by hue elements (yellow, blue and red with road sign boards) are intermittent [0,360]. Filling the space defines how much amount of white light is mixed to the original color and it lies between the range [0, 255]. HSI color spaces can be obtained by RGB color spaces using the equations given below. Theta is measured concerning the red-axis of the HSI model.

$$Hue = \begin{cases} for\ B \leq G & Hue = \theta \\ for\ B > G & Hue = 2\pi - \theta \end{cases} \tag{1}$$

$$with\ \theta = \cos^{-1}\left\{\frac{0.5[(R-G)+(R-B)]}{[(R+G)^2+(R-B)(G-B)]^{1/2}}\right\} \tag{2}$$

$$Intensity = \frac{(R+G+B)}{3} \tag{3}$$

$$Saturation = 1 - \frac{3}{(R+G+B)}[min(R,G,B)] \tag{4}$$

Only chromatic colors of road sign boards are considered by the hue elements. However, achromatic color of white markings is obtained by following equation:

$$Arc = \frac{abs(R-G)+abs(G-B)+abs(B-R)}{3D} \tag{5}$$

The degree of achromatic color output is represented by D (where D is set to 20) and the brightness of each color is represented by R, G and B. Arc value below 1 shows achromatic color, arc value greater than 1 shows chromatic color.

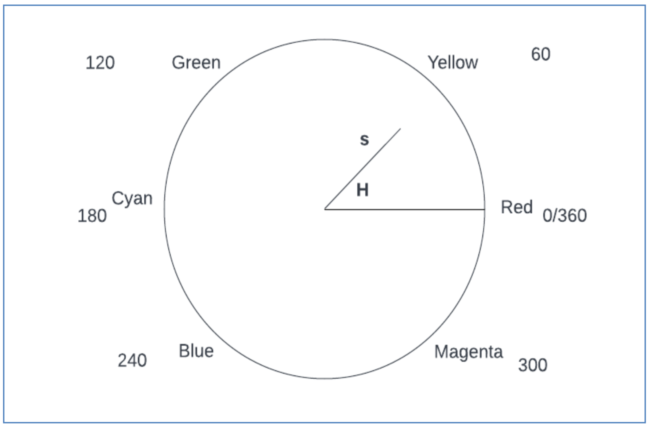


FIGURE 2. HIS model

Figure 2 indicates the red color range between the interval [0, 60] and [300, 360]. Dividing it by 360, we can get the hue element’s common range [0, 1]. As a result, the red color spectrum lies between the range [0, 0.166] and [0.833, 1]. The minimum value for color separation of traffic signs is set out in the following fig. 3 after the color inspection and filling of hand- selected sections of road sign boards.

Colour	Threshold Value
Red	H <= 0.027 and H >= 0.833
Yellow	H <= 0.166 and H >= 0.055 and S >= 0.350
Blue	H <= 0.650 and H >= 0.527
White	S <= 0.200

FIGURE 3. Threshold setting

The process of thresholding provides the result in the form of a binary image. The image contains background pixels shown by 0's, and the object of traffic signboards pixels by 1’s. After color separation, pre-processing methods such as morphological performance and filtering operations are used to analyse the region.

Shape planning:

In this phase, the regions found in the segmentation phase are subdivided into different kinds of shapes. The different shapes are rectangular or square, diamond, hexangular and circle. Sorting of shapes are performed under the grade formed by the binary images. Length of a certain number of pixels in the specific area of interest are pixels in the bounding box. Area of the shape is defined by the sum of the pixels in that shape. The total number of pixels in the bounding box refer to the region of that bounding box.

$$Extent = \frac{Total\ Pixels\ of\ ROI}{Total\ Pixels\ of\ Bounding\ Box} \quad (6)$$

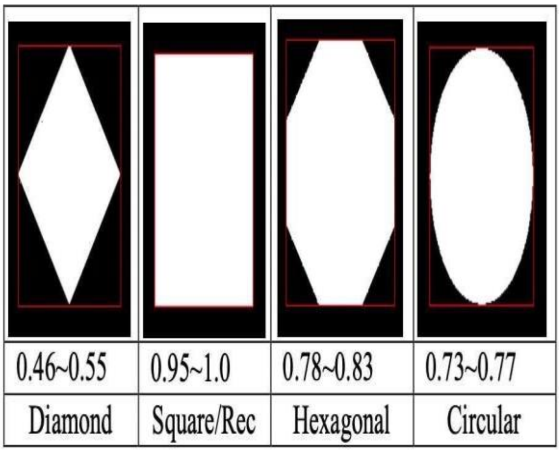
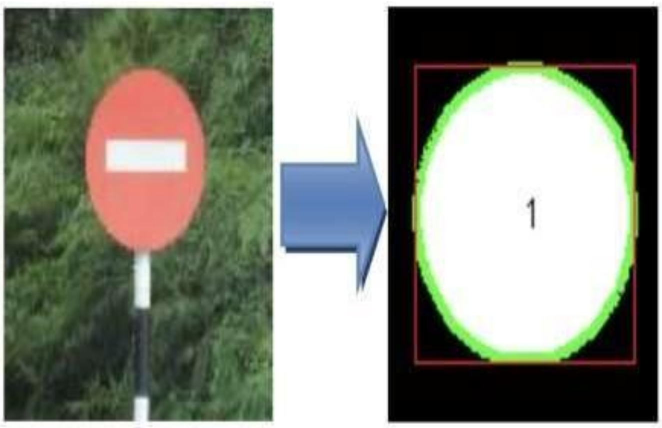
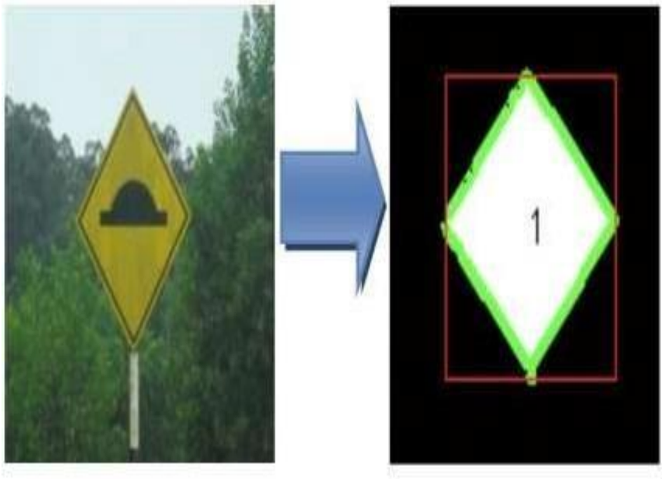


FIGURE 4. Pattern of traffic sign board shapes

Figure 4 displays a design of four shapes along with the associated interval of extent values derived from general images.



(a)



(b)

FIGURE 5. Classification of shapes with respect to “Extent”

Figure 5 gives the real signs that were photographed in an actual environment at University Technology PETRONAS and were recognized as having the shapes of a circle and a diamond based on the Extent value.

The bounding box’s red frame depends on the rectangle of the smallest size including the shape of area, while the green lines in the binary shape means shape borders are detected. One object was identified by the color segmentation category, as indicated by the label "1".

Symbol Recognition:

The bounding box and shape region gained from the shape categorization tasks are converted into a matrix of 180 x 180 pixels, in the detection and recognition process preparation. All perimeter ratio ranges and the region of the distinct symbols are examined with the standard image reference ratios.

Following are the equations of area-ratio and perimeter-ratios:

$$AreaRatio = \frac{Area\ of\ Symbol\ Region}{Area\ of\ Shape\ Region} \quad (7)$$

$$PeriRatio = \frac{Area\ of\ Symbol\ Region}{Area\ of\ Shape\ Region} \quad (8)$$

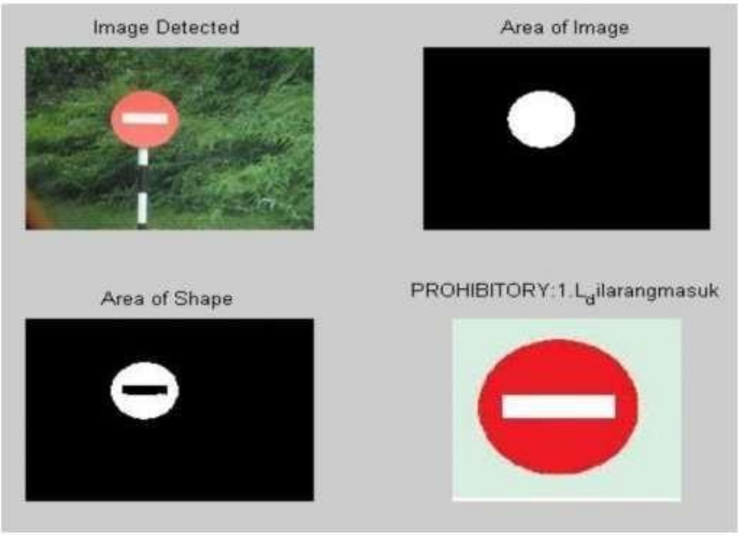


FIGURE 6. Sign board recognition using ratios of area

Figure 6 gives some examples of outputs of the detection and recognition process depending on the perimeter ratios and area.

Variables are used to store the standard-sized road signboard ratios.

The format that was proposed shows that the Extent's measurements are nearly comparable for all distinct scaling values (or that they vary depending on how far the observer is from the traffic signs on linear highways) and rotation techniques (relates to traffic signs in the hilly roads and corners).

Experimental Setup and Results

The system detects the traffic sign boards and gives alerts to the user with 98% accuracy.

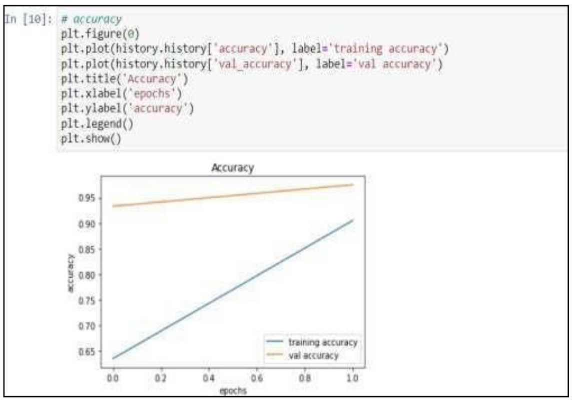


FIGURE 7. Accuracy vs epochs graph

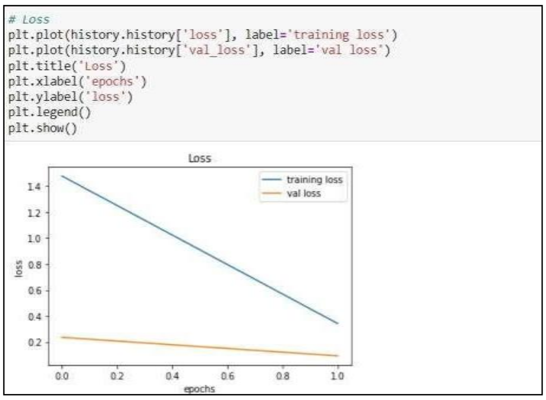
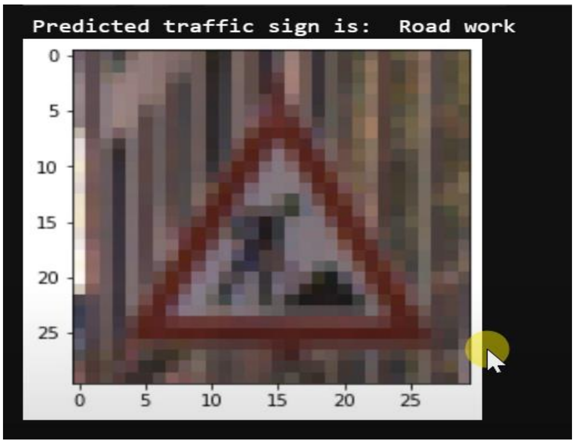


FIGURE 8. Loss vs epochs graph

The graph in Fig. 7 shows relation between accuracy and epochs. The accuracy is dependent on the count of the epochs. Maximum accuracy can be obtained by increasing epochs.

The graph in Fig. 8 shows relation between loss and epochs. The loss is dependent on the count of the epochs. Decrease in loss percentage can be obtained by increasing epoch.



(a)

(b)

Figure 9. Result

CONCLUSION

This technology is utilized to save precious lives by avoiding accidents that could have been avoided with better traffic sign boards. The project is primarily focused on the bulk of society's travellers, particularly night travellers, and it also aids traffic police in reducing traffic problems. The primary inspiration for this project came from the traffic accidents that occur when drivers fail to obey traffic signs. These traffic accidents result in fatalities, which is a wasteful loss of human life. The system proposed is user-friendly and offers optimal efficiency. Currently, 40% of deaths that occur each day are primarily the result of traffic accidents.

It is much easier to test and use the color-based techniques employed in traffic sign recognition. For in-depth investigation, large approaches for generating regions of interest are available. A good method for swiftly determining a vehicle's color is color detection. There are several viable shape-based methods for edge detection. To recognize traffic signs with minute edges, one needs to use a suitable colour enhancement approach. It is possible to create Region of Interest (ROI) pull-out techniques depending on color and form. The computer-based learning techniques are used to achieve the province of artistic outcomes. The previous Traffic Signboards Detection and Recognition algorithms, which have been tested on a few public datasets, have indicated high performance. Some fresh public data sets are required in order to test Traffic Signboards Detection methods that are intended for traffic signs from many other nations. Images taken by cameras are significantly impacted by unfavourable or harsh weather conditions including snowfall, intense rain, fog.

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