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FEATURE MATCHING FOR TRAFFIC SIGN BOARD RECOGNITION

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Abstract:

Traffic safety is a complicated problem which requires careful designing and planning to develop an ideal solution. Traffic rules are implemented by the government to safeguard the public for a harmonious society and these rules are implemented using traffic signs. The general public is expected to identify, interpret and follow the traffic rules and signs. Failing to understand these signs would result in undesired consequences. An autonomous system in a car which performs detection, recognition, interpretation and gives warning to the motorist would help in reducing the number of accidents. In the proposed system, we use MATLAB to implement the recognition of traffic signs using the images captured and this forms a part of Driver Assistance system. Our system works in real time environment with high detection accuracy of more than 90% in different lighting conditions in the day and on partial damaged sign boards.

Index Terms **- Feature, Road Sign, Traffic Sign, Feature Matching.**

I. INTRODUCTION

Presently, the Driver Support Systems (DSS) is developing in most of the companies the manufacture automobiles. DSS is very important in smart automobiles because, suppose the driver is under the influence of alcohol or is sleepy or tired and lazy a small mistake in perception or focus might end up with him meeting an accident. Hence, DSS plays a vital part in preventing road mishaps. Traffic Sign Recognition in real environment is very difficult as visibility is variable according to weather conditions. The color information is very sensitive to the variations of the light conditions such as shadows, clouds, and the sun. It can be affected by the daylight, illumination geometry, and viewers perception. Sign boards are usually found to be disoriented and damaged. When the image is captured from a car in motion, then it is usually blur due to the vibrations. Previous road signs were landmarks, showing distance or path. Throughout the mid 70's period, multi-directional signs at the intersections were popular, providing directions to cities as well as neighbourhoods. With the introduction of automobiles and the heavy traffic on the highways, a lot of people have opted pictorial signs. This also intends to increase road safety by providing warning, control and information signs. The paper provides an algorithm for traffic sign recognition in real environment. Its main focus is on shape recognition of the sign board by the method of pattern matching between a standard traffic sign and the ones that need recognition.

II. BACKGROUND WORK

In the literature, where grayscale images are used to interpret the outer edges of the signals, Hough transformations, Genetic Algorithms, and Neural Networks are favoured [1]. Feng Lin et.al [2] presents a new approach to the extraction of features by integrating both local and global features. For other studies, colors are taken into consideration and used, for particular, for the sign board segmentation from the rest of the picture. [3] [4] [5] [6]. This usage is somewhat distinct from the approach used for the use of color details in this review. Color spaces that are not influenced by lighting changes, such as HSI and HSV color models, are also used [7] [8] [5].

Qiong Wang [9] presents an effective alternative approach to the HSV model for the segmentation of sign boards in natural scenes. The use of the shape information in the detection phase used in [5] [10] [11] is also an alternate way of extracting features. But some difficulties emerge with the use of shape details. For eg, the picture can include objects that have comparable shapes to sign boards, like screens, doors, vehicles, and signs having the name of the store. The new feature extraction method[2] is explained by integrating local and global features and extended efficiently to the classification of sign boards. Center Symmetry Local Binary

Pattern (CSLBP) is an upgrade over the local binary pattern (LBP). Kushal Virupakshapaa [12] depicts a two-phase key-point-based algorithm uses road sign detecting and recognizing detectors.

Ratheesh Ravindran et.al [13] illustrate an improved Single Shot Detector algorithm using multi-feature synthesis and optimization called MF-SSD for sign board detection. M. S. Monika Lasouta [14], Presents a sign board detection and recognition algorithm based on image gradient knowledge.

Neural networks are commonly used for the detection and identification of sign boards, often as a classifier in recognition step [5] [15] [16] [17]. The prototype of template matching is the second most frequently used option in the recognition phase [11]. SIFT addresses many issues with earlier Algorithms, such as the sluggishness of the template-based matching techniques, the need for a wide variety of training images, such as neural methods, or the need for a prior understanding of sign's physical properties [18]. Kiraan C.G et.al [19] [20] [7] Current RGB color-based thresholding approach and feature points was introduced for a real-time sign board identification and recognition system. The system is capable of identifying and recognizing full-resolution multiclass signs images with high precision, and the identification and recognition are partially reliable due to hue shifts, blurry edges and minor blockings [18] [3] [20]. In [4], a new approach focused on deep visual features to boost the efficiency of sign board recognition is proposed.

W. Canyong [17] presents detection of sign boards and identification methods is built on the basis of the YOLOv3 system. Most of the methods described in literature are used in real-time applications. Few were brought into the autonomous car implementation phase, driving assistance cars [3] [20] [7]. In [15], the application of the convolutional neural Networks (CNNs) model for the recognition of sign boards (TSR) systems is discussed.

III. FEATURES OF ROAD SIGNS

Traffic signboards are bridge between the traffic laws and the driver. The laws to be followed by an individual riding or driving are put on boards and placed in necessary locations. Be it a warning sign of a hump ahead or be it displaying speed limit, traffic sign boards make it simpler to follow. It is human tendency to sometimes look past these boards and that is where our algorithm comes into play.

A signboard is a sign that provides information or instruction using a combination of shape, colour and symbols but excludes information in writing. Safety signboards should not contain text. This is because the symbols or pictograms on a signboard are intended to be understood, independently of the language ability of the person viewing it.

3.1 INDIAN ROAD SIGNS

In Indian sign boards, the colours and shapes used on safety signboards are:

- Red for prohibition
- Yellow for caution
- Green for positive action
- Blue for mandatory actions
- Discs for prohibitions and instructions
- Triangles for warnings
- Squares and rectangles for emergency and information signs

The traffic signs in India are broadly categorized as informatory, Warning, Prohibitory and Mandatory sign boards. Apart from these classifications, there are few signs categorized as special sign boards. The sign boards under five categories and criteria to classify is mentioned in Table 1.

Table 1. Criteria for classification

Type of Sign	Colour		Shape			
	Blue	Red	Circle	Triangle	Rectangle	Other
Informatory	✓				✓	
Warning		✓		✓		
Prohibitory		✓	✓			
Mandatory	✓		✓			
Special		✓				✓

Under each category, there are various traffic sign boards such as stop , give way, one way, speed limit etc. Few sample sign boards under each category are shown in Figure 1.

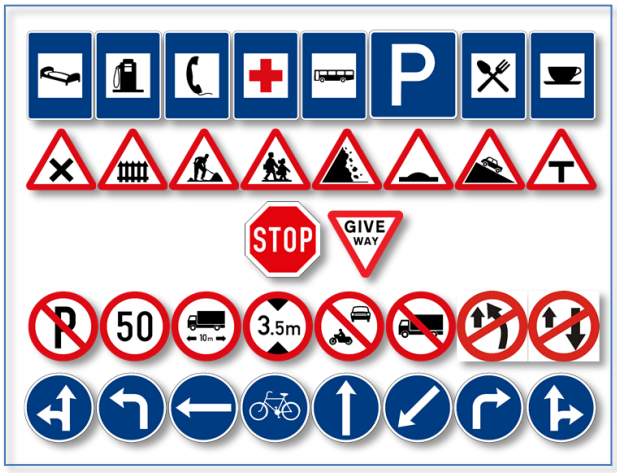

Figure 1. Categories of Traffic Sign Boards in India

INFORMATORY SIGNS

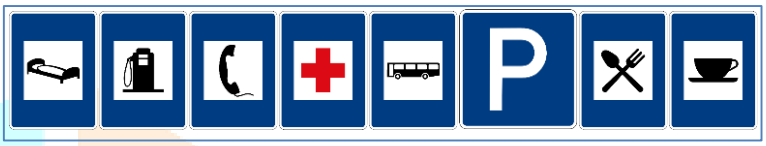

Figure 2. Informatory signs

Informatory sign boards are blue sign boards that are square in shape and tell us about any public building that is present in the surrounding as shown in Figure 2. For example, a hotel or a hospital. Apart from this, information signs gives us more information about the start (and end) of a kind of traffic situation.

WARNING SIGN BOARDS

Figure 3. Warning signs

The warning signs depicted in Figure 3 have an influence on the priority rules. They warn road users of a potentially dangerous traffic situation.

PROHIBITORY SIGNS BOARDS

Figure 4. Prohibitory Signs

The prohibition signs outlaw a certain action and they indicate certain actions that road users are not allowed to do. Fe sample sign boards are shown in Figure 4.

1) MANDATORY SIGN BOARDS

Figure 5. Mandatory signs

The mandatory sign boards as in Figure 5 show us rules that we have to follow. A right turn or if it is only cycle zone etc. It tells us beforehand if there is a turn ahead or if there is a junction ahead of us. In other words, mandatory signs enforce an obligation that road users must comply with.

SPECIAL REGULATION SIGN BOARDS

Figure 6. Special regulatory signs

These sign boards are very different from the other group of sign boards. They have a peculiar shape and these sign boards are important in limiting speed and giving priority vehicles way to go. The priority signs have an impact on the priority rules. Sign boards as given in Figure 6 indicates who has priority and who should give priority.

3.1 DATASET

For experimentation and assessing the performance of algorithms, we have used publicly available traffic sign dataset German Traffic Sign Recognition Benchmark (GTSRB). Pictures of road sign are captured under different scenarios such as urban, rural and highway during day and dusk. Road signs shown in Figure 7 shows the pictures taken in different lighting conditions, viewing angle, distance and blurring.

Figure 7. Road signs from German Traffic Sign Recognition Benchmark dataset

IV. SYSTEM OVERVIEW

The system, depicted in figure 8, has different stages that perform operations for recognition of the sign boards. Image is acquired by a camera mounted on an automobile. More than 1000 images captured in various lighting conditions are used for testing the algorithm.

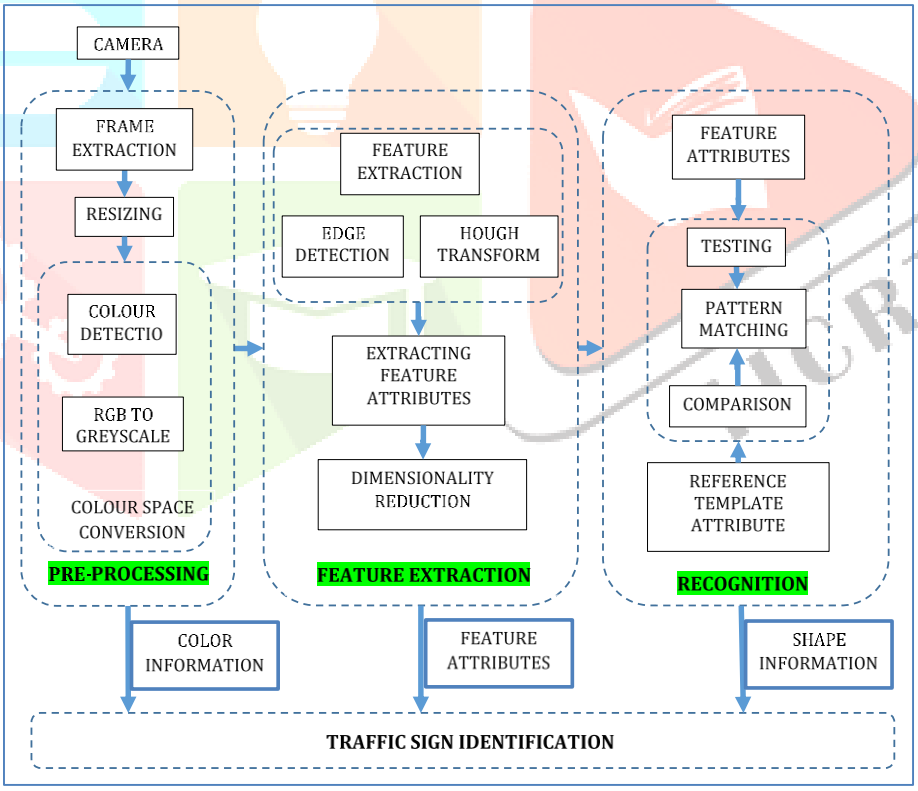

Figure 8. System Architecture

According to the color information from the sign board, the sign board is separated from the remaining image. Objects of a color close to that of a sign board (red or blue) may be obtained from the picture. To filter these undesirable images, shape detection is used to help identify the real sign board. The feature detection involves canny edge detection and Hough transform for the detection of the shape and extraction of the necessary portion of the captured image.

Figure 9. Gray Scale Conversion

The most common shape-based approach is the Hough transformation. The Hough transformation usually isolates features of a particular shape within a given image. It can be applied to detect triangular and circular signs. The main advantage of the Hough transformation technique is that it is tolerant of gaps in feature boundary descriptions and is relatively not affected by image noise. However, its main disadvantage is the dependency on input data.

Feature recognition uses the pattern matching algorithm and convolutional neural networks to identify the sign board and extract its feature. The core theory for the pattern matching is to calculate in two pictures the Euclidean distance between patterns to match them.

This process simplifies image analysis with a drastic reduction in the data to be processed whilst maintaining useful structural data on object boundaries. This idea has been tried with the canny edge detector which has lesser probability of error rate.

V. EXPERIMENTAL RESULTS

Algorithms are tested with MATLAB programming. For validating the results, manual observations are followed along with other mathematical modelling techniques.

Tests are conducted under following conditions:

- Variable lighting condition
- Blurring effect
- Poor visibility / Effect of Dusk
- Multipe appearance of sign
- Motion artifacts
- Damaged or partially obscured sign

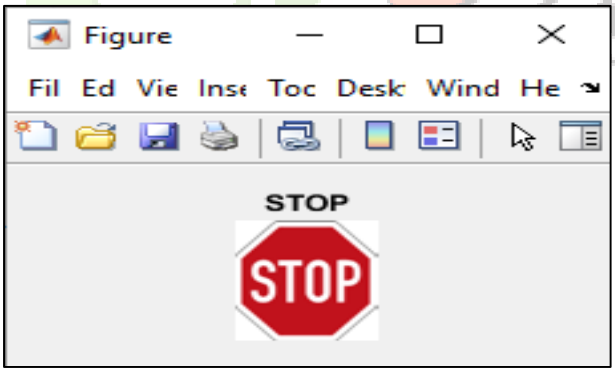

Figure 10. Sign Board recognized as **STOP**

Experimental result on the picture shown in Figure 10 reveals that the algorithm correctly determines the real picture representing the slowdown sign board. The average time to run is 5.20 minutes to 5.630 minutes. When the image resolution decreases, the program speeds up. Experiment on video frames identifies the sign board as shown in Figure 11.

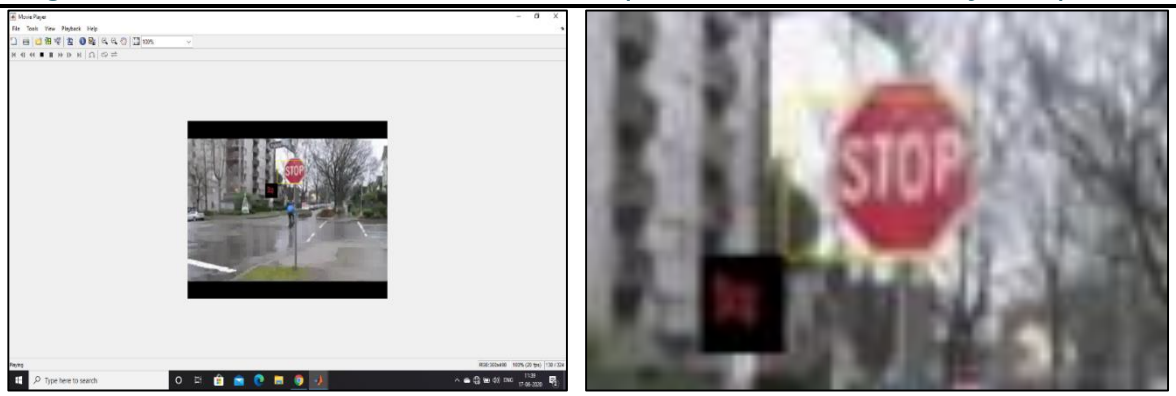

Figure 11. Traffic sign recognition in Video frame

5.1 SIGN BOARD DETECTION EFFICIENCY AND PERFORMANCE

Sensitivity and precision values are determined using experimentation. Sensitivity is the capacity to correctly identify a condition, while specificity is the capacity to correctly exclude a condition.

Using extracted information, the outcome is divided into four categories of measurement factors. They are False positive (FP)-when the sign board is incorrectly detected, False negative (FN)-when the sign board is perceived as a non-sign region, True positive (TP)-when a sign board is correctly identified and True negative (TN)-a non sign region correctly identified. Recognition efficiency is tabulated in Table 2.

Table 2. Recognition Efficiency

Measuring Factors	**Formula**	**Recognition Efficiency**
Sensitivity	TP/ (TP + FN)	89.43%.
Specificity	TN/ (TN + FP)	99.12%.
Precision	TP/ (TP + FP)	98.21%.
False positive rate)	FP/ (FP + TN)	0.009%.
Accuracy	(TP+TN) / (TP+TN+FP+FN)	95.71%.

The overall accuracy of the system of sign board recognition is 95.71%, whereas the detection accuracy is 94.85%. The TPR is 89.43%, while FPR is 0.009%, according to the data review. A high recognition rate in Octagonal or "BERHENTI" sign is 94.94% and the lowest is "no parking" with recognition rate of 84.09%. Recognition system processing time is 0.18 s. The Traffic Sign Detection and Recognition (TSDR) system's overall processing time is 0.43s.

Table 3. Description of signs for the trainings of neural networks

				Total
Test outcomes	Positive outcomes	True Positive=110	False Positive=2	112
	Negative outcomes	False Negative=13	True Negative=225	238
		123	227	350

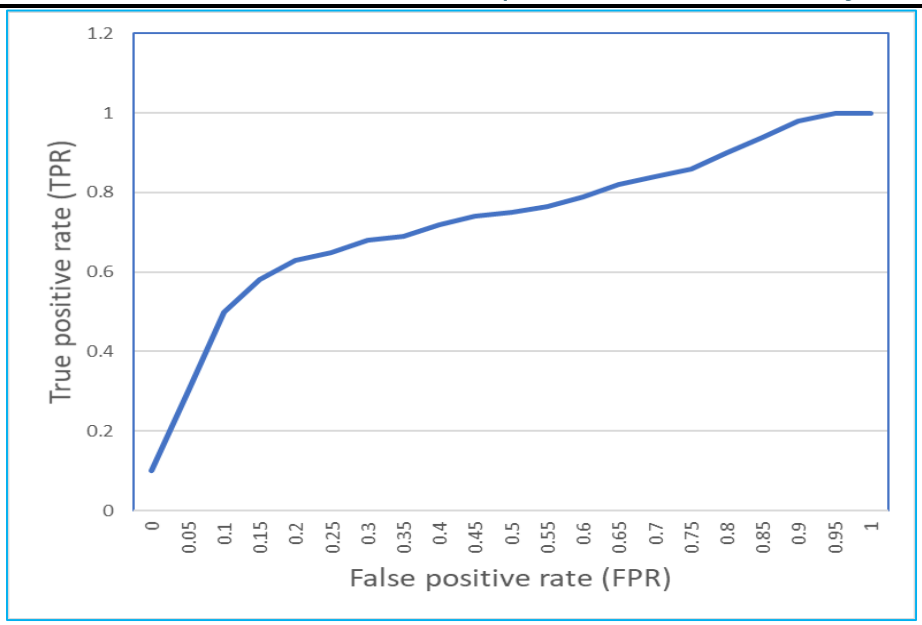

Figure 12. Graph of FPR versus TPR

Table 4. Execution time and Recognition rate

Sign Board	Average time of execution (s)	Recognition percentage under Normal Conditions	Recognition percentage under undesirable Conditions
STOP	47	98.5%	88%
Warning – Give Way	49	98%	87%

Accuracy of recognition is compared to other approaches dependent on specific form characteristics. The pattern matching algorithm achieves 97 per cent precision compared to 96 per cent precision of Haar invariant features and 90 per cent precision of Fourier Transform (FT) coefficient. The algorithm is designed mostly to operate in real time environment. Various non- technical factors affect the system in real time and there might be performance degradation.

The factors are Variable lighting condition – lighting plays a vital role in helping the camera grasp the image. To resolve this, an algorithm based on adaptive colour threshold segmentation has been proposed. Fading and blurring – the images captured can be blurry or faded because of rain or snow. This sometimes causes false recognition. To overcome this a hybrid shape detection and recognition is used to increase efficiency. Damaged sign board – sign boards could be damaged, partly occluded or clustered. To overcome this hybrid segmentation and detection methods are used. Real time application – accuracy and speed play a vital role in the grading of a system. We use convolutional neural networks for this.

VI. CONCLUSION

In feature extraction for the detection and Recognition of Sign boards, strategy that we proposed overcomes various difficulties that is being faced in bringing out an efficient automatic sign board detection and recognition system for both automatic as well as manual cars. We have achieved the goal of developing an efficient TSDR system based on traffic sign dataset. In the image acquisition stage, the images were captured by an on board camera and tested under different weather conditions. The developed system has shown promising results with respect to the accuracy of 95.71% and false positive rate 0.009. The recognition performance is evaluated by using Receiver Characteristic Curve (ROC) analysis. The simulation results are compared with the existing methods showing the correctness of the implementation.

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