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Research Article

# Traffic Sign Recognition For An Intelligent Vehicle : A Review

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**Abstract**

Globally, the road traffic accidents are increasing year by year. The main causes of road accidents are carelessness, speed, driver distraction, ignorance of the rules and neglecting traffic signboards. There is a high probability that the driver may miss some of the traffic signs on the road. Automatic driver assistance systems will help and decrease the driver distractions. Traffic sign detection and recognition is the major component of automated driver assistance systems. These systems assist drivers to drive safely. While driving a vehicle, the driver gets an alert message like go slow, pedestrian crossing, U-turn, school zone, men at work, etc. This system reduces drivers' burden of making decisions and increases their awareness about safe driving. Sign Identification and information extraction is one of the important tasks for guidance and safety. Intelligent transport system (ITS) should recognize road circumstances such as traffic signs and imminent road works automatically. There are three phases to recognize traffic signs: Traffic Sign Detection, feature extraction, Recognition.

**Keywords**: Traffic sign detection, Feature extraction, Recognition.

## 1. Introduction

According to the global status report on road safety 2018, released by the World Health Organization(WHO), 1.35million deaths happen annually due to road traffic collisions. This report highlighted, road traffic injuries are the leading killer of people aged 5-25 years [1]. The ratio of road accidents in India for every hour is about 56accidents and 14 deaths occur every hour. Table 1. Shows the statistics of road deaths in 2017.

In 1968, a conjecture was made by an international treaty called Vienna convention on road signals and signs to Improve the standards of an road traffic sign across all the countries an international treaty aiming to standardize traffic signs across different countries was signed[2]. the government should possess certain prescribed rules and regulations to ensure the safety standards.All the drivers must follow these rules to prevent accidents and to be safe and secure. Neglecting these traffic signs leads to the risk of their life as well as the life of other drivers, passengers and pedestrians. Traffic signs laws are described as visual language such as different signs and texts that are known as traffic signs. There are various categories of traffic signs: some distinct shapes like circles, triangles, rectangles and octagons. The road signs have different font sizes that consist of text, portraits or combination of both text and image. There are 92 Indian traffic signs that are classified as warning, compulsory, regulatory and informative which are distinguished by colour and shape. All traffic signs help to reduce accidents and increase awareness. Fig.1. shows the different category of traffic signs.

In order to ensure the safety of the driver the road signs are placed at certain places .These makes the drivers know how fast to drive.with the help of these signs the drivers may get necessary information. Traffic Signs include many useful environmental information which can help drivers to change the road ahead and driving

requirements.Invisible signs, because of the fading due to weather conditions may pose undesirable situation of the driver.The troubles that have variations in illumination like light levels, twilight, fog, rain, andshadow, motion blur and signs occlusion. The drivers get to know System situation turn or not to turn.terrific signs are understood by the drivers by system. Serious accidents happen when driver's miss signs due to distractions of drivers.

According to Paclik el.al [3], the first study of automated road sign recognition was reported in Japan In 1984. Since then, a number of methods have been developed for road sign detection and identification. Automatic detection of road signs is a challenging but demanding job.The cameras are mounted in front of vehicles to detect and recognize the traffic sign. The cameras are fixed with a system for capturing the images, and specified hardware for driving assistance applications. Road signs have specific properties that distinguish them from other outdoor objects. For identification of road signs Operating systems are used in automatic recognition.

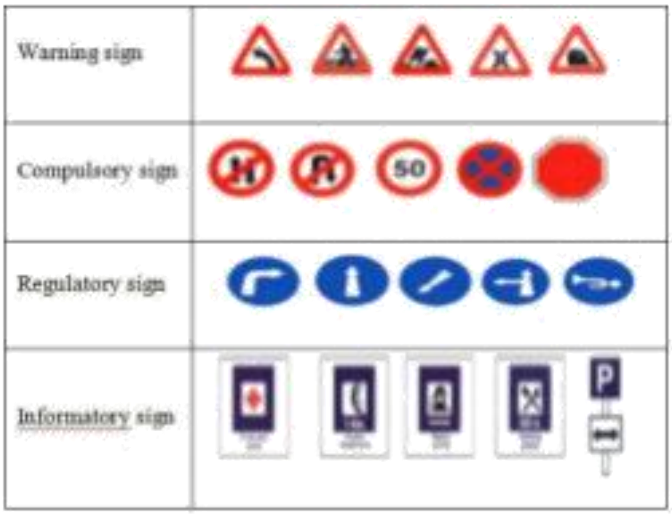


**Fig.1. Different category of traffic signs**

There are various problems to be resolved before creating traffic sign detection and recognition systems. The problems to be resolved are:

- ●Inconsistent lighting and weather condition.
- ●Sign board colors may be faded or blurred,
- ●Sign pattern and shapes damaged
- ●Signs can vary in scale as the vehicles moving closer,
- ●Multiple road signs on one board may create confusion
- ●Poster banners like artificial objects may present on the sign board.
- ●Image quality varies from camera to camera so poor visibility

Table 1. Statistics of road deaths in 2017.

| State | (2016) | (2017) | change |
|---|---|---|---|
| Punjab | 5077 | 4,278 | -15.7 |
| West Bengal | 6944 | 5,953 | -14.3 |
| Gujarat | 8130 | 7,289 | -10.4 |
| Telangana | 7219 | 6,595 | -8.6 |
| Tamil nadu | 17218 | 16,157 | -6.2 |
| Bihar | 4901 | 5,429 | +10.8 |
| Odisha | 4483 | 4,790 | +7.3 |
| Chhattisgarh | 3908 | 4,107 | +5.1 |
| Uttar pradesh | 23650 | 24642 | +4.3 |
| Nation | 1,50,935 | 1,46377 | -3.0 |

Extra value of driver assistance provides an improved driving experience with a user friendly assistance system and ensures the safety of the passenger. The speed limits on the freeways and other city roads are different. The Work zones have different speed limits. In some locations speed limits are different for day timings andnight timings. The traffic speed limit signs that appear by the side of the road should be observed to follow traffic rules. The traffic signs and the speed of the vehicle is displayed automatically if the vehicle is equipped with an automatic speed detection system. The cruise speed can be automatically selected by using the speed detection system and the cruise control system. Intelligent

the transport system improves traffic safety by providing drivers with safety measures about road hazards. To make a safe journey for divers, traffic sign recognition plays an important role. There are two phases for recognition of traffic signs : (i) traffic signboard detection (ii) traffic sign recognition.

**2. Different Dataset Description**

In traffic sign detection and recognition, selecting of datasets for different tasks and methods are essential. There are many datasets for different traffic sign for detection and recognition systems,

1) Belgian Traffic Sign Dataset contains 9,000 images with 4,565 different road signs which are visible upto 50 meters from the camera. The images taken from four different video sequences captured by eight high resolution cameras. The images are recorded from Flanders region in Belgium [6].

2) German Traffic Sign Detection Benchmark: There are 900 full images of 1206 traffic signs. The images in the dataset converted to RGB color space are stored in a raw PPM file. The road signs which are involved in the images were labeled manually [7].

3) Chinese Traffic Sign Dataset: This dataset consists of 1100 images and the resolution of images are mainly1024 * 768 and 1280 * 720. There are three classification of traffic signs present in the dataset dataset, that are prohibitory signs, danger signs and mandatory signs including challenging samples under various scenarios such as poor/strong lighting, affine transformation, imaging blurring, etc. There are datasets for different regions and environment which are used for different groups and research proposals, such as Google Street View panoramic images [8], Sweden Traffic Sign Detection Data Set [9], TsinghuaTencent 100K[10], VideoClips of Streets Of Tokushima City [11].

**3. Traffic Signs Detection**

Maldonado-Bascón[12] implements three task that are segmentation, shape classification and recognition. HSI color space helps to extract input images through thresholding for chromatic signs. Segmentation is classified by using linear SVMs. SVMs with Gaussian kernels helps in recognition process. The hue and saturation components take values ranging from 0 to 360 and from 0 to 255 that helps to obtain the threshold value of animage. The minimization of structural risk deal by SVM. SVMs were developed to solve binary classification problems. The classification with a threshold helps in majority voting method; if the total number of votes are lesser than threshold value, the analyzed result is rejected as a noisy shape. The probabilities recognition that get successful results are 93.24% small size, 67.85%medium-sized, and 44.90%large mask.

Ravindra S. Hegadi [13] implements two steps (1) In an image location of sign is detected by : ROI segmentation, A “region of interest” is an segmented part of an image that consists of a traffic sign. Thinning And Edge detection is used to reduce the edge thickness in binary image region clustering helps to cluster, total number of pixels and their center distances. The analysis of shapes in an image is done through HoughTransform which is a unique and effective way in the detection phase. (2) recognition of the sign, Similarity Transformation consider two systems which are differentiated by one scale coefficient x and y, each axis which has parallel translation is grouped by two different components. The sign radius in the two images helps to measure the parameter of scale.

Thakur Pankaj[14] implements three main stages : 1) pixels of image segments and clusters based on the color features for regions of interest (ROIs); 2) traffic-sign detection by using the relationship between area and perimeter, the boundary touching point 3) correlation coefficient to match the unknown symbols with the known reference of traffic symbols which are stored in the database.

Ali Behloul[15] implements a system that consists of three phases which are: segmentation, detection and recognition. The first phase determines appropriate traffic sign shapes on the area of the road scene. The features of traffic signs are extracted and identified by the Recognition process and there are three main classes: geometrical methods help to detect geometric shape to detect signs, colorimetric methods used to detect color in the detection phase. Segmentation of an image is done through a simple vector filter, the detection module user generated maps to detect and recognize the sign in geometric form, traffic sign image consists of 48 imageswith

360×270 pixels containing three different traffic signs which are stored in a database. The detection of shape in image has accuracy of 95%.

Siva Prasath[16] Detection based on color and shape criteria of traffic signs are two approaches.detection of symbol and text based traffic signs is done by using each MSER and HSV color thresholding. Implementation Of MSER extraction are (i)Performance of an easy light thresholding of the image is done by sweeping threshold of intensity from black to white(ii)Connected elements are extracted .To measure Thresholding Value Of color space, Hue – Saturation – Intensity is used,because it has powerful illumination changes than RGB. For encoding of color information that have possible values for Hue element vary between 0°-360° and for theSaturation element between 0- 255,hue saturation channel is used.Hough

transform,edge image, Cannydetector,are vital role for extraction of features.To categorize every region of interest in an image The Recognition procedure is assigned .To recognize the specific character in an image ,Optical Character Recognition plays an effective role.Procedure of OCR engine (i) An image of scanned paper is acquired by system (ii)The scanned paper is an input for the OCR engine.(iii)The portions of the image are instructed to recognize shapes by engine .

Anju Manjooran et.al[17] proposed Traffic Sign Board Detection and Voice Alert System,there are two parts in traffic sign :sign detection and alert,speed control.the image of traffic sign is captured by camera which is present in front of vehicle. When the system identified traffic sign boards of speed limit, stop, turning and suchspeed reducing signboards the speed of the vehicle is reduced to certain range gradually if the speed of the vehicle is above the limit. At the time if the driver tries to accelerate the speed of the vehicle above the limit it cannot be done for a certain range of the time. The data which is captured by camera is send to MATLABprogram and for recognition of traffic sign is done through SURF(speed up robust feature) algorithm,it has two steps (i)multiscale analysis based on boxer filters (ii)feature detection (iii) feature description (iv)feature matching.voice alert to driver is done through tts command through speaker.

Dilip Singh Solank[18] implemented the Speeded up Robust Features (SURF) algorithm used for feature detectors and descriptors with rotation and illumination invariance. The features of an image can be an edge, a corner, a point etc. The object in an image for matching features is estimation by using affine geometric transformations. recognition of traffic signs is done by optical character, Canny Edge Detector is used to segment the text inanimage. The segmented text is cluttered to improve optical character recognition results.

Wen-Yen Wu[19] proposed road sign extraction and recognition. the RGB images are transformed into the HSVcolor space : hue, saturation, and value. Mathematical morphological operations help to reduce the noise intheimage. Separation of red and blue color objects in an image is separated by using an image labeling method. The signis segregated as 3×3 regions which are arranged by the vertices .Segregated regions are used for the feature of classifying the road signs into the triangular, rectangular, circular, and rhombus shape.

S.Sathiya[20] implements four modules: Detection of traffic panel sign, segmentation, feature extraction and reorganization of traffic signs using SVM. edges are detected using sobel operator. Thresholding is used for determining a threshold value as a criterion to select the required region of interest.otsu's thresholding is used in this method. Morphological Operations are used to reduce the noise and hole of high contrast in an image and features are extracted by DCT, DWT and Hybrid DWT-DCT. Support vector machines are adopted to classify the inner part of road signs.

Xianyan Kuang[21] implements MSER method in which image enrichment is done to improve region of interest in an image. Enrichment of color in an image is done by an algorithm to enhance red and blue colors before using MSER to extract ROIs, which overcomes the disadvantage of color threshold segmentation method, such as illumination changes like faded image, bad weather conditions. Contrast Limited Adaptive HistogramEqualization algorithm [22] compares the local histogram of image. Recognition of traffic signs is done by a random forest method in which a simple decision tree is used.

**4. Traffic Sign Recognition**

Nadra Ben Romdhane[23] implements two steps for traffic sign recognition and tracking.recognition phase is subdivided into two stages they are detection and classification.In detection phase an ejection process which help to remove traffic sign that are present on other roads is done by region of interest(ROI) analysis of the segmented regions are labeled to form connected regions so that all the connected pixels are grouped as one possible region and can be calculated. Histogram oriented gradient and support vector machine is used to classify the feature vector in an image. TS region is normalized to 32×32 pixels and divided into 12×12non-overlapping local regions. Each one of the local regions are extracted from the HOG features. Histograms of edge gradients with 9 orientations are calculated from each of 4×4 local cells.The gradient at each pixel is discretized into one of 9 orientation bins, and each pixel "votes" for the orientation of its gradient.

SVMclassifier makes binary decisions a multi-class classification to accomplish by a set of binary classifiers together with a voting case,and it is applicable to divide the plane that has maximum distance between the closest points of the support vector in the training set. The Lucas-Kanade tracker is used to track traffic signs.

Dr.G.Balakrishnan [24]proposed Indian Signboard Detection and Classification Using Image ProcessingTechniques ,Morphological processing algorithms are applied to remove non pertinent data and isolate the signboards,a neural network is used to classify the road signs.

Aparna A. Dalve et.al[25]proposed Street Level Imagery for Smart Vehicle;there are two stages:detection of region and character recognition.The detection stage explores knowledge of the road that describe the size and location road in the frame.MSER and

optical character recognition is used for text detection .The algorithm have two phases- (i)The Detection in which stages are:a) Preprocess input image b) Detect all possible road sign candidates c) Reduce total number of candidates by applying contextual and temporal information on traffic panels. (ii) Recognition in stages are :a) Recognition of Text from Traffic signboards: 1) Perspective Correction 2) Detect text characters 3) Form characters into lines 4) OCR of region ;b) Recognition of Symbol from Traffic Signboards: 1) Find White MSERs 2) Find color MSERs 3) Classify shapes 4) Classify signs.

Gabriel Villalón-Sepúlveda et.al[26] implements two phase,the normalized RGB space helps to calculate and analyse color statistics ROIs in which traffic signs are present .The second phase solves the recognition problem of the traffic signs-board in ROIs with the help of statistical template matching strategy and templates used in normalization RGB space. The two variables are required for a chromaticity filter that describes dominant wavelengths and the components of the trichromacy color model in which it has a subspace of two normalized values. For solving the identification of ROIs as traffic signs the traffic sign detection approaches responsible.Mean intensity and standard deviation of traffic sign for each pixel,are two statistical models employed for a set of images which provide a probability of chromaticity values.

Yatham Sai Sangram Reddy[27] proposed Traffic signs recognition for driving assistance,which have two parts detection and recognition .Each image of Traffic Sign is recognized using images of symbols database by KNNclassifier.Haar feature-based cascade classifier is a part machine learning approach which used in recognition. Steps of Haar-like Classifier are:1) Collect the positive and negative training images.2) Mark positive images using Image Clipper tools which in annotations file.3) Create vector file based on positive marked images usingopencv_create samples tool 4) by Using opencv_traincascade application,Haar XML file is created for traffic sign board.The stored image is compared in the database and search for Nearest Neighbour .

Paclik et al. [28] used a Laplace kernel classifier to classify the road signs. A pre-classifying procedure is applied to accelerate the detection. Piccioli et al. [29] proposed a method to detect traffic signs. They first detect the region of interest which may contain a traffic sign.

Zadeh et al. in [30] used model matching analyzing the area ratio of the colors in the regions of interest horizontally and vertically in order to differentiate between traffic signs with similar overall color ratios. The advantage of their approach is that the method is invariant to rotation and size of the region and so the number of potential models is substantially reduced, thus accelerating the systems recognition time.

**5. Comparison between Different Techniques Used for Detection and Recognition**

**Table 2.** Comparison between different techniques used for traffic sign detection and recognition

| REFERENCES | TRAFFIC SIGNS | DETECTION | EXTRACTION | RECOGNITION |
|---|---|---|---|---|
| **Dilip Singh Solanki (2002)** | Circular,Rectangular,triangular,octagonal shape | (i) Geometric Transform<br>(ii) Canny Edge Detector | affine transform | Maximally Stable Extremal Regions |
| **Wen-YenWu(2007)** | Symbol signs | HSV color space | image labeling method | visual data mining |
| **Maldonado** | Circular | HSI with fixed | linear SVMs | SVMs with |

| | | | | |
|---|---|---|---|---|
| **Bascón et.al(2007)** | sign,Triangular sign. | thresholds. | | Gaussian kernels. |
| **Ravindra et.al (2011)** | Triangular shape,circular shape,rectangular shape | (i) ROI segmentation with image thresholding (ii) Line Detection. (iii)Shape Check. | Hough transform for ellipse detection. | Similarity transformation. |
| **ThakurPankaj et.al (2013)** | Triangle, Circular, Square,Diamond, Rectangle. | (i)Decorrelation Stretching (ii)Color Space Selection (iii)K-Means Clustering | (i)Boundary Point Touching (ii)Peri2Area. | 2-D Correlation. CoefficientTechnique |
| **S. Sathiya et.al (2014)** | Triangle | (i) sobel edge detection (ii)Otsu's thresholding method morphological dilation | (i)DCT, (ii)DWT (iii)Hybrid DWT DCT | SVM |
| **Ali BEHLOUL (2014)** | Triangle,Circular, Square. | (i)The Bilateral ChineseTransform (ii)The Radial Symmetry transformation(iii)The vector of the Distance to Borders | The simple vector filter | SURF description |
| **Jack Greenhalgh (2015)** | Text image | Maximally stable extremal regions (MSER) | HSV colour thresholding | OCR |
| **Nadra Ben Romdhaneet.al(2016)** | Triangle, Circular. | (i) Radial symmetry (ii) Hough Transform | Thresholding spacecolor | (i)Neural Network (ii)SVM |
| **R. Siva Prasath et.al (2016)** | - | (i) MSER and HSV thresholding (ii) Hough transform and canny edge detector | HOG DESCRIPTORS | (i)OCR (ii)SVM |
| **G.Revathi et.al(2016)** | Triangular shape. | (i)Color Thresholding (ii)Gray Scale Conversion (iii)Use of Median Filter (iv)Edge Detection | Artificial NeuralNetworks | (i) Sobel edge detector (ii)CannyEdge detector |
| **Aparna A. Dalve et.al(2016)** | Text and symbol images | MSER method | Edge based method | OCR |
| **Gabriel Villalón** | stop and yield | chromaticity filter | normalized RGB | Viola–Jones |

| | | | | |
|---|---|---|---|---|
| **Sepúlveda et.al(2017)** | (giveway)signs | | color space | method. |
| **Yatham Sai Sangram Reddy(2017)** | school zones , pedestrian crossing zones | Viola-Jones algorithm | HAAR Cascade Training | KNN classifier |
| **Anju Manjooran(2018)** | Text and symbol signs | MSER method | tts command | Speed Up Robust Feature algorithm |
| **Xianyan Kuang(2018)** | Circular,Triangular Rectan) gular shapes | MSER method | Contrast Limited Adaptive Histogram Equalization[40] | random forests |

**6.Conclusions**

Traffic sign detection and recognition are the two major divisions of automated driver assistance systems. These systems assist drivers to drive safely. The overall analysis of the review work is compared with different traffic sign detection and recognition methods. Different edge detection methods and Gabor filter is used for traffic sign detection, histogram equalisation method if used for improving the quality of an detected image, different transforms and SURF features are used for feature extraction. Neural networks, SVMand K-NNclassifiers are used for traffic sign recognition part. Among all, histogram oriented gradient feature extraction methods and k-NN and SVM classifiers are performed well.