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# An Effective Method for Classification of OBSTRUCT Traffic Signs to Control Road Accidents: A review

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***ABSTRACT: -*** *Classification of traffic signs with partial occlusions is important for traffic sign maintenance and inventory systems. It is also important to help drivers identify possible traffic signs in time. Motivated by human cognitive processes in identifying an occluded sign, a novel structure is designed to explicitly handle occluded samples in this work. Occlusion maps are analyzed for possible occluded signs, and a new occlusion descriptor is proposed to distinguish occluded signs from negative samples. A series of tests shows that the developed method could effectively handle samples with partial occlusions and thus reduce the missed detections caused by occlusions. The developed method could also be easily used for any other object detection.*

## INTRODUCTION

Autonomous vehicle driving systems (AVDS) recognize potential dangers, threats, driving limitations, and possibilities. One of the key factors for successful AVDS developments to identify appropriate traffic rules valid on a certain road sector or in a junction. Such visual recognition helps auto navigation or navigation assisting systems to be safer because most car accidents occur due to a lack of concentration and failures to notice important traffic signs. A large number of traffic sign recognition systems have been developed since the 1980's. The first solutions were focusing on optical-based micro-programmed hardware in order to avoid computational complexity and other contemporary mobile computing related limitations [6]. Later on, software-based solutions have emerged with the first in-car integrations [7]. In-car embedding required real-time image processing, nevertheless, they still used parallel hardware components for acceleration and very low camera resolution and frame rate to lower data size complexity. Web cameras were getting cheaper and high resolution in the middle of the 2000s which boosted traffic sign recognition research in recent years. On the other hand, that is why high precision real-time traffic sign recognition is still considered to be a hard task because data size increment is quadratic by using high-resolution cameras while computational power increases linearly according to Moore's law. Computational power limits applications even further in mobile environments.

## Literature Review

Article [1] proposed a robust traffic sign recognition system is introduced for driver assistance applications and/or autonomous cars. The system incorporates two major operations, traffic sign detection, and classification. The sign detection is based on color segmentation and incorporates hue detection, morphological filter, and labeling. A nearest neighbor classifier is introduced for sign classification. The training features are extracted by the SURF algorithm. Three feature extraction strategies are compared to find an optimal feature database for training. The proposed system benefits from the SURF algorithm, which achieves invariance to the rotated, skewed and occluded signs.

S. K. Berkaya et al. [2], give a new method for circular traffic sign detection and recognition. Comparable performances are attained with respect to the best-performing methods. Compatibility to real-time operation is validated. Automatic traffic sign detection and recognition play crucial roles in several expert systems such as driver assistance and autonomous driving systems. In this work, novel approaches for circular traffic sign detection and recognition of color images are proposed.

Article of [3], proposed a traffic sign detection and recognition system by applying a deep convolution neural network (CNN), which demonstrates high performance with regard to detection rate and recognition accuracy. Compared with other published methods which are usually limited to a predefined set of traffic signs, our proposed system is more comprehensive as our target includes traffic signs, digits, English letters, and Chinese characters. The system is based on a multi-task CNN trained to acquire effective features for the localization and classification of different traffic signs and texts. In addition to the public benchmarking datasets, the proposed approach has also been successfully evaluated on a field-captured Chinese traffic sign dataset, with performance confirming its robustness and suitability to real-world applications.

Authors of [4], presents a high performance and robust system for traffic sign recognition with digital map fusion. The proposed system is enhanced by the fusion of different sensors and recognition is improved. Traffic sign is detected by a monochrome camera added by a reflective surface detector whereas recognition is achieved by a template matching algorithm. Digital Maps used in this work are standard navigable data. For localization, the GPS receiver and the odometer of the test vehicle is used with the developed particle filter based map-matching algorithm.

## OVERVIEW OF GENERAL PROBLEMS

Traffic sign recognition is about to understand vision-based real-life scenarios in an artificially controlled environment. While limitations help engineers to build AVDS by having extensive knowledge of traffic situations when traffic rules are not broken, real-life scenarios still differ in many ways (see Figure 1), i.e. the problem space is quasi-infinite.

Figure1 Example images for aging, vandalism, occlusion, and an occlusion with rotation, respectively, showing different lighting conditions

One of the most discussed problems is how to detect and to compensate for the change in ambient lighting conditions, including weather changes, daylight, and vehicle turns. Cameras are optimized for human view (in) abilities, so they change displayed color representations according to lighting angle and brightness. For example, cameras add the least important color (usually blue) to capture the sense of shade, fog, rainy, or cloudy weather, or to compensate grayish patterns in images. Another trick is to reduce the red components (and increase grey) in indirect lighting conditions: human eyes still sense extensive red pixels while pictures get the impression to be more authentic. If cameras are set against incoming lighting, i.e. one drives against the Sun, cameras compensate high luminance values to white by turning all colors into grey. One must add there is almost no project on night time condition TSR [8]. Aging and vandalism also affect image perception. Deterioration or intentional deformations (e.g. corrosion, paintings) result in either a loss or a misinterpretation of information. These problems cannot be resolved using camera systems only. [9] Deals with random degradation problems to low-resolution images, however, their generative model rather fits for degradation function than real-life deteriorations. [10] Model deteriorations as if they would be long-distance recognition problems. They stated that luminance is a good feature for distance invariant recognition which does not help locally damaged traffic signs to be identified but the retroreflective layer holds information to help the recognition process. That is why speed limit recognition systems use auxiliary light emission and they extract this retro-reflective information where they are available. Videos are sequences of images taken at different speeds that introduce focusing or blurring problems, and sometimes inhibit traffic signs to be captured at a reasonable or "recognizable" (e.g. at least 12px) size. For example, cameras take images every 0.5m at a speed of 50km/h which causes traffic signs to appear at most two frames at sharp right turns. High-speed camera recordings can be compensated by increasing the frame rate until real-time limits are reached.

## ARCHITECTURE FOR TRAFFIC SIGN RECOGNITION

Real-time AVDS must face all the aforementioned problems while they solve the three basic steps of recognition (see Figure 2):

- Color segmentation or adjustment which includes video/image decoding and color space transformations.
- Selection of regions of interest (ROI) where traffic signs are present in the image.
- Identification of traffic signs, i.e. feature extraction techniques used with data mining classifiers.

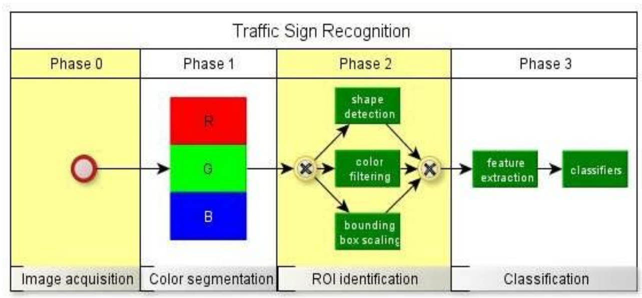


Figure 2 General architecture for traffic sign recognition

## COLOR SEGMENTATION

There are three different groups of solutions: those who use natively available color spaces like RGB[11], RGBY, YUV, or YCbCr, others use special color space transformations like HSL, HSI, or HSV/HSB[12] and new researches focus on more complex color spaces, e.g. CIELAB[13], CIECAM, and CIELUV which are very good at modeling human color perception. RGB and YUV are obvious choices for traffic sign recognition, the most common video codes natively support these color spaces, therefore no extra processing time is necessary. On the other hand, such gains in processing time is generally lost whenever colors like red, blue, or yellow are to be extracted in natural environments. This problem can be solved easily using HSL and similar color spaces at the cost of a calculation of a matrix product. There is no hard proof whether RGB or HSL color space is better suited for traffic sign recognition both has some benefits and drawbacks [15]. In the case of CIECAM, calculating CIECAM requires a considerable computation time, but the results of [13] show that this color space can improve the overall classification accuracy rate by 8% in sunny, cloudy, and rainy weathers compared to HSL.

## SELECTION OF REGIONS OF INTERESTS

The most common approaches are using color, shape, and patch-based filtering to select regions in images that may contain traffic signs. Color filters select region candidates where a specific distribution and quantity of valid traffic sign colors are present at a valid size [12, 13, 16]. As we stated before, color perception is a fuzzy process. In a city like environments red, blue, and white colors are too frequents, e.g. ad panels, phone boxes, biking robes have often used this color, so color filters usually identify too many interesting regions that slow down image processing. Color-based filters are generally used for highways only. Shape filters use well-known edge detection algorithms; however, they are sensitive to noises, so a Laplacian filter is often required for smoothing. Different types of Hough transformations are also popular, but since their complexity is O (n2) or higher if rotations are taken into account where n is the number of pixels. As a consequence, shape filters are not used in real-time applications in their pure form [17]. Note that, decreasing n significantly improves the overall performance. One way to do that is by using color filters for preselecting ROIs, and another way is to use some specific points or features and calculate transformation on these points only. The latter is called patch-based filtering. The most of patch-based approaches are motivated by the work of [18] Based on a cascade of boosted Haar's features. Haar's features, in this case, are linear equations on pixel values within rectangles which are classified by the Ada Boost algorithm. Since these rectangles fit for only parts traffic signs the Viola-Jones approach can identify rotated and occluded traffic signs as well. Viola-Jones approach complexity is O (fsn) where f is the number of features, s is the size of the rectangle, and n is the number of pixels in an image, so if and only if fs it is quasilinear, i.e. only it is fast for finding small objects in high-quality images.

## OUR PROPOSED TRAFFIC SIGN RECOGNITION AND TRACKING METHOD

In our context of study, we are interested to recognize and track danger and prohibitory traffic signs since they constitute the important cause of accident-prone situations. As shown in Figure 3 Our proposed method is composed of two steps: Traffic signs recognition and tracking. Relying on our previous introduced lane detection method, we detect the lane limits in the closest regions of the images. Next, these lane limits are used to delimit the region of interest where potential TS may exist.

### A. Traffic Sign Recognition

The traffic sign recognition performs on two steps: Detection and classification.

1) Traffic Sign Detection: - The traffic signs detection aims to find out the potential road signs regions.

### A) Delimitation of ROITS

Through simple image processing techniques, we will create a reduced search mask to perform the detection step and reduce the search effort for these signs. Therefore, we will apply a discarding process to reject TSs that belongs to other roads. Hence, we will apply our proposed algorithm for lane limit detection proposed. Relying on the detected lane limits in the near region (ROIr and ROIl), we will use the right lane limit and the Horizon line (Hz) to draw a quadrilateral on the right side of the image. This quadrilateral is considered as our new Region of Interest (ROITS).

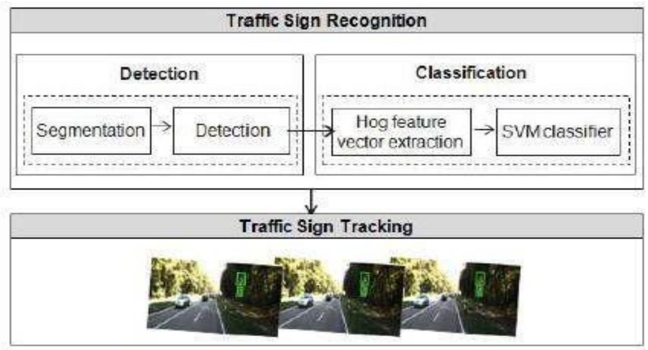


Figure3 the proposed traffic sign recognition and tracking process.

### B) Segmentation

In this step, we proceeded with color segmentation within this ROITS. In fact, the measured color of TS is often a mixture of the TS original color and the added outdoor lighting. Therefore, the color model for TS segmentation should be seemly selected. As it is commonly known, the color used in TSs seeks to capture human attention. Therefore, we selected the HSV color space as it is based on human color perception. Indeed, the hue value is invariant to light and shadows variation in daylight. Applying a threshold on each of HSV component, we segmented the TSs appearing on the ROITS. Then we apply a closed morphology operation to have more compact areas of interest and eliminate interruptions.

### c) Detection

This step aims to detect the precise location of the TSs. In order to achieve this goal, an analysis of the segmented regions is carried out. Therefore, we labeled the connected regions so that all the connected candidate pixels are grouping as one potential region (using 8-neighbors). Next, a bounding box characteristic (height, width, area) is calculated for all potential regions.

### Traffic sign classification

The classification of potential traffic sign regions is a key step since it helps to make a decision to keep or reject a potential traffic sign. To ensure a prominent classification, we applied the Histogram of Oriented Gradients (HOG) operator to extract the HOG feature vector. Next, an SVM classifier is applied relying on the already extracted feature vector.

**Feature vector extraction**

The Histograms of Oriented Gradients (HOG) is one of the well-known features for object recognition. The HOG features imitate the visual information processing in the human brain. They are able to deal with local changes in appearance and position.

**SVM Classifier**

In our study, we are interested to recognize the 25danger and prohibitory TSs since the reduced concentration on them constitutes the major accident-prone situations. To build our TSs recognition system, we have proceeded with the SVM classifier thanks to its performance in statistical learning theory. Actually, Support Vector Machine is an efficient technique for classification which carries out an implicit mapping of data into a higher dimensional feature space.

**Traffic Signs Tracking**

Once a traffic sign is recognized, we perform a monocular tracking step in order to have a continuous capture of the traffic sign while accelerating the execution time. Since we are in a moving camera context, it is more appropriate to use an optical flow-based method. Thus, we apply the Lucas-Kanade tracker as it has a high performance to find the exact match under illumination. Changes and affine transformation. The bounding box which involves the detected TS includes a set of interest points that we extract using a Harris detector. For each interest point, the tracker searches for the matching point in the next frame within a padded region around the TS location in the previous frame.

**A. Qualitative Evaluation**

For this evaluation, we compared our solution with the method proposed by Long et al (Method A) which had proved its performance in real-time environmental conditions. We have implemented it according to their corresponding manuscript.

**B. Quantitative evaluation**

In order to further evaluate our traffic sign recognition method, we first compared its performance with Method A in terms of Recall, Precision, and F-measure.

**CONCLUSION**

In this proposed work, we introduced a new method for recognition and tracking of traffic signs dedicated to an automatic traffic assistance system. Potential traffic signs regions are detected, then classified using HOG features and a linear SVM classifier. Afterward, we keep tracking traffic signs so as to have a continuous capture of the traffic sign while accelerating the execution time. The proposed system shows a good recognition rate under complex challenging lighting and weather conditions. As future work, we aim to experiment with other feature descriptors and classifiers as well as comparing the performance of our method with the most recent methods.

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