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Artificial Neural Network based Automatic Traffic Regulation System

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ABSTRACT: The main goal of Traffic Sign Detection and categorization is to regulate traffic signs, warn a driver, and command or prohibit certain actions. Automatic recognition of traffic signs is also important for an automated intelligent driving vehicle or for driver assistance systems. Traffic signs or road signs are signs erected at the side of or above roads to give instructions or provide information to road users. There are many more other types of traffic signs such as special regulation signs, signs for direction and position, welcome sign etc. This paper aims to present a color segmentation approach for traffic sign recognition based on LVQ neural network and also focuses on triangular edge detection and feature extraction based on Hough transformation and HOG respectively. Individual text characters are detected as MSERs and are grouped into lines, before being interpreted using optical character recognition. Recognition accuracy is vastly improved through the temporal fusion of text results across consecutive frames. Additionally we using ultrasonic sensor to regulate the speed of vehicle if, two vehicles runs closely each other

KEYWORDS: LVQ, MSER, HOG, SVM, Ultrasonic Sensor.

I. INTRODUCTION

The automatic detection and recognition of traffic signs is a challenging problem, with a number of important application areas, including advanced driver assistance systems, road surveying, and autonomous vehicles. While much research exists on both the automatic detection and recognition of symbol-based traffic signs, this could be partly due to the difficulty of the task caused by problems, such as illumination and shadows, blurring, occlusion, and sign deterioration. Without the use of additional temporal or contextual information, there is few information to determine traffic signs from non traffic signs on the fly, while driving, other than basic features, such as shape or color. On this basis, the number of false positives (FPs) likely to occur in a cluttered image, such as a road scene, is high. This is demonstrated in the example , where although the traffic sign present in both images is successfully detected, more FPs are detected by the system (in the top scene) when additional structural and temporal information is not deployed. We approach this problem by detecting large numbers of text-based traffic sign candidates using basic shape and color information. This over detection is important to ensure that no true positives (TPs) are missed. We then reduce the large number of detected candidate regions by making use of the structure of the scene, as well as its temporal information, to eliminate unlikely candidates. The proposed system comprises two main stages: detection and recognition. The detection stage exploits knowledge of the structure of the scene, i.e., the size and location of the road in the frame, to determine the regions in the scene that it should search for traffic text signs. These regions are defined once the vanishing point (VP) of the scene and, hence, the ground plane are determined. Potential candidate regions for traffic signs are then located only within these scene search regions, using a combination of MSERs and hue, saturation, and value (HSV) color thresholding. By matching these regions through consecutive frames, temporal information is used to further eliminate FP detected regions, based on the motion of regions with respect to the camera and the structure of the scene.

II. LITERATURE SURVEY

Much research exists on both the automatic detection and recognition of symbol-based traffic signs and the recognition of text in real scenes, there is far less research focused specifically on the recognition of text on traffic

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Without the use of additional temporal or contextual information, there is few information to determine traffic signs from nontraffic signs on the fly, while driving, other than basic features, such as shape or color. On this basis, the number of false positives (FPs) likely to occur in a cluttered image, such as a road scene, is high. This is demonstrated in the example in Fig. 1, where although the traffic sign present in both images is successfully detected, more FPs are detected by the system (in the top scene) when additional structural and temporal information is not deployed.

We approach this problem by detecting large numbers of text-based traffic sign candidates using basic shape and color information. This over-detection is important to ensure that no true positives (TPs) are missed. We then reduce the large number of detected candidate regions by making use of the structure of the scene, as well as its temporal information, to eliminate unlikely candidates.

III. PROPOSED SYSTEM

The proposed system comprises two main stages: detection and recognition. The detection stage exploits knowledge of the structure of the scene, i.e., the size and location of the road in the frame, to determine the regions in the scene that it should search for traffic text signs. These regions are defined once the vanishing point (VP) of the scene and, hence, the ground plane are determined.

Potential candidate regions for traffic signs are then located only within these scene search regions, using a combination of MSERs and hue, saturation, and value (HSV) color thresholding. By matching these regions through consecutive frames, temporal information is used to further eliminate FP detected regions, based on the motion of regions with respect to the camera and the structure of the scene.



Figure. 1. System output showing detection of traffic signs (left) without and (right) with the use of structural and temporal information

To improve the accuracy of recognition, OCR results from several frames are combined together by matching individual words through frames and using a weighted histogram of results. The entire system pipeline is shown in Fig. 2.

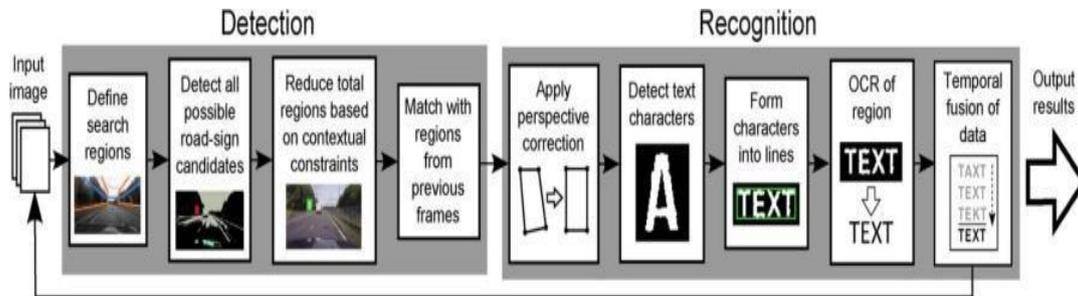


Fig. 2. Pipeline for detection and recognition stages of the proposed approach.

IV. DETECTION OF TEXT-BASED TRAFFIC SIGNS

The first stage of the proposed system detects candidates for text-based traffic signs. This consists of three phases: de-termination of search regions (regions of interest where the text sign is expected to be found), detection of all possible candidates within these regions, and reduction of candidates using contextual constraints. Search regions of interest for traffic signs are found within the image, by first locating the sides of the road in the image and then defining 3-D search boxes, which are projected back onto the original 2-D frame.

A. Finding Sides of Road and VP

In order to determine search regions for traffic signs in each frame, the sides of the road and the road VP must be detected. Our approach to VP detection is traditional and popularly used in other works. First, the Canny edge detector is used to detect edges in the image, which is followed by the Hough transform to locate straight lines. The total number of Hough lines is then reduced by eliminating lines that are too short, that do not approximately pass through the center of the frame, or (for the purposes of our application) that appear near the top of the image; an example frame is shown in Fig.3

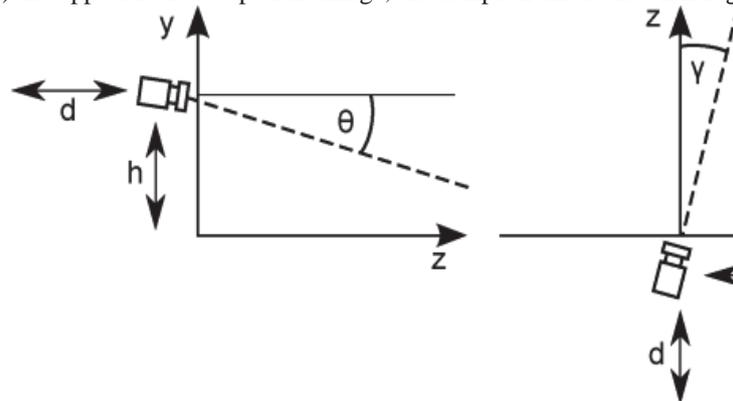


Fig. 3. Camera position and captured frame

An “accumulator” of line intersections is then created from the intersections between the remaining Hough lines, the peak of which is taken to be the VP of the road. The parameters for Canny and Hough were determined empirically on a subset of our data set and fixed throughout our experiments. Where u and v represent coordinates in the original frame, m and n are the dimensions of the original frame, α_u and α_v are the angular aperture, and x and z represent the coordinates in the IPM image. The values h , l , and d represent the position of the camera with respect to the ground plane, as shown in Fig. 3. These values can be estimated and adjusted, in order to shift and scale the IPM image.

From the reduced set of Hough lines, it is possible to approximate the sides of the road in the IPM image. If we assume that the camera is located on the center of the vehicle facing forward and that the vehicle is in the middle of the lane, it

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follows that the center of the current lane will be in the center of the IPM image. An example of the IPM image and transformed Hough lines is shown in Fig. 4.



Fig.4. Output of various stages of algorithm to define search regions.

The set of IPM Hough lines are then further reduced by eliminating lines that are not approximately vertical and lines that are below a certain length. This set of lines is then divided into two groups, for the left- and right- hand sides of the image. The mean of all lines, weighted by line length, is then calculated for each side of the image. These average lines are taken as approximations of the sides of the road. Estimates for the VP and sides of the road are detected in every frame, and they are then tracked throughout subsequent frames using the Kalman filter.

B. Defining Search Regions within the Original Frame

Once the sides of the road are detected, the size and location of the search regions can be defined. Three search regions are used, i.e., one to the left-hand side of the road, one to the right, and one above. The dimensions of these regions are determined empirically through analysis of the validation data set and kept constant throughout our experiments. The top search region is defined to be the width of the road, given that overhead gantries, which appear in this region, never extend beyond the sides of the road. Therefore, the width of this region is determined dynamically based on the detected positions for the sides of the road. The dimensions and height of the roadside regions are fixed, but their horizontal positions change dynamically to position them by either side of the road.

The real-world dimensions of these regions can be roughly estimated, by assuming that the distance between the overhead gantry and the ground is approximately 5.1 m, i.e., the minimum legal unmarked gantry height in the U.K., and using this as a reference. These dimensions are stated in Table 1.

TABLE 1
DIMENSIONS OF SEARCH REGIONS

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Region	Width (m)	Height (m)	Length (m)	Height from ground (m)
Road-side	6.4	8.6	30.6	0.95
Overhead	road width	7.8	30.6	5.0

V. EXPERIMENTAL RESULTS

The proposed method currently runs at an average frame rate of 14 frames/s, under Open Source computer Vision OpenCV), on a 3.33-GHz Intel Core i5 CPU. A considerable existing algorithm. These were the methods proposed by Reina *et al.* and González *et al.* Since both methods were designed to recognize Spanish road signs, which are blue and white, it was necessary to adapt the algorithms to detect U.K. road signs, which also feature green and brown backgrounds. The method of González *et al.* detected blue road signs as MSERs in the blue channel of a normalized red, green, and blue (RGB) image. Therefore, to extend this to green road signs, MSERs were also detected in the green channel. Brown road signs were detected as dark-on-light MSERs in a grayscale frame. The method of Reina *et al.* uses hue, saturation, and intensity (HSI) thresholding to find candidate blobs for blue road signs. Therefore, additional thresholds were added to their method for the detection of brown and green road signs. These algorithms were optimized using the same validation data set used to develop our proposed method.

These data comprised nine video sequences, with a total of 23 130 frames, at a resolution of 1920 1088 pixels. The ground truth for detection was based on human observation; therefore, distant or heavily blurred traffic signs, which were unreadable by the eye, were ignored. The data set used for testing was entirely separate from the validation set used for the development and parameter tuning of the proposed and implemented systems. Regions were determined to be candidate traffic signs, if detected for at least five subsequent frames. The results of this comparison are shown in Table.2

TABLE 2
RESULTS OF COMPARATIVE ANALYSIS FOR THE DETECTION STAGE

Method	Precision	Recall	$F_{measure}$
Reina et al. [16]	0.58	0.64	0.61
González et al. [35]	0.54	0.68	0.60
Our method without use of structural information	0.19	0.90	0.31
Our method	0.96	0.90	0.93

It can be seen from these results that the proposed method achieves an $F_{measure}$ of 0.93, whereas Reina *et al.* and González *et al.* reach the considerably lower values of 0.61 and 0.60, respectively. The use of geometrical, contextual, and temporal information in our system allows the total number of FPs to be reduced, thus increasing its precision and $F_{measure}$. Also included in Table 2 are results for our text-based traffic sign detection method without the use of structural information.

As expected, the resulting increase in FPs causes a huge reduction in precision, whereas the recall stays the same. In addition to reduced precision, the computational expense means that the frame rate drops from 14 frames/s to 6 frames/s. This is due to both the increased search area for candidate traffic signs and the slow down created by the increased number of detected FPs that it is necessary to process.

TABLE III
RESULTS FOR THE RECOGNITION STAGE

Method	Precision	Recall	$F_{measure}$
Standard Tesseract OCR	0.48	0.34	0.40
OCR with shape correction only	0.69	0.75	0.72
OCR with temporal fusing only	0.83	0.33	0.47
Full proposed method	0.87	0.91	0.89

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We compare the results for OCR applied to a single instance of each detected traffic sign when the region was largest and most visible in the frame without any pre-processing, against OCR after application of our perspective correction method described in Section IV-A, OCR after application of our temporal fusion method described in Section IV-D, and then against OCR after the application of both perspective correction and the temporal fusion method. The results are presented in Table III and show that use of our perspective recovery and temporal fusing methods vastly improve the recognition accuracy. It can be seen that temporal fusing improves the precision but not the recall; this is due to the rejection of low-confidence words by the system. The total system performance, i.e., for both detection and recognition stages, based on the number of individual words recognized in all traffic signs, in all video sequences, gave a precision value of 0.97, a recall value of 0.80, and an F measure value of 0.87.

IV. CONCLUSION

A novel system for the automatic detection and recognition of text in traffic signs based on MSERs, LVQ and HSV thresholding has been proposed. The search area for traffic signs was reduced.

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