Traffic Sign Detection and Recognition for Smart Cars

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Abstract— In order to be deployed in real-world driving environments, self-driving cars must be able to recognize and respond to exceptional road conditions, such as highway work zone signs. In this paper, we present a set of Digital image processing (DIP) and microcontroller (ATmega16) that recognize, through identification of work zone signs, alert the driver of vehicle. Traffic sign detection and recognition system is becoming an essential component of smart cars. Speed-Limit Sign (SLS) is one of the most important traffic signs, since it is used to regulate the speed of vehicles in downtown and highways. Also we have upto 30 traffic signs in our database. In addition, the proposed solution does not require the installation of infrastructure on the road and it can be installed into any vehicle. Also most of the road accidents can be avoided using this system.

Key words: Traffic sign, RGB to HSV conversion, training images, template matching, traffic sign detection

I. INTRODUCTION

According to modern requirements for vehicle safety there must be noted that effective driving is often more dependent on computer systems that these vehicles are equipped with rather than the driver. Therefore the main measure to reduce accidents on the roads is to be done in the development of systems that provide control of the vehicle while moving.

To solve this problem, we plan to develop an automated system that would allow to recognize traffic signs along the way, in advance informing the driver about changes in driving conditions without detracting from driving. Thus the driver will not be distracted from driving when special vigilance is required.

The aim of this Master Thesis is to develop a method for traffic signs detection for vehicles that reduces the number of accidents while driving. This method will be developed as an automated software-hardware solution that will be supplied with the vehicle. The main advantage of the automated system of traffic signs detection is a reduction of the risk imposed on the driver of the vehicle while driving, as well as increasing the information content.

This method is expected to be implemented in vehicles as an integrated system. The user of this method will be the driver who will have to get visual and audible warning when the traffic sign is on the path of the vehicle. Automating traffic sign detection allows us to reduce the amount of time necessary for appreciating the state of movement and actions of the driver for any manipulation. Creating your own system, will allow to take into account all the features of currently existing developments, and to minimize the redundancy of procedures and increase the efficiency of the system developed.

II. RELATED WORK

This section further describes our approach by comparing it with prior work in the area of traffic sign recognition. For any traffic sign recognition method that focuses on vision sensors, an initial requirement is the locating of potential sign image regions from an input image. Some systems, including ours, use color information to localize signs. In addition, for any sign recognition system, which utilizes color, it is necessary to find an optimal range of target color values; indeed, the actual values of the target color vary based on image acquisition processes. Several researchers have manually surveyed color values which work for most of the sampled images, whereas others, including ours, use machine learning techniques to obtain the optimal thresholds of the target color. A manual process of finding color values is attractive, due to its simple implementation, yet tends to be error prone.

Another dominant approach for traffic sign detection is use of sign shapes. Some researchers use the geometric property of sign shapes, such as equal angularity, to locate the centroids of traffic signs. This intrinsically error-prone approach relies on a geometric property, one is not preserved under perspective imaging, and assumes high contrast in image intensity, a quality not easily acquired from real-world image acquisition real-world image acquisition.

III. BLOCK DIAGRAM

A. Main System Block Diagram

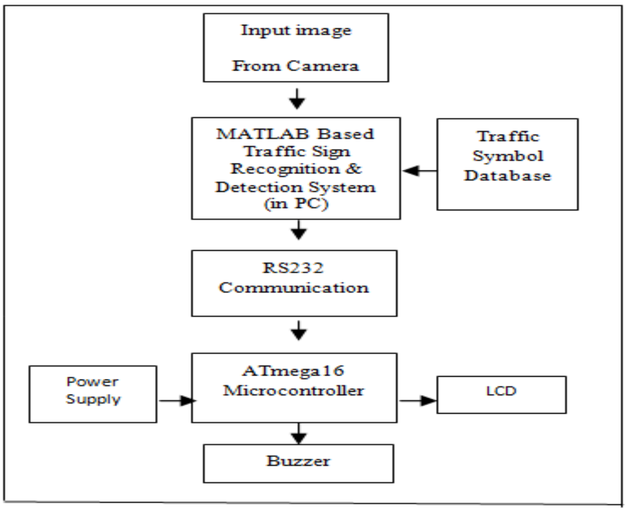

Fig. 1: Main system block diagram

1) Microcontroller

ATmega16 is an 8-bit high performance microcontroller of Atmel's Mega AVR family with low power consumption. Atmega16 is based on enhanced RISC architecture with 131 powerful instructions. Most of the instructions execute in one machine cycle. Atmega16 can work on a maximum frequency of 16MHz. ATmega16 has 16 KB programmable flash memory, static RAM of 1 KB and EEPROM of 512 Bytes. The endurance cycle of flash memory and EEPROM is 10,000 and 100,000, respectively. ATmega16 is a 40 pin microcontroller. There are 32 I/O (input/output) lines which are divided into four 8-bit ports designated as PORTA, PORTB, PORTC and PORTD.ATmega16 has various in-built peripherals like USART, ADC.

2) Camera

The camera, we have used having technical specification like 24 Mega pixels (3264X2448) interpolated Image Resolution, Indoor, Outdoor environment, USB 1.1 I/O interface, RGB 24, I420 Image Format .Also have some features as Image Resolution 24 Mega pixels (3264X2448) interpolated, Image Flip Horizontal, vertical Monitor Type CRT & LCD, Lens View angle 54 degree, Power Consumption 160mW typical.

3) RS 232

USB to RS232 serial port converter. It provides PCs, notebooks and handheld computing devices using USB an external PnP RS232 port. USB to Serial adapters comes in several different variations in regards to interface types.

The most commonly used interface type is serial RS232. Other frequently used interfaces are RS485 and RS422. Regardless of which interface type the adapter has it usually looks the same, with the one difference that RS232 adapters usually have a DB9 connector for connecting to the serial device whereas the RS485 and RS422 adapters usually have a screw terminal header for connecting a serial device.

4) LCD

Most of the LCD Displays available in the market are 16X2 (That means, the LCD displays are capable of displaying 2 lines each having 16 Characters a), 20X4 LCD Displays (4 lines, 20 characters). It has 14 pins. It uses 8lines for parallel data plus 3 control signals, 2 connections to power, one more for contrast adjustment and two connections for LED back light.

IV. TRAFFIC TEMPLATE

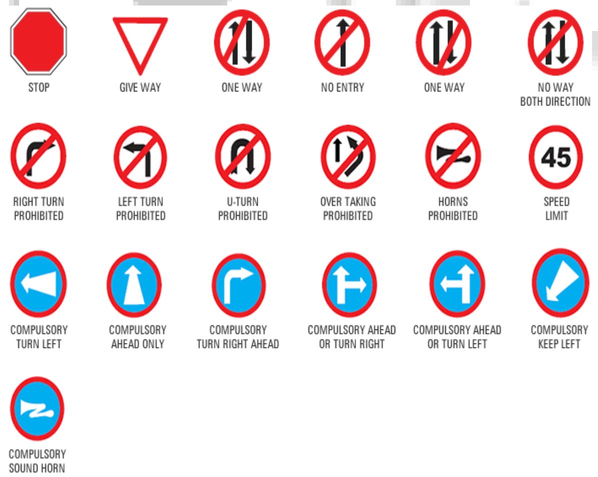

Fig. 2: Traffic Template

A. Image Processing Block Diagram

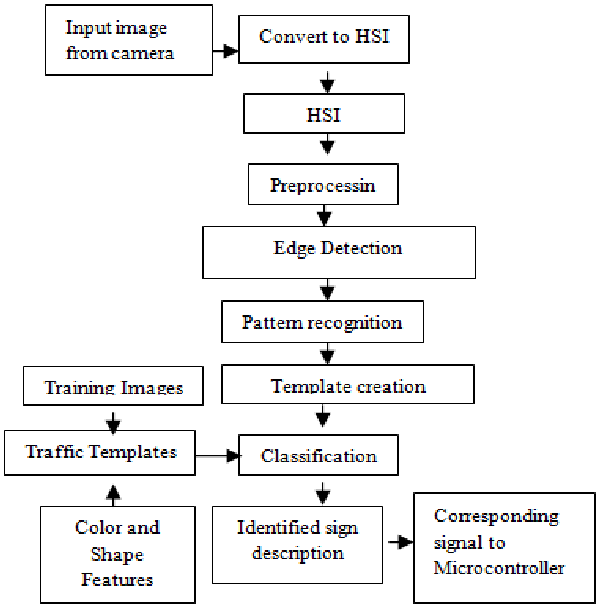

Fig. 3: Image processing block diagram

V. IMAGE PROCESSING

A. Color Segmentation

1) RGB to HSV conversion

RGB color space is the combination of 3 primary colors of light: Red, Green and Blue which is mostly used by most computer devises. Commonly used color space that corresponds more naturally to human perception is the HSV color space, whose three components are hue, saturation and value. The HSV color space allows decoupling the color, saturation and intensity information, which can be very useful to find sign colors for all the pixels where a (R, G, B) channel is maximum, the hue is determined by the difference of the other two channels, divided by the difference of the maxi-mum and minimum value of the three channels. The result is a value between -1 and 1, which is shifted according to the (R, G, B) channel of the maximum. To avoid pixels where the color is not well defined is set to 0, all values where the difference between MAX and MIN is below a threshold value.

2) Color Thresholding

Thresholding is the simplest method of image segmentation. From a grayscale image, thresholding can be used to create binary images. During the thresholding process, individual pixels in an image are marked as “object” pixels if their value is greater than some threshold value (assuming an object to be brighter than the background) and as “back-ground” pixels otherwise. This convention is known as threshold above. Variants include threshold below, which is opposite of threshold above; threshold inside, where a pixel is abeled “object” if its value is between two thresholds; and threshold out-side, which is the opposite of threshold inside. Typically, an object pixel is given a value of “1” while a background pixel is given a value of “0.” Finally, a binary image is created by coloring each pixel white or black, depending on a pixel’s labels. Color images can also be thresholded.

Candidate objects are selecting via thresholding. Thresholding refers to the procedure that creates a binary image; pixels with illumination values above a predefined threshold are assigned value 1, and all the others are set to 0. Thresholding is conducted in HSI (Hue – Saturation – Intensity) color space, as it is more robust to illumination changes than RGB. Only Hue and Saturation channels are used, as these components encode color information.

Fig. 4: Color Segmentation

B. *Text Detection*

The focus of this technology is on selection and recognition of geometric shapes of the signs and traffic signs text data. The technology uses the scale of brightness and contrast, thus reducing the noise on night image processing. Basically, this method widely uses pattern recognition of textual information, contained on a traffic sign, using methods of image segmentation. According to what manufacturers say, it reduces the probability of error in the case of high noise on the processed image. Furthermore, there is a traffic sign recognition process using the technology of neural network.

Fig. 5: Text Detection

C. *Classification*

The output of the detection stage is a list of candidate objects that could be probable road signs. This list is forwarded to the recognizer for further evaluation, and then to the classifier to decide whether the objects in the list are either rejected objects or road signs, and in this case the classifier responds with a sign code. To design a good recognizer, many parameters should be taken into consideration. Firstly, the recognizer should present a good discriminative power and low computational cost. Secondly, it should be robust to the geometrical status of sign, such as the vertical or horizontal orientation, the size, and the position of the sign in the image. Thirdly, it should be robust to noise. Fourthly, the recognition should be carried out quickly if it is designed for real time applications. Furthermore, the classifier must be able to learn a large number of classes and as much a priori knowledge about road signs should be employed into the classifier design, as possible.

VI. METHODOLOGY

The proposed methodology in this paper, to perform the analysis for image processing using steps:

1) Convert the input RGB image to HSV image.
2) Separate H mask, S mask and V mask.
3) Apply color thresholding fuction on H mask.
4) Perform edge detection using Canny edge detector.
5) To extract inner traffic sign, use Largest Square function on S mask.
6) Convert into bounding box then crop and resize it.
7) Create the template and match with the database(training images).
8) Identify the sign description.
9) Send corresponding signal to microcontroller.
10) Display the traffic sign information on LCD.

VII. EXPECTED RESULTS

The proposed algorithm is developed and tested using MATLAB and output is display on LCD. Forty-nine randomly chosen road sign images were tested, analyzed and finally evaluated based on the percentage of correct detection and recognition. For testing purpose, road traffic sign images of different classes were taken.

The color detection algorithm is applied first to road signs. As output of this algorithm red or blue color traffic sign were detected. Then inner text of the traffic sign is detected using text detection algorithm. The output of given traffic sign is shown on LCD and also in audio form.

The results of the study are summarized in Table 1 to show the performance of the proposed ro ad signs detection and recognition algorithm.

Classifica-tion of traffic sign	Num-ber of signs	Correc-t detecti-on and recogn-ition	False detectio-n and recognit-ion	% correct	% false
Warning sign	8	7	1	87.50 %	12.50 %
Compuls-ory sign	12	12	0	100%	0%
Regulator-y sign	7	6	1	85.71 %	14.28 %
Total	27	25	2	91.07 %	8.92%

Table 1. Result Table

From Table 1, out of the twenty-seven signs that were tested, the total number of correct detection and recognition of randomly chosen road signs is twenty-one and the total number of false detection and recognition of road signs is two. The percentage of correct detection and recognition of road signs is 91.07% while the percentage of false detection and recognition of road signs is 8.92%.

VIII. CONCLUSION

This paper has presented a set of Digital image processing(DIP) and microcontroller (ATmega16) methods that localize, detect, and classify work zone signs to obtain detailed information about highway workzones, such as bus prohibited, left turn prohibited, no entry, one way, horn prohibited etc. The results show the positive impact on avoidance of most of the road accidents when following the advice of the system.

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