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Multimedia based Real Time Traffic Sign Recognition System and its Analysis

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Abstract

Background/Objectives: Traffic sign recognition system is a multimedia based real time which guides and assist the driver visually with audio to decrease the road accidents. **Methods/Statistical analysis:** Hundreds of small pictures are registered by the regional transportation authority of every country which guides the drivers as well as road users by providing information related to current status of the road. All most in all countries red and blue color with a particular shape like triangle, circle and rectangle are used to prepare small pictorial signs. In proposed research, features of color and shape are used to detect, track and recognize traffic signs. Templates are prepared using canny images and centroid of captured sign from the video. Such templates are matched with the knowledgebase by translating images according to the centroid point of a shape. **Findings:** Proposed research paper introduces the traffic sign recognition system with multiple output formats like video and audio with the textual information of the tracked signs. Analysis of the developed system is focuses in this paper. Each prohibitory, obligation, cautionary and informatory signs are tested to check the robustness of the system during number of experiments. According to the analysis report more the 100 signs are tested and the performance of the proposed research is nearly 93%. Knowledgebase has been prepared for all traffic signs. **Application/ Improvements:** The proposed system produces more than 93% which can be improved to get exactly 100% accuracy level.

Keywords: Centroid, DAS, Knowledgebase, Sign Recognition, Translation

1. Introduction

While driving a vehicle on a road we can notice small sign boards with red circle, blue circle, red triangle and blue rectangles on a road sides are traffic signs. Road users can not ignore such signs. These signs are basic helpers of the drivers to guide then what to do's and not to do for safe driving. In the earlier time stones and wooden signs were used. Later, signs with directional arms were introduced[1]. Now a day small pictorial signs are used to provide safety while driving. Basically these traffic signs are categorized in: Mandatory Signs (Prohibitory and Obligation), Cautionary/Warning Signs and Informatory Signs[2,3].

1.1 Mandatory Signs

Prohibitory and Obligation signs are collectively known as Mandatory signs[3]. It is mandatory for the driver to follow such signs for the safety of other road users. Red circles with white black ground and black pictogram are the identity of prohibitory signs for ex. Signs for no entry, left tern prohibited etc. Signs with blue circle with white pictogram are obligation signs like pedestrians only, compulsory left turn etc.

1.2 Cautionary Signs

Red triangle with white background and black pictogram are cautionary signs. These are basically warning signs

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which warn the driver about the upcoming hurdles on the road[3]. Turn left, cross road ahead are the example of cautionary signs.

1.3 Informatory Signs

Blue rectangle with white background and black pictogram are informatory signs. These signs help the road users to provide information regarding the facilities available on the road[3]. Eating place ahead, airport ahead are the examples of this category. Figure 1 shows the signs of each above category.

Figure 1. (a) Mandatory sign (b) Cautionary signs (c) Informatory signs.

2. Traffic Signs Detection and Recognition System (TSDRS)

India records more than 100,000 fatalities due to road accidents each year and the number of injuries reported amount to more than 500,0007[4]. Technology can be helpful in decreasing such road accidents. TSDRS helps the road users by guiding and providing all traffic related information about the law, to warn the driver about the dangerous condition ahead and current status of the road in advance, so that driver can find his/her way safely. This real time computerized system produces the output simultaneously as the driver go ahead and keep informing about the latest situation before they take place on the road automatically. For example Right curve ahead, this traffic sign inform the driver that the upcoming road is moving at right side.

3. Approaches used in Traffic Signs Recognition

Basically color based model, shape based model and combination of color and shape based models are used to develop traffic signs recognition.

3.1 Color based Recognition

Traffic signs use red and blue colors. This type of models is work on the value of each pixel of digital images. Such digital images are made up of RGB (Red, Green and Blue) colors. Many color schemes are available to store digital images they are RGB, HSI, HSB, YUV etc[5].

3.2 Shape based Recognition

Traffic signs are made up using geometric signs like triangle, circle and rectangle shapes. These shapes are used to categorized and identified traffic signs.

The research for detection of signs had been started from 1984 onwards. The first paper on Traffic sign recognition was published in Japan in 1984[6].

Following techniques are used in previous work with color based model.

Color threshold and neural networks, fuzzy sets, color filtering or ring partitioned method, Matching Pursuit (MP) filters, Ada-Boost and Haar wavelet features, FOSTS model, Hough transform, Color Distance Transform (CDT), multi-layer perceptron neural network, Pictogram Contours, Curvature Scale Space (CSS) representation and particle swarm optimization[7].

One of the most difficult problems with this approach is lighting condition. If the captured frame is too light or too dark the system performs wrong output in a previous work. Some algorithms fail when the background of the input image has too much red color information. Some are not working with night scene, rainy and cloudy conditions and the road sign may not be recognized, even if it is correctly detected.

Following techniques are used in previous work with shape based model.

Geometrical analysis of the edges, Pattern Matching, symmetry transform, Support Vector Machine (SVM), Neural Network, Kalman Hough transform filter, Fast Fourier Transform (FFT), Edge orientation histograms, Hough transform, Support Vector Machines (SVM) and visual attention mechanism[7].

Some traffic sign are overlap because of similarity in a design of different sign with minor changes. Some of the shape based techniques are also fail in some situations occurs due to occlusion, lack of contrast and indistinct edge between the sign and the background. The problem of the scattered edge points are faced by some techniques which produced wrong edge detection.

Some researchers use color and shape based model collectively to get the advantages of both approaches and to get rid of from loopholes of both approaches which are found, if one of them is used as individually. Even though in this research area 100% success yet to be achieved. As per the literature survey it is concluded that some system is need to the problems faced by existing systems. To develop such system at affordable cost is a noble cause towards the society.

4. Challenges

The traffic sign detection and recognition is a quite new research area in image processing. Such type of automated system is very useful to the driver. A very first traffic sign recognition systems appear in 2008 on BMW 7-Series and after that on Mercedes-Benz S-Class. Volkswagen Phaeton also available with this technology[8]. System requires high definition cameras mounted on a car. The existing systems are available only in high class cars. Now a day car is a basic need and some affordable traffic sign recognition systems for all types of cars are required to assist a driver.

Major challenges in traffic sign recognition system are:

- The place of the signboard
- Night Lighting condition
- Weather effect
- Shadow effect
- Signboards may be partially hided by objects like trees, other vehicles and with some other objects.

As per the literature review it has been narrated that previous work are not up to the level satisfactory. Hence, there is a need of a traffic sign recognition system, which is able to solve the problems faced by existing systems. To develop such system at affordable cost is a noble cause towards the society.

5. Research Work

Proposed research paper focuses on the introduction of the development of the automatic traffic sign recognition system and analyze the output produced by the resultant system. Basic model of TSDRS is as shown in Figure 2.

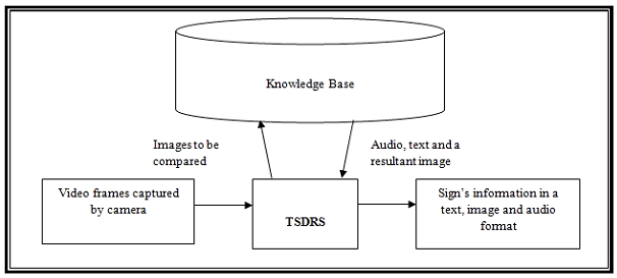

Figure 2. Model of TSDRS.

According to this model input is coming to the system from the cameras mounted on the vehicle. These cameras continuously capturing the video and submit the frames after each fixed interval to the system as an input. Implemented algorithm are applied to the input and if any traffic signs are found by the system then the information related to this sign is displayed as well as played the related audio to concentrate the driver. The captured signs are matched against all the registered signs stored in a knowledge base. The resultant matched signs are tracked with the red highlight box to alert the driver.

6. Different Stages of TSDRS

The proposed system is collection of following stages:

- Image Capture
- Color Identification
- Shape identification
- Template preparation
- Sign matching
- Sign Recognition

The flow of all above stages of TSDRS is represented in Figure 3.

During Image capture image is fetched continuously by the cameras mounted on a car. In the next stage the objects with red and blue color are fetched because red color sign may be prohibitory and cautionary sign in a scene and blue signs may be obligation and informatory signs. During shape identification circular, triangle and rectangle objects are selection from the previous stage. Each shape among these three have specific category.
Proposed system uses centroid feature of the shape to identify whether it is a circular, a triangle or a rectangle. Depending on the coordinates of a centroid point of a

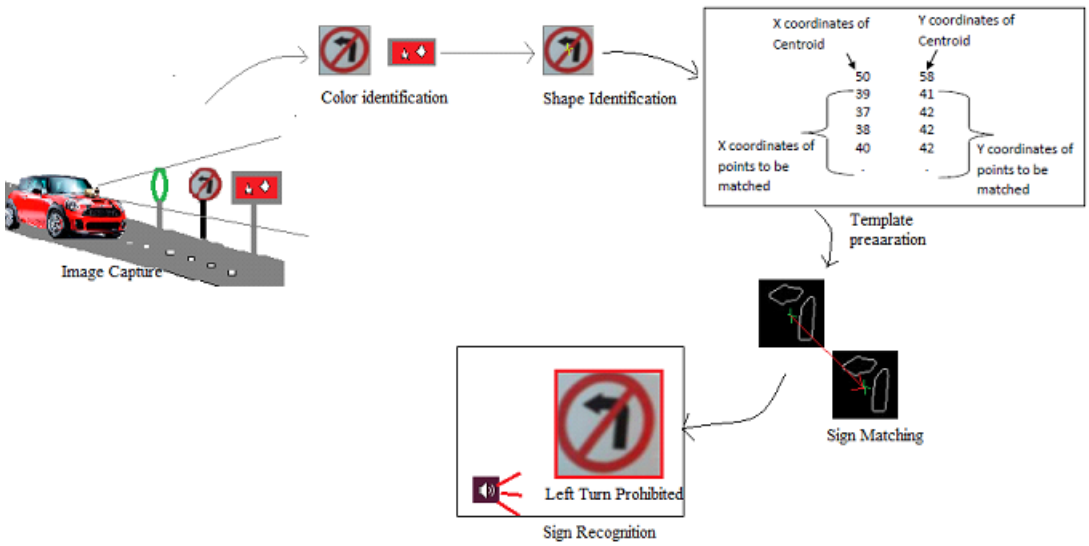

Figure 3. Flow of the stages of TSDRS.

captured sign the shape is categorized[9]. The centroid of an image is the mean position of all the points in all of the coordinate directions in a shape. It is also known as geometric center and barycenter. The centroid of a finite set of n points

$$C(x,y) = \frac{x1 + x2 + \ldots\ldots\ldots + xn}{n} , \frac{y1 + y2 + \ldots\ldots\ldots + yn}{n}$$

Figure 4 shows the location of a centroid in a shape. Figure 4(a) shows the difference in y coordinates of centroid points of a same size of a triangle and a circle, whereas Figure 4(b) shows the difference in x coordinates of centroid points of a rectangle and a circle.

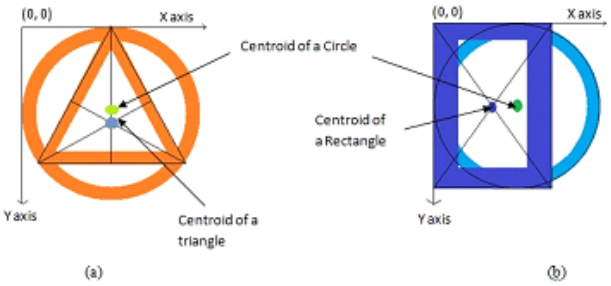

Figure 4. (a), (b) Location of a centroid in various shapes.

At the end of shape identification stage, traffic sign is identified from the frame. The next stage is to create a template file which stores the features of the identified sign for matching purpose. During this stage canny method is applied to derive the feature of the sign image. Coordinates of a centroid of a shape is also fetched from the image. Finally all these features are stored in a template file.

The registered template stored in the knowledge base consists of coordinates of a centroid, audio file detail, actual image file detail, short description of a sign and coordinates of edges of a sign. Table 1 shows (a) various actual signs, (b) template sign and (c) sign captured by the developed system using camera.

At the end of sign matching, system is able to make a comparison between temporary templates with registered templates stored in knowledge. As we can see in Figure 3 temporary template is translated according to the coordinates of a centroid of a templates stored in a knowledge base to find the matched sign. If matching points are beyond the threshold value then both signs are considered as matched signs[10].

The final stage is to produce the output of the system. If the sign is found similar with the sign stored in a knowledgebase, the multimedia output is prepared which include visual, textual and audio format.

7. Result Analysis

Almost all mandatory, cautionary and informatory signs are tested during number of experiments. The following Figure 5(a,b) gives the preview of the execution of the developed system.

After making experiments of 101 actual signs in 6 video

Table 1. Actual sign (b) template sign (c) Sign captured by the camera

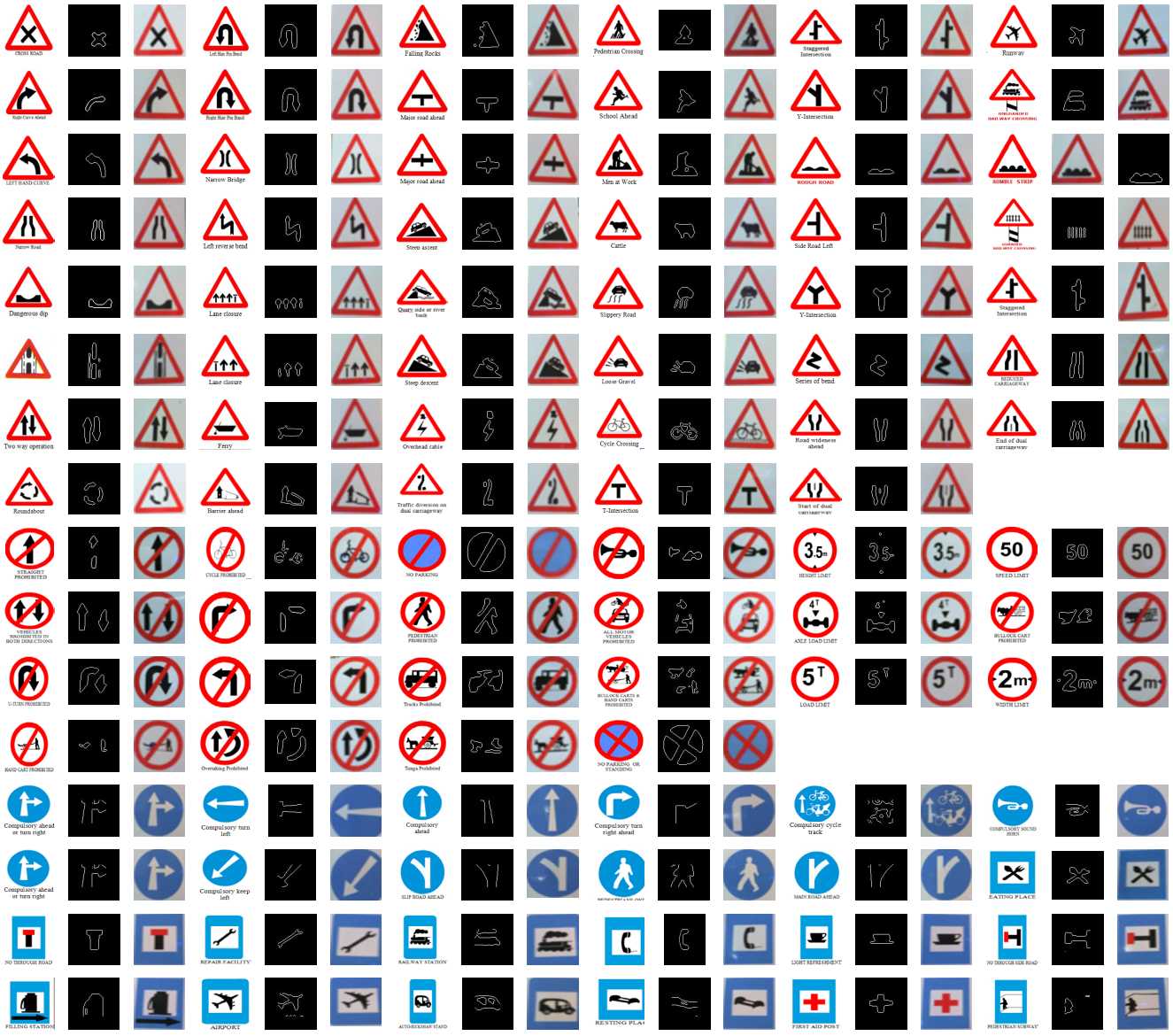

Table 2. Analysis of system performance

Video file	Actual signs	Correct recognition	Incorrect recognition	Signs missed by the system	Success Ratio (%)
1	15	15	-	-	100
2	17	16	-	1	94
3	12	11	1	-	92
4	21	18	1	2	86
5	14	13	1	-	93
6	22	20	1	1	91
		Overall performance			93

files the result is collected and it is shown in Table 2.
The Table 2 shows that out of 101 actual signs the system gives incorrect result for 4 signs and could not give the result for other 4 signs. Hence the performance of the system is nearly 93%.

Figure 5. (a), (b) Preview of execution of a system.

8. Conclusion

Traffic sign detection and recognition system is developed and implemented in MATLAB. Result produced by the proposed system is analyzed and prepared the report to show the robustness of the system. From the result analysis report it is concluded that the accuracy level of a proposed system is more than 93%. This system can be improved to get nearly 100% successes by improving existing algorithms and usage of hardware with high configuration.

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