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IMAGE PROCESSING APPROACH TO DETECT ROAD SIGNS IN INDIAN ROADS

Dr. Ajit Danti [1] , Smt. Jyoti .Y. Kulkarni [2]
[1 2] *Department of Computer Science*
[1] Professor & Director, Jawaharlal Nehru National College of Engineering, Shimoga, Karnataka, India.
[2] Assistant Professor, Govt. First Grade College, Bijapur, Karnataka, India.
[2] *Email - jyotirajju@gmail.com*

ABSTARCT:

Most of the Indian rural and suburban roads are not ideal for driving due to improper and invisible road signs. This has led to many accidents causing loss of lives and severe damage to vehicles. Many techniques have been proposed in the past to detect these problems using image processing methods. But there has been little work specifically carried out for detecting the issue of road sign detection in Indian roads. To address this acute problem, the study is undertaken with the objectives like, to make a survey of Indian roads, to suggest the method to detect road signs and their classification and to suggest automated driver guidance system. In this regard, Color Segmentation and Shape Modeling with Thin Spline Transformation (TPS) is used with nearest neighbor classifier for road sign detection and Classification. Therefore, the attempt is made to invent an automated driver guidance mechanism to make the driving safe and easier in Indian roads. The experimental results obtained are tested with real time image database collected across different roads in sub-urban areas in India and found satisfactory.

Keywords: *Image Processing; Road sign; Thin Plate Spline(TPS); Nearest Neighbor Classifier; Color Segmentation.*

1. INTRODUCTION

Developing an automated driver guidance system is very important in the context of Indian road conditions. A driver finds it difficult to control the vehicle due to sudden pot holes or bumps or sudden turns where the road signs are not very prominent or missing most of the times. Suppose if there is a system with integrated motion camera and an integrated onboard computer with the vehicle, a simple driver guidance system based on frame by frame analysis of the motion frames can be developed and there by generate the alarm signals accordingly. So that the driving can be made quite easier.

Road Image analysis is very important aspect for automated driver support system. Real-time qualitative road data analysis is the cornerstone for any modern transport system. So far, most of the analysis is done manually and the use of image processing techniques for qualitative analysis is still at its early stage. In this paper description about novel image processing algorithm to detect road sign with the results is given, which assign a qualitative description to a road scene. The qualitative description of a road scene can be used for controlling road lights and putting hazard signals on the road side, thereby warning drivers to slow down or direct them to alternative routes. An attempt has been made to analyse a wider view of the path and evaluate the whole description of road status. This full frame image processing application requires a low-cost frame grabber and a Pentium-based computer system for on-line real-time operations.

A sample block diagram of the overall prospective is presented in figure 1.

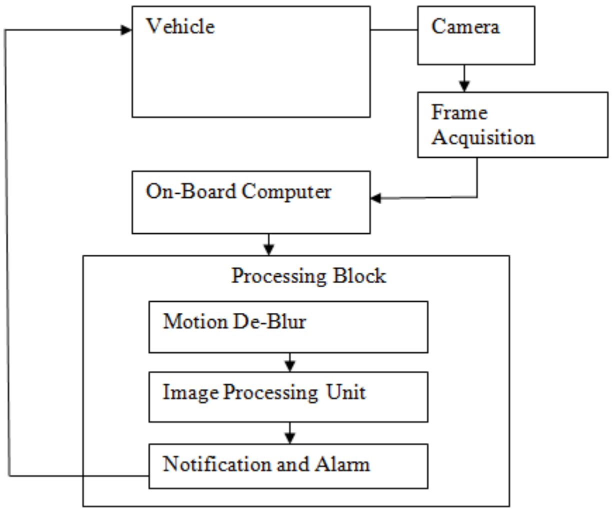

Figure 1: Basic Block Diagram for Driver Guidance System

2. RELATED WORK

[1] The study presents an application of computer vision methods to traffic flow monitoring and road traffic analysis. The said application is utilizing image-processing and pattern recognition methods designed and modified to the needs and constraints of road traffic analysis. These methods combined together gives functional capabilities of the system to monitor the road, to initiate automated vehicle tracking, to measure the speed, and to recognize number plates of a car. Software developed was applied, approved with video monitoring system based on standard CCTV cameras connected to wide area network computers. Traffic signal lights are triggered using an inductive loop. At a traffic light, an automobile will be stopped above an inductive coil and this will signal a green light. Unfortunately, the device does not work with most motorbikes. Using a passive system such as a camera along with image processing may prove to be more effective at detecting vehicles than the current system.

[2] The study determines that the features of various motorbikes and automobiles are sufficient enough to classify it as traffic.

[3] The study introduces a visual zebra crossing detector based on the Viola-Jones approach. The basic properties of this cascaded classifier and the use of integral images are explained. Additional pre and post processing for this task are introduced and evaluated.

[4] The study proposes that the autonomous vehicle system is a demanding application for our daily life. The vehicle requires on-road vehicle detection algorithms. Given the sequence of images, the algorithms need to find on-road vehicles in real time.

[5] The authors propose detection of road signs from stream of video frames. The technique here is a threasholding on RGB color space and binary masking for extraction of the road sign areas. This is the technique adopted here in this paper for extracting the ROI of road signs.

[6] The author presents a robust and real time approach to lane marker detection in urban streets based on generating a top view of the road, Gaussian filters are used, RANSAC line fitting is used to give initial guesses to a new and fast RANSAC algorithm for fitting Bezier Splines, which is then followed by a post-processing step.

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[7] The study proposes a methodology to detect lanes in video frames. This method used here is a parabolic lane model to represent lanes in each video frame. Randomized Hough transform and a Genetic Algorithm is used to estimate the parameters of lane model. The proposed method is tested on different road images taken by a video camera from Ghazvin-Rasht road in Iran.

[8] This paper presents road signs are detected by means of rules that restrict color and shape and require signs to appear only in limited regions in an image. Which are then recognized using a template matching method and tracked through a sequence of images.

[9] Real-time Traffic Sign Detection paper Yield sign, stop sign and red-bordered, circular signs are considered. First, image is color segmented based on a thresholding technique. Then, corner features are detected using convolution masks Geometric constraints used for shape recognition along verification methods for each sign.

[10] Hough has proposed an interesting and computationally efficient procedure for detecting lines in pictures. In this paper the use of angle- radius rather than s lope-intercept parameters simplifies the computation further. Also it is concentrated on general curve fitting, and gives alternative interpretations that explain the source of its efficiency.

3. PROPOSED WORK

A sample block diagram of the proposed work is represented in figure 2 as shown below.

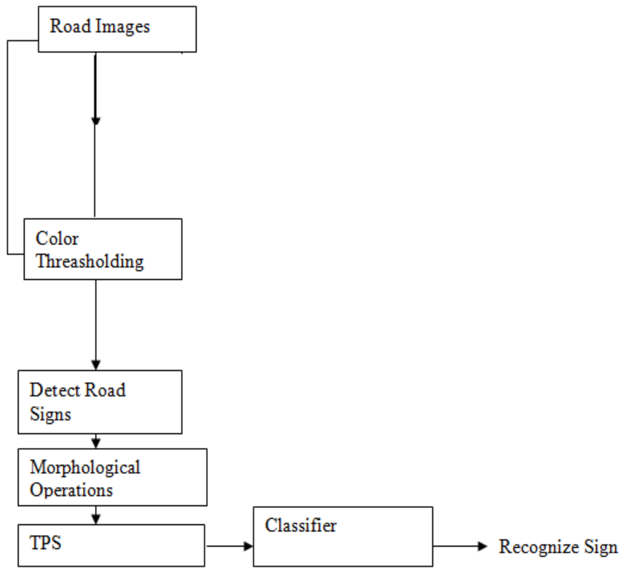

Figure 2: Generalized Block Diagram of the Proposed Work

In this study a database of Indian road images is collected. Images are acquired from a sedan from outside the driver’s window with a digital still camera from a stationary vehicle. Hence, the images give an estimated view of the road side as seen by the driver. The proposed work considers stationary images to build the image processing system and leaves the blur removal filtering for future enhancement in the work. Acquired images are fed to the image processing system. Here, TPS is applied over the extracted sign image to get features for road signs. These features are classified with Nearest Neighbour Classifier to classify the road signs if any, present in the scene.

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4. METHODOLOGY

Following are the phases of algorithm.

4.1. *ROI segmentation with image thresholding*

The first step of the algorithm is the region of interest segmentation which can be detected using sign color information [5]. A "region of interest" is an area of the image that may contain a road sign and is represented in figure 3. A new black and white image is constructed in which all the pixels that satisfy certain thresholds of the sign color are black and the background is white (binary image – an image with only two possible pixel values) and is represented in figure 4. Generally the road signs are created on white with red color for better visibility which is therefore threasholding the area with pure red and white color is necessary. Ludwig Lausser et. al. [3] presented a study on "Detecting zebra crossings utilizing AdaBoost".

Figure 3: Sign locating

Figure 4: Extraction of Sign

4.2. *Thinning and Edge Detection*

The Color based segmentation result varies with different intensities of the image which are different due to different light conditions. Hence the segmented area is never the only ROI expected. Therefore after image thresholding, a thinning algorithm is implemented. This process reduces the thickness of the edge in the binary image. In result, the edges after the implementation have a thickness of one pixel.

4.3. *Identifying the region and clustering*

Region identification is the calculation of the bounding box which includes the regions. Once the bounding box is placed across the segmented region, entire sign is within the bounding box. Now the bounding box is extracted with a size of 64x64 matrix. When images are taken from different distance, the shape of the signs in the bounding box as well as bounding box size differs. As such resizing helps in extracting images or image regions of same size. Though the enclosed information may vary interms of mean intensity information, shapes remain identifiable.

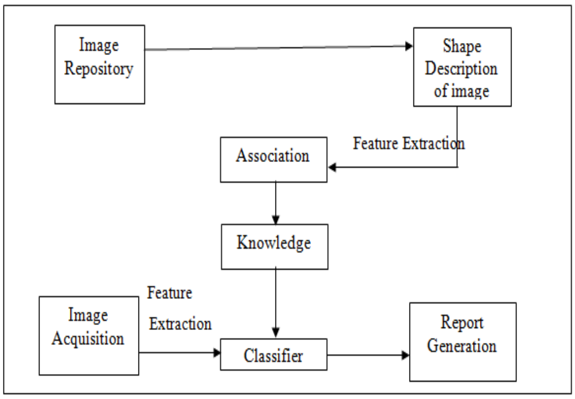

Figure 5:Generalized Block Diagram of Road Sign Detection

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4.4. *Thin Plate Spline (TPS) and Recognition*

An important feature in the image is the edges of objects. It is possible to extract image Contours from the detected edges. From the object contour the shape information is derived. As it is already being discussed that images taken from different distances with respect to the sign image will have shape information at different sizes, it requires a transformation in size or rotation invariant because, in Non-straight roads sign will appear at different angle of rotation.

The shape context is a technique of representing the shape information or edge or contour information as a set of function or polynomial with function parameter or polynomial parameters. The basic idea is to pick n points on the contours of a shape which is best matching for another p points with respect to a test shape. For each point p_i on the shape, consider the $n-1$ vectors obtained by connecting p_i to all other points. The connection or the correlation of the points describe a set of vectors which inturn is a representation of modeling. So, for the point p_i, the coarse histogram of the relative coordinates of the remaining $n-1$ point is defined to be the shape context of p_i.

$$h_i(k) = \#\{q \neq p_i : (q - p_i) \in \text{bin}(k)\} \quad (1)$$

The bins are normally taken to be uniform in log-polar space. This is because a log polar space is rotation invariant. The fact that the shape context is a rich and discriminative descriptor can be seen in the figure 6, in which the shape contexts of two different versions of the letter "A" are shown.

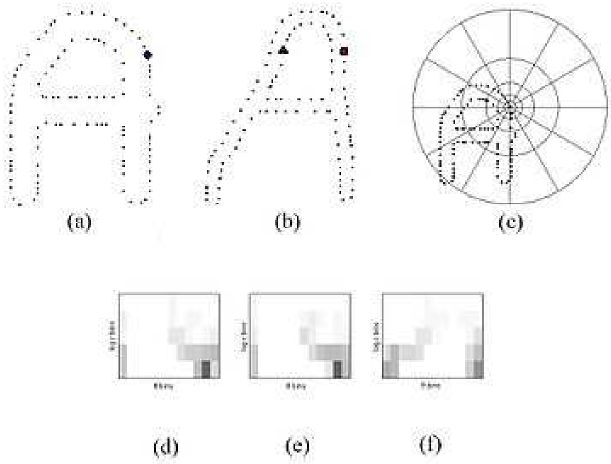

Figure 6: Shape Descriptor and Log Polar Transformation of an Image

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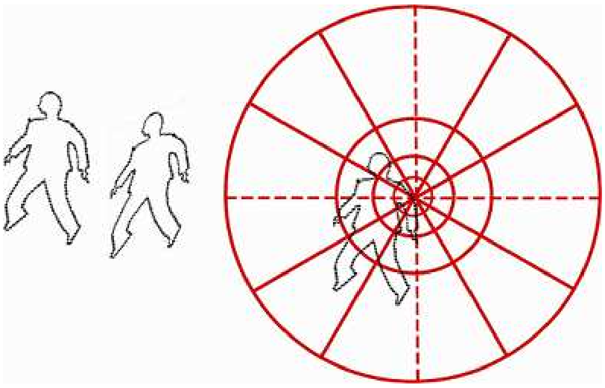

Figure 7: Shape Descriptor and Log Polar Transformation of an Image

In the above figure, (a) and (b) are the sampled edge points of the two shapes. (c) is the diagram of the log-polar bins used to compute the shape context. (d) is the shape context for the circle, (e) is that for the diamond, and (f) is that for the triangle. As can be seen, since (d) and (e) are the shape contexts for two closely related points, they are quite similar, while the shape context in (f) is very different.

Now in order for a feature descriptor to be useful, it needs to have certain invariances. In particular it needs to be invariant to translation, scale, small perturbations, and depending on application rotation. Translational invariance come naturally to shape context. Scale invariance is obtained by normalizing all radial distances by the mean distance α between all the point pairs in the shape although the median distance can also be used. Shape contexts are empirically demonstrated to be robust to deformations, noise, and outliers using synthetic point set matching experiments. One can provide complete rotation invariance in shape contexts. One way is to measure angles at each point relative to the direction of the tangent at that point (since the points are chosen on edges). This results in a completely rotationally invariant descriptor. But of course this is not always desired since some local features lose their discriminative power if not measured relative to the same frame.
Shape matching can be summarized in the following manner;

- Compute the shape context of each point found in step 1.
- Match each point from the known shape to a point on an unknown shape. To minimize the cost of matching, first choose a transformation TPS that wraps the edges of the known shape to the unknown (essentially aligning the two shapes). Then select the point on the unknown shape that most closely corresponds to each wrapped point on the known shape.
- Calculate the "shape distance" between each pair of points on the two shapes. Use a weighted sum of the shape context distance, the image appearance distance, and the bending energy (a measure of how much transformation is required to bring the two shapes into alignment).
- To identify the unknown shape, use a Nearest Neighbour Classifier to compare its shape distance to shape distances of known objects.

5. RESULTS

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Figure 8: Sample Database for Road Signs

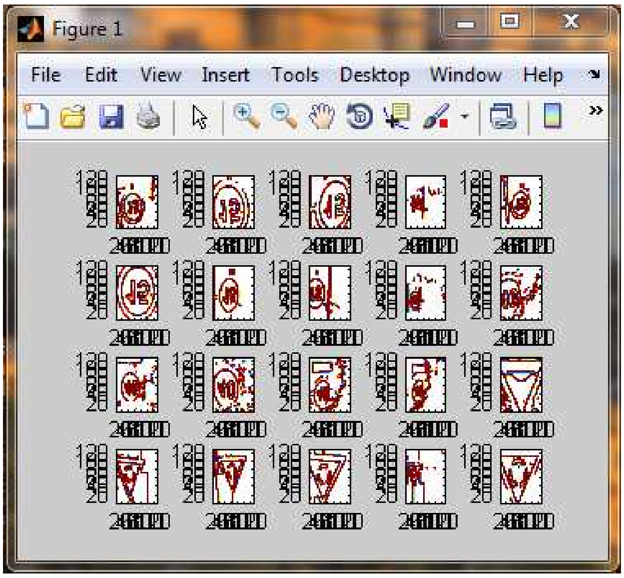

Fig 9(a) : Result for Road Sign Training Images

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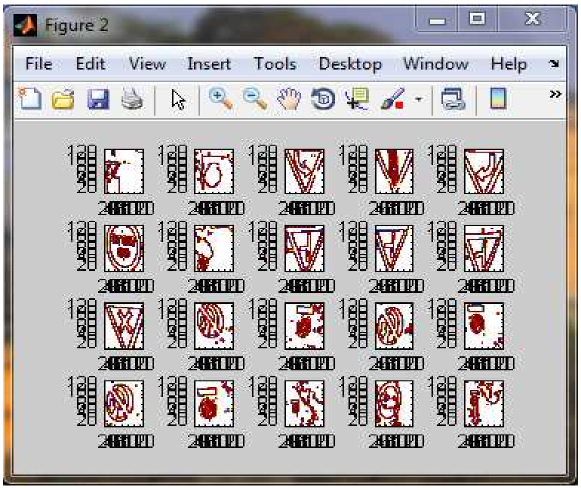

Fig 9(b): Result for Road Sign Training Images

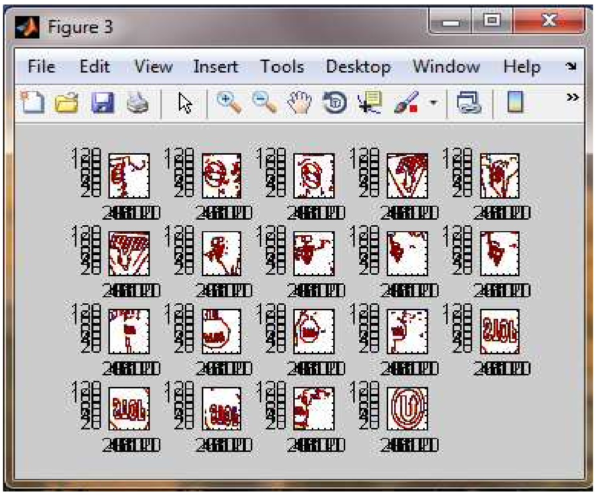

Fig 9(c): Road Sign Training Images

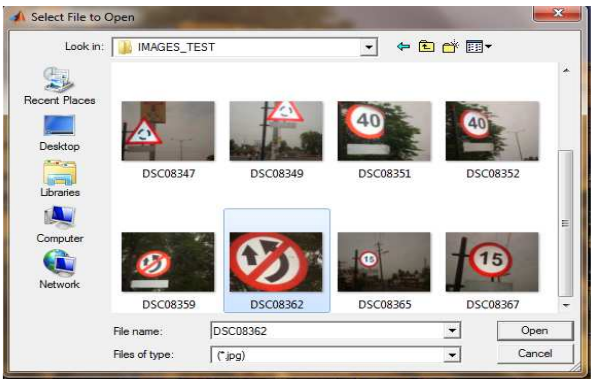

Fig 10: Result for Road Sign Testing.

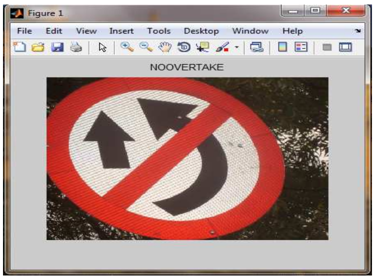

Fig 11: Result for Road Sign Recognition.

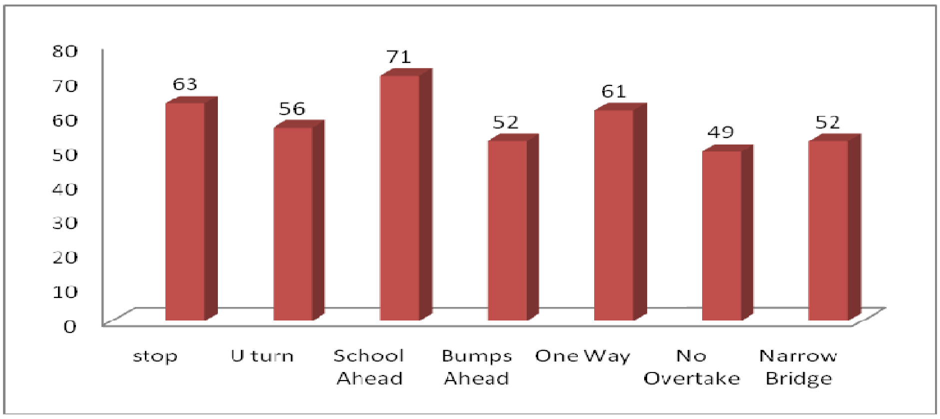

Figure 12: Efficiency of Road Sign Classification

6. CONCLUSION

Real Time Road Images with real traffic conditions presents many challenges as for as image processing and analysis is concerned. Segmentation process segments many unwanted parts of the image and not the pure road signs. Similarly signs taken from different distances give different results. Therefore the proposed work is a break through as for as achieving results for Indian road images are concerned. The algorithm for Road Sign detection, classification and recognition gives an overall efficiency of about 70% which can be further improved by developing better filtering techniques to filter out unnecessary objects like the riders or other backgrounds of the road.

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