A robust multi color lane marking detection approach for Indian scenario

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***Abstract*— Lane detection is an essential component of Advanced Driver Assistance System. The cognition on the roads is increasing day by day due to increase in the four wheelers on the road. The cognition coupled with ignorance towards road rules is contributing to road accidents. The lane marking violence is one of the major causes for accidents on highways in India. In this work we have designed and implemented an automatic lane marking violence detection algorithm in real time. The HSV color-segmentation based approach is verified for both white lanes and yellow lanes in Indian context. Various comparative experimental results show that the proposed approach is very effective in the lane detection and can be implemented in real-time.**

Keywords- Color segmentation; HSV; Edge orientation; connected components.

I. INTRODUCTION

Traffic accidents have become one of the most serious problems in today's world. Roads are the choicest and most opted modes of transport in providing the finest connections among all other modes [1]. Due to increase in vehicles from 3,00,000 in 1951 to about 7,30,00,000 in 2004 [2] as shown in Fig 1, traffic accidents especially road accidents have become predominant. According to official statistics 105,725 people were killed in road traffic crashes in India in 2006 (NCRB, 2007) [3]. During recent years, traffic fatalities increased by about 5 percent per year from 1980 to 2000 [2] and since then have increased by about 8 percent per year for the four years for which statistics are available as shown in Fig 2.

The major factors that contribute to road accidents are due to negligence of the driver. Reducing the accidents on road is possible by improving the road safety. Increasing the safety and saving lives of human beings is one of the basic features in Advanced Driver Assistance System (ADAS), a component in Intelligent Transportation System (ITS). A real time computer vision based system plays an important role in providing a useful and effective information like lane marking [20], departure and front and side images etc. The present paper deals with the detection of lanes on roads especially Indian typical roads.

Many researchers have shown lane detectors based on a wide variety of techniques. Techniques used varied from using monocular to stereo vision using low level morphological operations to using probabilistic grouping and B-snakes [22]. All the techniques are classified into two main categories namely feature based techniques and model based techniques. The feature based technique combines low level features like color; shape etc. in order to detect the lane and the model-based scheme is more robust in lane detection when different lane types with occlusions or shadows are handled. Road and lane markings can vary greatly, making the generation of a single feature-extraction technique is difficult. So, we combined the features of both color based and edge based techniques [23], [24].

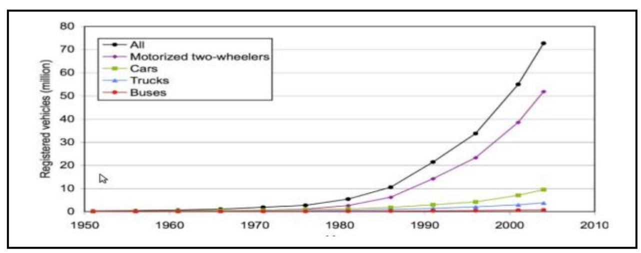

Figure 1. Registered vehicles, 1951 through 2004

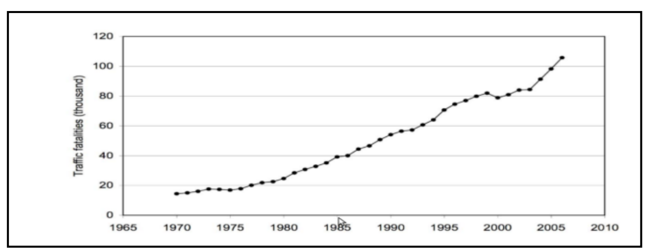

Figure 2. Traffic fatalities, 1970 through 2006

II. STATE OF ART

During the Recent years, many techniques for processing and analyzing images for lane detection have been proposed which involves, Template Matching and Ellipse Modeling Approach to Detecting Lane Markers [4]. Lakshmanan and

Kluge [5] applied deformable template model of lane structure to locate lane boundaries without thresholding the intensity gradient information. Yim and Oh [6] developed a three-feature-based automatic lane-detection algorithm using the starting position, direction, and gray-level value of a lane boundary as features to recognize the lane. ZuWhan Kim [7] developed new method for lane detection which involves lane boundary hypotheses generation and probabilistic lane grouping. M. Bertozzi and A. Broggi [8] were proposed a method for lane-detection which is based on morphological filter. It is observed from literature study that only very few attempts have been made to work on color images [9]. Yu-Chi Leng and Chieh-Li Chen [10] proposed a method for lane-detection which is based on urban traffic scenes [20]. Yue Wang, Eam Khwang Teoh and Dinggang Shen developed Lane detection and tracking using B-Snake [22]. H. Zhang, et al proposed a Novel Lane Detection Algorithm Based on Support Vector Machine.[21]. In the present study, two lane features, lane width and lane boundary continuity, are proposed to obtain reliable and quality lane detected results.

III. Lane marking detection using HSV-Edge based Approach

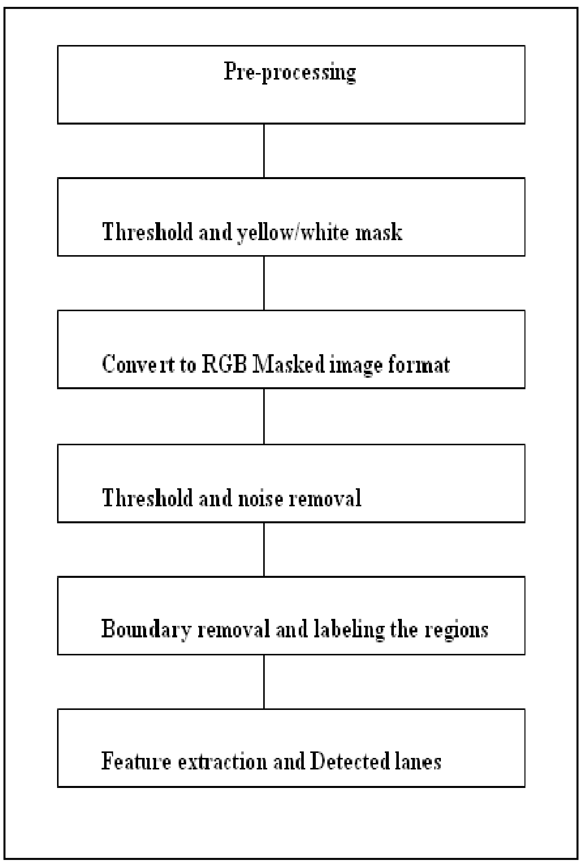

Figure 3. Proposed approach

Many lane detection approaches [17], [18], [19] use color model in order to segment the lane line from background images. However, the color feature [2] is not sufficient to decide an exact lane line in images depicting the variety of road markings and conditions. If there are many lanes or obstacle which is similar to lane color, it will be difficult to decide an exact lane. Similarly, some lane detection method uses only edge information. The proposed method involves the combination of both color segmentation and edge orientation to detect lanes of roads of any color (especially yellow and white which are the common colors for the lane).

IV. Color Segmentation

In color segmentation [11-12], we will find out the objects or part of the image that were of the lane color. That is the image at the end possesses only those parts of the image which has the lane color (yellow or white). The color segmentation deals with the color feature of lane markings. The method works out with the hue saturation value color model rather than the red green blue color model.

A. Pre-processing

The pre-processing includes reading the input image, conversion to HSV format and split into individual H, S and V bands. The first step in the process is reading the input image. If the image taken is a gray scale image then the image is read as a two dimensional array. If the input image file contains a true color (RGB) image, it is a three-dimensional array mxnx3. The RGB image is converted into HSV format [13] as hue, saturation and value are properties of a particular color in an image whereas Red, Green and Blue are the primary colors which when combined gives rise to a particular color. Then we segment the areas of a particular color of HSV image by applying thresholds to Hue, Saturation and Value from the HSV image.

B. Threshold and yellow/ white mask

The values of the Hue, saturation and value of the Lane color are set as the thresholding values. Table 1 describes the set of threshold values are used for yellow and while colored lanes. The values are taken after through experimentation on different types of road images under various conditions.

C. Boundary removal and labeling the regions by connected components

We employ the logical and operation of the masks in the above step to obtain the Single Lane colored mask and then apply the colored masks to RGB bands by typecast the yellow object mask/white object mask, as the case may be, into the class of RGB image by using cast function. Now this RGB image obtained is split into individual Red, Green and Blue bands .To each Individual band we multiply the "yellow Objects Mask/ White Objects Mask" so as to obtain masked red green blue images separately. Now we concatenate these masked images into a single masked RGB image. The final masked RGB image consists of the desired lane colored portions only.

TABLE I. Threshold values for detecting yellow and white color lanes

Table Head	**Yellow color lane**		**White color lane**	
	Low	***High***	***Low***	***High***
Hue	0.10	0.14	0.0	0.14

Table Head	Yellow color lane		White color lane	
	Low	*High*	*Low*	*High*
Saturation	0.4	1.0	0.0	0.2
Value	0.8	1.0	0.8	1.0

V. EDGE ORIENTATION

The lane colored objects that are identified in the color segmentation step are subjected to the edge orientation by using the eccentricity [14] property of shape. After the image is subjected to these steps we finally will be able to detect the lane of any color on the road.

A. Threshold and noise removal

The masked image obtained at the end of Color Segmentation process is considered as the input image in this step. In the thresholding step [15-16], the input image is converted into a gray scale image. The intensity of a gray scale image varies from 0 to 255(0 for black and 255 for white).Since the lanes to be detected are in white color, the pixel intensity at the region of the lane is closer to 255 (>200). Therefore we set a threshold value above 200. The pixels whose intensity is above threshold are made white and the pixels below the threshold are eliminated. Thus a gray scale image is converted into a binary image that has intensity values 0 or 1 of which our lanes are an integral part.

The next step in our process is removal of unnecessary pixels. These unnecessary pixels include the noise and the boundary objects existing in the image. We performed these operations by performing certain morphological operations on the image. We first morphologically open the binary image and eliminate all the connected components of the binary image that have the number of pixels less than the amount specified by us.

B. Remove boundary objects & labeling the regions

The next step in the process is identifying the boundaries of the lighter regions inside the binary image. Through this the number of regions existing in the image is identified and is also labeled accordingly. The regions in the image are visualized by assigning the colors to all the regions existing uniquely.

C. Feature extraction and detecting the lanes

After identifying different regions inside the binary image, we need to measure the properties like region like Area, Eccentricity, Major Axis Length, Minor Axis Length, Orientation and Perimeter etc., of each and every region of the image in order to find the lanes present in the road image. In this paper we are mainly concerned with the property Eccentricity. The value of eccentricity varies from 0 to 1. The value 0 indicates that the region is in the form of a circle and if it is 1, then the region is a straight line. Since our lanes are straight, they may have the eccentricity value closer to 1. We store the eccentricity values of each region in an array and compare them with a value 0.98 and the regions having eccentricity more than 0.98 are identified and stored separately in another array.

The final step of the system is detecting the lanes. This can be easily done by mapping the original image with the binary image on which the lanes have been identified. We iterate the array of straight lines produced in the above step and mark each pixel of the region being iterated is marked with the required color thus identifying the lanes in the image.

VI. PERFORMANCE ANALYSIS FOR YELLOW COLORED IMAGES AND WHITE COLORED IMAGES

The images shown in Figure 4 and Figure 5 represent the way to detect the yellow colored lanes and white colored lanes respectively by using the HSV values shown in Table 1. In Figure 4, we consider yellow colored lane image as input and after applying the said series of steps we have an output image with identified yellow colored lines and in Figure 5, a typical Indian road with white colored lane is considered for the test and after applying the said series of steps, the exact location of the white lines are detected and identified.

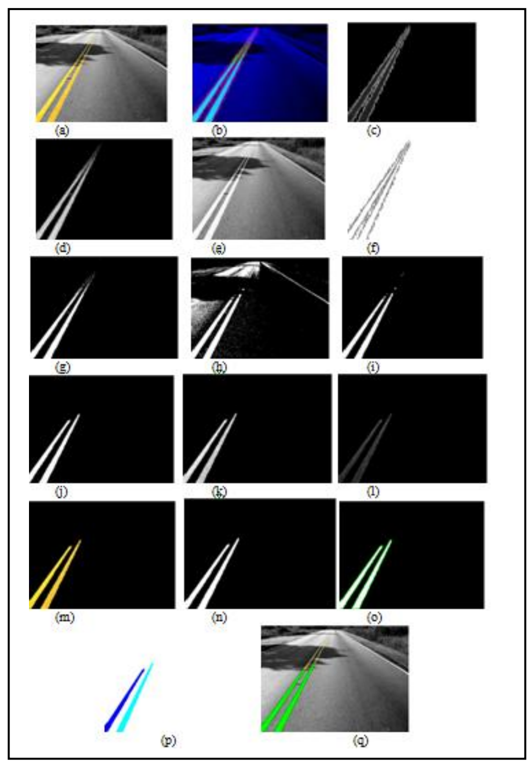

Figure 4. (a) Original Image (b) HSV image(c) Hue Image(d) Saturation image(e) Value image (f) Masked Hue(g) Masked Saturation(h) Masked Value(i) Yellow Masked image (j) Masked Red Image(k) Masked green image(l) Masked blue image(m) Masked yellow image (n) Threshold Image (o) Boundaries identified (p) Regions labeled (q) Identified lanes.

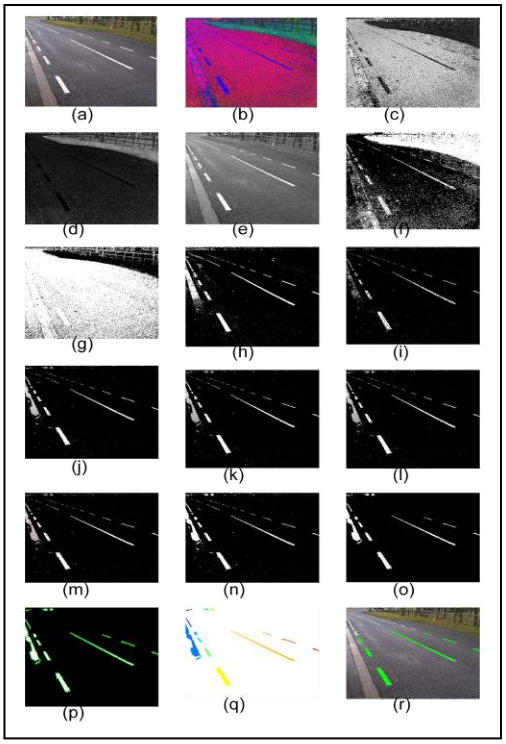

Figure 5. (a) Original RGB Image (b) HSV image (c) Hue Image (d) Saturation Image (e)Value Image (f) Hue Mask (g) Saturation Mask (h) Value Mask (i) White portions left (j) Masked Red Image (k) Masked Green Image (l) Masked Blue Image (m) Masked RGB Image (n) Thresholded Image (o) Noise Removed image (p) Boundaries Identified (q) Regions Labeled (r) Lanes Identified

VII. Conclusion

In this paper, we have developed and implemented a novel algorithm to detect white and yellow colored lanes on the road. The lane detection method is robust and effective in finding the exact lanes by using both color and edge orientations. The main contributions in this paper are the color segmentation procedure identifies the yellow of white colored lanes followed by edge orientation in which the boundaries are eliminated, regions are labeled and finally the lanes are detected. As the height of the camera is relatively constant with respect to the road surface, the road portion of the image can be exclusively cropped by providing the coordinates, so that identifying the lanes becomes much more efficient. The experimental results show the effectiveness of the proposed method in cases of yellow and white colored lanes. The entire work is done in a static way that is on an image. We can extend this to detect lanes in a video.

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