IJCTA, 9(7), 2016, pp. 3239-3244 ISSN: 0974-5572

A Vision based approach for vehicle Anti-collision system

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ABSTRACT

In India, there is a road accident every 80 seconds. The global status report on road safety 2013 estimates that more than 231,000 people die in road traffic crashes in India every year. 93% of the accidents are due to human factors. In that, 23% of the accidents are caused due to rear-end collision of vehicles. Road safety has become a major issue with the number of vehicles increasing at an alarming rate. In case, if the vehicle drivers are given an early warning, a lot of crashes can be avoided. Thus, if a device is designed and incorporated in vehicles it will reduce the incidence of road accidents. A lot of research has been done in anti-collision warning systems to assist drivers based on sensors, whereas this is an image processing approach. The main objective of this work is to avoid vehicles colliding with stationary cars or trucks in roads. The image of the road is obtained using a camera placed in the rear end of the vehicle. The obtained RGB image is converted into HSV color model and the hue, saturation, value histograms are calculated. For texture feature, Gabor filter is applied. The feature vector is fed into the SVM Classifier for classification of image into road and non-road. The platform (road or non-road) in which the vehicle has been parked is identified from the output of the classifier. If the vehicle is parked fully on road or if road is predominant, then a RF transmitter is used to send an alarm signal for a certain range. The cars approaching the stationary vehicle are fitted with a receiver. When the car comes in the range of the transmitter, alarm signal is received to alert the driver. Thus, by alerting the driver, he comes to know about the stationary vehicle parked ahead, in advance. Thus, the proposed work will reduce the number of collisions by alerting the driver.

Keywords: Gabor filter, HSV color space, Support Vector machine, road surface classification.

1. INTRODUCTION

The frequency of traffic collisions in India is amongst the highest in the world. A National Crime Records Bureau (NCRB) report reveals that every year, more than 231,000 traffic collision-related deaths occur in India. The actual number may be higher than what is documented, as many accidents go unreported. Lack of road sense and failing to maintain lane are the major causes of accidents on highways.

An important thing to remember in case of a vehicle break down on the highway is to turn on the parking lamp and move the vehicle to the service lane. As discussed earlier, the number of accidents in highways due to rear end collision has increased over the years. Also, the registration of light motor vehicles and heavy motor vehicles is also increasing at an alarming rate and most of those vehicles are fast moving. In the international scenario, most of the vehicles are incorporated with collision avoidance systems. In India, collision avoidance systems are not implemented practically. But there are some collision warning systems such as proximity sensors. But the drawback in this system is that it works only for a very short distance of about 10 -15 cm. Other signs used during parking of vehicles are parking cones and parking lamps. The defects of the use of parking lamps are that drivers do not have proper road sense to switch it on, they are not visible in curves and not clearly visible in day time. The issues that have to be solved in this work are,

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- A technique to understand whether the vehicle is on road or not.
- Distant warning so that the driver of the approaching vehicle will be warned earlier and at a considerable distance
- The algorithm should also work in curved roads.

The main objective of this proposed work is to avoid vehicles colliding with stationary cars or trucks in roads by transmitting a wireless alarm signal by detecting the platform in which the vehicle is parked using Image processing techniques.

2. PRIOR WORK

Graovac et al. [1] has presented the novelty in mainly four aspects of texture based road detection methods. Automatic choice of best candidate from descriptors and simultaneous use of both structural and statistical texture descriptors is done. Stoklasa et al. [2] has implemented a new approach for road detection based on similarity database searches. In this method, images are divided into regular samples and for each sample the most similar image is retrieved from the database. Falola et al. [3] has presented a preprocessing strategy to remove the salient pixels from an image by extracting edge detected frame matrix, scanning each column in bottom-up approach, replacing values above a pixel value by zero if pixel value at a location is zero and repeating for all columns until all salient pixels are minimized. Alvarez et. al [4] suggested a novel approach which combines shadow invariant feature vector and a model based classification approach for road detection . Tsung-Ying Sun et al. [5] has proposed a method for road detection based on HSI color model feature extraction, Fuzzy C means algorithm based segmentation. The post processing work includes filtering after segmentation. This method works on still images and it provides better results compared to RGB model based method for lane extraction. Olusanya Y. Agunbiade et al. [6] has suggested an approach for road detection using HSV color space method. Morphological post processing is done and there is no tracking. This work is for offline SVM based road region classification, Qualitative Analysis and it is used for shadow removal applications. Erke Shang et. al. [7] proposed a novel approach for unstructured road detection on contextual information in which RGB histogram value is used. This method outperforms state of art methods using the same low level feature space.

3. MATERIALS AND METHODS

3.1. Image Acquisition

The road image is acquired by a digital camera placed on the rear end of the vehicle. The images are in 1280 x 720 resolution. The acquired RGB image is converted into a HSV image.

3.2. Feature Extraction

After color space conversion, the important and essential task is to measure the properties of an object because objects have to be detected based on these computed properties. In the feature extraction step, the task is to describe the regions based on chosen representation, e.g. a region may be represented by its boundary and its boundary is described by its properties (features) such as color, texture, etc. The overall flow of the proposed work is shown in Figure 1.

3.2.1. Color Features

RGB color model is the way computers treat color, whereas HSV color model tries to capture the components of the way humans *perceive* color. Moreover, HSV eliminates the effects of shadow and illumination. Therefore, HSV color space is chosen for processing. The HSV color space has three components: hue, saturation and value.

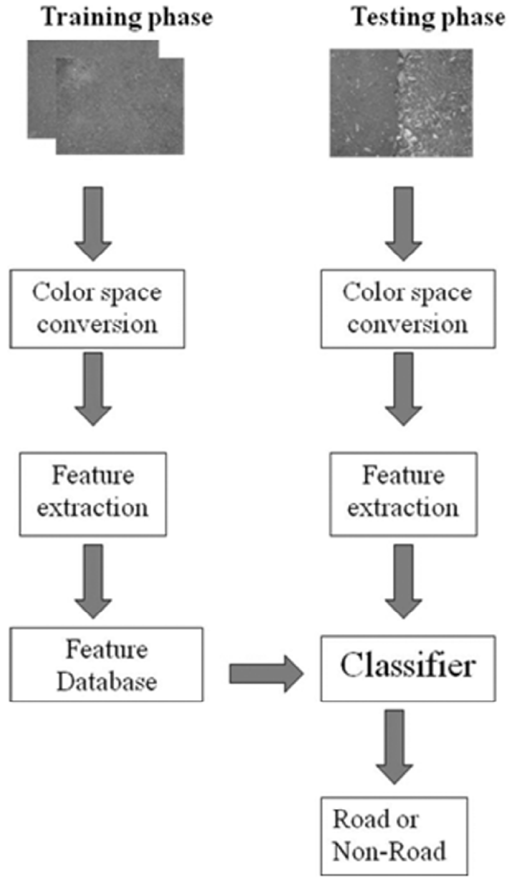


Figure 1: Overall flow diagram of the proposed work

1) *Hue: Hue* is the angle of the vector to a point in the projection, with red at 0°, while *chroma* is the distance of the point from origin.

$$\text{Hue, } H = \begin{cases} \theta & if \ B \le G \\ 360 - \theta & if \ B > G \end{cases} \tag{1}$$

$$\theta = \cos^{-1}\left\{ \frac{\frac{1}{2}\left[(R-G)+(R-B)\right]}{\left[(R-G)^2+(R-B)(G-B)\right]^{\frac{1}{2}}} \right\} \tag{2}$$

2) *Saturation:* Saturation reveals the range of grey in the color space. '0' indicates grey and '1' indicates a primary color.

$$S = 1 - \frac{3}{(R+G+B)}\left[\min(R,G,B)\right] \tag{3}$$

3) *Value:* Value is the average of R, G and B in RGB model.

$$V = \tfrac{1}{3}(R+G+B) \tag{4}$$

20 bin histograms of hue, saturation and value is calculated and taken as a feature for training and testing of images.

3.2.2. Gabor Texture feature

$$f(x,y) = \frac{1}{2\pi\sigma^2}\exp\left\{-\frac{x^2+y^2}{2\sigma^2}\right\}\cos(2\pi(\omega x\cos\theta + \omega y\sin\theta)) \quad (5)$$

where ω is the phase, θ is the orientation and σ is the bandwidth or effective width. 20 bin histogram of gabor filtered image is calculated and taken as a feature for training and testing of images. The above four features are concatenated as a single feature vector. The feature vector is fed to a classifier for the classification of platform into road or non-road surface.

3.2.3. Classification

The classification of road and non-road surfaces is tested using SVM classifier. SVM is a set of administered study methods that evaluates data and identifies patterns. SVM constructs a hyper plane in an eminent spatial feature space which is used for classification. A worthy separation is achieved by a hyper plane that has the greatest distance to nearest training data point of any class. SVM tries to find the best hyper plane which depends on Support Vectors present in the space. Support Vectors are the data points that lie close to the decision surface. The SVM algorithm calculates the hyper plane such that the edge around the plane is highest.

4. RESULTS AND DISCUSSION

Eleven different types of road surface images were taken. Images of the road and non-road surfaces were taken at various times. Digital camera of resolution 8 mega pixels was used to capture the images of the road at a height of 1-2 feet. The dataset contains 200 road images and 200 non-road images. Sample images of road and non-road surfaces are shown in Figure 2 and Figure 3 respectively.

The classification result of road and non-road surface images are shown in Figure 4 and Figure 5 respectively.

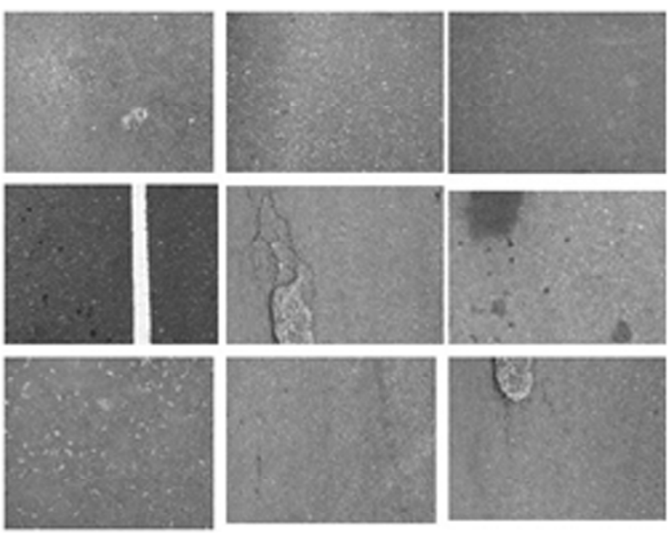


Figure 2: Samples of Road Surfaces

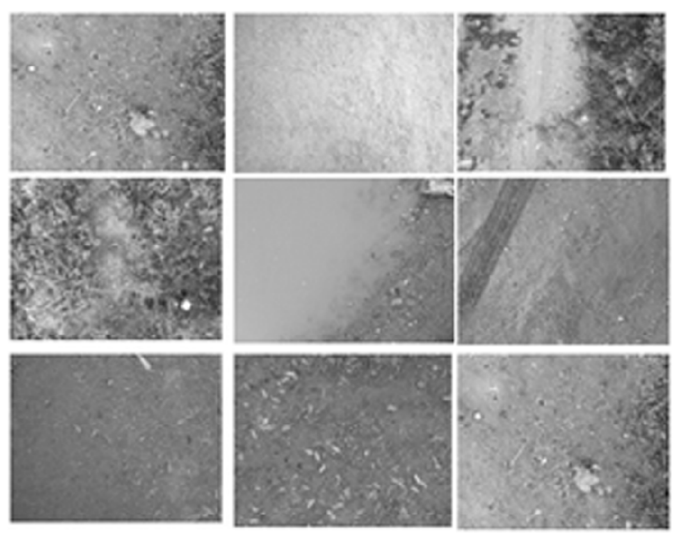
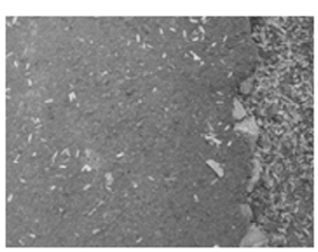
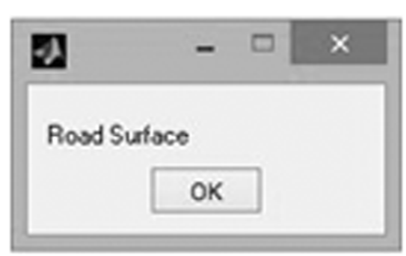


Figure 3: Samples of Non-road Surfaces



(a)



(b)

Figure 4: (a) Road image (b) Classifier result

(a) **(b)**

Figure 5: (a) Non-road image (b) Classifier result

The confusion matrix for the classification of road and non-road surfaces using SVM Classifier is shown in Table I.

Table 1
Confusion matrix of the classification of paintings using svm classifier

True class	*Classified*	
	Road	*Non-road*
Road	76.33 %	23.67 %
Non-road	4.00 %	96.00 %

The classification accuracy of SVM classifier is about 85.73%.

5. CONCLUSION

This proposed work approves the influence of color and texture features of road and non-road surfaces, since the results obtained by the feature extraction are the most distinct ones. Considerable deviations suggest further improvement of the system. The proposed work is an innovative method for classification of road surface and the accuracy and results obtained have a potential in real time implementation of collision warning system by road detection. The biggest limitation of this system is its inability to work with images in night time and also with different viewpoints.. To improve this program, several changes have to be made. The first one refers to the database: A better one, with night images, and better image quality by using cameras in real time application must be taken. The future goal is to interface the decision making system with Arduino Uno kit in order to transmit a warning signal from the decision making system to an RF Transmitter through Arduino kit.

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