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Rear-Lamp Vehicle Detection and Tracking in Night Conditions to prevent Accidents

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ABSTRACT

Automatic recognition of vehicles in front can be used as a component of systems for forward collision prevention. When driving in dark condition, vehicles in front are generally visible by their tail lights. The main objective of advanced driver-assistance system proposed in this paper is to prevent accidents during night time and thus to put aside our society from vehicle accidents. The proposed novel image processing system detect vehicles at night and recognize their tail lights using red color threshold and tracks them using kalman filter technique. This system efficiently spots vehicle at different distances and in different weather and lighting conditions and provides danger warning to the driver when the distance between the vehicles is less than 10m.

KEYWORDS – Vehicle recognition, forward collision, driver assist, automotive, image processing

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INTRODUCTION

Vehicle calamity statistics are jarring at night. Even though the traffic is 60 percent less, more than 40 percent of many fatal car accidents occur at night. Every year, thousands of people are injured or killed as a result of vehicle accidents at night time, and in many cases the accident did not occur due to any fault on the injured person or the departed victim. Developing countries face worsening situation while in developed countries the situation is generally improving. Pedestrians and two wheelers bear the brunt most during night time.

The developed countries are now focusing to develop intelligent and smart cars with accident prevention facilities. To detect the vehicle by using their lamp pair, the concepts such as morphological processing and light edge detection are used. These concepts come under Digital Image Processing area. The proposed work identifies rear lamp of vehicles during night conditions and estimate the distance between vehicles for alerting drivers when the distance falls below 5 m.

LITERATURE SURVEY

As rear lights must be in red colour by law, several systems have utilized colour to aid vehicle detection. Chernet al[1] detected rear lights by colour filtering in RGB space to detect red and white regions. Wang et al[2]suggested a very different approach with the hardware based solution without any signal processing technique. Cucchiaraet al[3] detected vehicles during day and night using surveillance video, but approached both the environments with different techniques. Chan[4] proposed particle filter framework method to detect vehicles by day and night. Ronan et al[5] suggested morphological operations for detecting vehicle lights. The Kalman filter is reportedly employed by Kolleret al[6] for multivehicle tracking. The trajectory of vehicle lamp is used by Julia et al to distinguish it from surrounding stationary lights, such as street lamps and reflective road signs. Bayesian templates, is used in conjunction with a Kalman filterby Dellaert and Thorpe[8]for tracking of vehicles during daylight conditions. Rajnandiniet al[9]suggests several automatic accident prevention detections using smart phone. This proposed work focuses on vehicle tracking suitable for Indian environment to avoid accidents during time.

EXPERIMENTAL DATA CAPTURE

The camera should be mounted internally on the vehicle behind the rear view mirror for capturing rear lamp of vehicles. The camera module has a resolution 352 × 288 and a frame rate of 18Hz. It is essential that the camera is mounted in level. If not, it will interfere with the symmetry searches in the detection algorithm. Figure 1 shows a camera placement in vehicle.

Figure 1.Camera Position In Vehicle

Several instances of real world traffic events are captured in urban, rural and forest areas for assessing the sensitivity of this driver assistance system. Video captured in critical weather conditions like heavy rain is also included, as detection will be a challenging task when the road surface becomes wet and rear lights reflected on it. The parameters of the algorithm is refined and tuned using the performance results of experimental test data. The captured video recording details are shown in table 1.In Table1, weather condition “Bad” implies the worst atmosphere like mist and so on. “Good” implies better environment and noise free. “Normal” implies better environment with noise.

Table.1 Details of Video data

Captured Video	Weather condition	Road condition	Time Duration
Test_Video_001	Normal	Forest	8.00 pm –8.10 pm
Test_Video_002	Good	Village	7.50 pm –8.05 pm
Test_Video_003	Normal	City	9.00pm –9.12 pm
Test_Video_004	Bad	Town	11.30pm –1.45pm
Test_Video_005	Good	City	11.00pm - 1.13pm
Test_Video_006	Bad	Town	10.40pm - 0.50pm
Test_Video_007	Normal	Village	9.20pm - 9.30pm
Test_Video_008	Good	Forest	8.25pm - 8.30pm
Test_Video_009	Normal	Forest	7.15pm – 7.25pm
Test_Video_010	Good	City	8.00pm – 8.06pm
Test_Video_011	Normal	City	8.45pm – 8.50pm
Test_Video_012	Normal	Village	9.02pm - 9.12pm
Test_Video_013	Good	Town	8.50pm – 8.55pm
Test_Video_014	Good	Village	10.10 pm –0.15pm
Test_Video_015	Bad	Town	9.30 m – 9.35 pm

PROPOSED METHODOLOGY

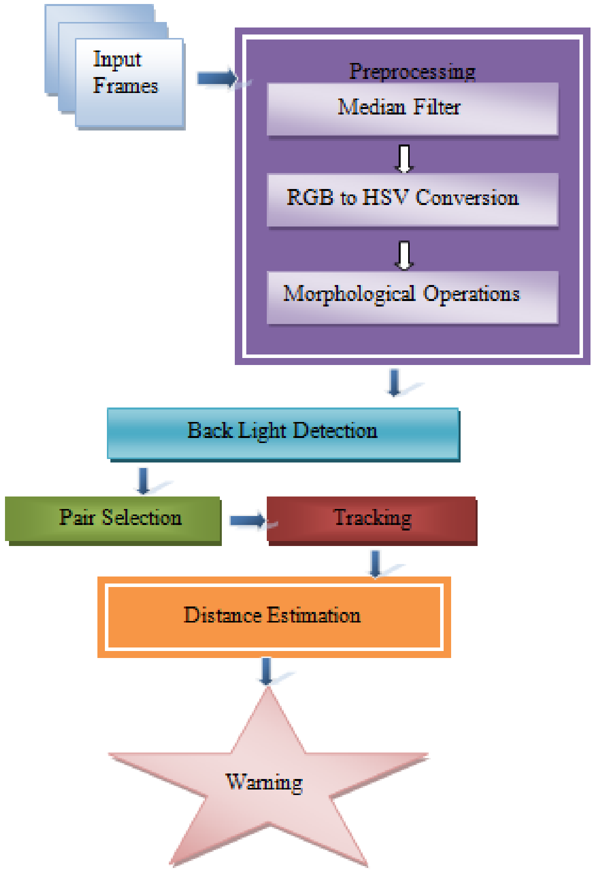


Figure 2: Architecture of Proposed Work

The architecture of the work is shown in Figure 2. The captured video is converted into many frames. The numbers of frames are based on the video format. AVI files need 18 frames/Sec while MPEG requires 26 frames/sec to avoid loss of information. In this work, AVI files are used and hence 18 frames are considered..

PREPROCESSING

Preprocessing is carried out in two steps: (a) The input frame is median filtered to reduce noise before performing the color threshold. (b) The noise free RGB frames are converted into HSV frames. The RGB image is converted to HSV since people view colour in RGB domain. Rear-facing lamps are segmented from the color video using the camera fitted based on red-color threshold. This color threshold is obtained from automotive regulations and adapted for real-world conditions in the hue–saturation–value (HSV) color space. The threshold values are shown in the table 2.Video frames are converted into binary frames. A sample frame and its binary image is shown in Figure 3.

Table 2. Threshold Values

	Minimum	Maximum
Hue	342^O	9^O
Saturation	0.0	1.0
Value	0.75	2.0

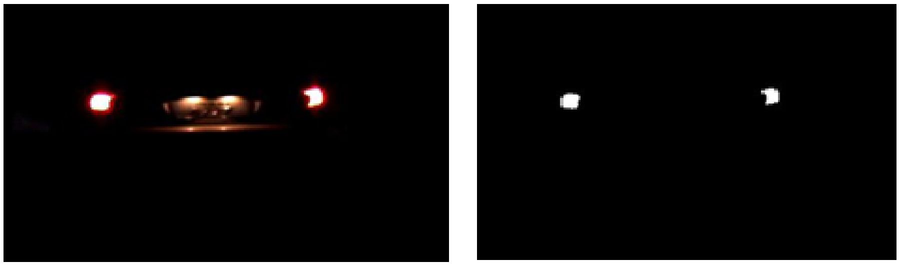


Figure 3.Input Frame & its Binary Image

Morphological operation is done to reducenoise. The morphological techniques likes erosion and dilation are employed.Dilation inserts pixels along the boundaries of objects in an image, while erosion eliminates pixels on object boundaries. The number of pixels inserted or removed from the objects in an image depends on the size and shape of the structuring elementdesigned to process the image. Erosion actually removes the noise in the input binary frame. Dilation reconstructs the interesting region that can be eliminated during the time of noise removal.

LAMP DETECTION

After removing noise, the input frames are subjected to edge detection. The Edge Detection block identifies the edges in an input image by approximating the gradient magnitude of the input image. Canny edge detector is used in this work. The Canny method employs two thresholds to the gradient: a high threshold for low edge sensitivity and a low threshold for high edge sensitivity. Edge identification starts with the low sensitivity result and then continued to include connected edge pixels of the high sensitivity result.

LAMP PAIRING WITH TRACKING

Pairing of lamps is done based on the size, shape and intensity of the light. The final stage in the lamp pairs symmetry check is the comparison of the aspect ratios of the light candidates. This is done to prevent objects of different shapes but same size and position being paired. As a last check, the width to height aspect ratio of the bounding box containing the tail-lights is checked to meet the following constraints.This is done to make sure that similar objects at a large distance apart, such as lights from vehicles in different lanes, are filtered out of the lamp pairing process.

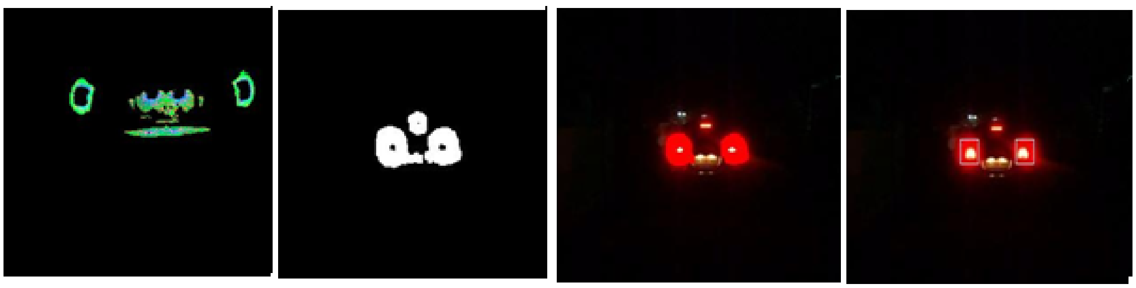
$$4 \leq \frac{Width(BoundingBox)}{Height(BoundingBox)} \leq 10 \quad (1)$$

DISTANCE ESTIMATION AND DANGER WARNING

Finally, the danger distance is estimated for providing collision warning action. Collision warning is issued when the distance of the ongoing vehicle is below 10m within 0.04 seconds.

RESULTS AND DISCUSSION

The overall processing result and the output image of each stageis shown in Figure 4. Out of 15 videos tested using this proposed work, only in one video the rear lamp is not properly identified. Hence the detection rate is 93.33%.



(a) **(b)** **(c)** **(d)**

Figure 4. Rear Light Detection

(a) HSV Frame (b) Morphological Operation (c) Red Light Detection (d) Pair Selection

CONCLUSION AND FUTURE WORK

In this paper, a system that detects vehicles in front at night using a forward-facing video camera is proposed. Red-color thresholds derived from automotive regulations are adapted to real-world conditions utilizing the HSV color space. A shape- and size-independent color image cross correlation approach to pairing detected lamps was deployed in the detection system. Collision warning is displayed when the distance of the ongoing vehicle is below 10m.The proposed system is tested for several real time events during night conditions and the detection rate is 93.33%. As a future work, we are considering hardware implementation of the algorithm to further speed up the process of detection to suit real time conditions.

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