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Vehicle Spotting in Nighttime Using Gamma Correction

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Abstract Vehicle detection has become an important and challenging aspect of a safe transportation system in the nighttime as most accidents occur at night due to the absence of night lighting conditions. Many algorithms detect the vehicles at nighttime based on the headlights of the vehicles, but it does not apply in the daytime or when the headlights were off. These algorithms also find difficulty when vehicles are in no motion or when it is in parking in the night. In this paper, two approaches, image transformation (IMT) approach and the vehicle detection (VD) approach, are used to detect the vehicles in the nighttime. IMT approach is built based on OpenCV and Gamma correction. This approach is used to change the illumination of the images which are not clearly visible or very dark images. Gamma correction increases brightness of an image. Second, the OD module uses the Haar cascade classifier. The patterns in this classifier can identify the vehicle/ object based on those patterns. In this paper, our approach will identify the vehicles in night which are parked or headlights were off, based on patterns like in the daytime by increasing the brightness of the images, to avoid the confusion of headlights.

Keywords:- Image transformation; Vehicle detection; OpenCV; Gamma correction; Gamma; Classifiers; Illumination; Brightness

1 Introduction

Vehicle detection is the main problem in traffic/driving assistance system. Manual work has always been proven slower and less efficient due to human errors and many other factors that affect living beings. So certain intelligent traffic control systems using various techniques have been developed[1]. As there are many different techniques and algorithms to detect the vehicles in the daytime, it helps the driving assistance system to avoid accidents. But there are only few algorithms and techniques to detect vehicles in the nighttime. A less research is done on nighttime as compared to the daytime[2]. Many vehicle detection algorithms work on daytime light conditions with different approaches compared to nighttime.

However, the more accidents occur at night than daytime[3]. It is very crucial to find vehicles in nighttime to avoid accidents. There are 55% chances for road accidents in the night because at the nighttime they cannot see the opposite/parked vehicle because of headlight high intensity or environment low intensity of background[2]. The main information about the vehicle existence is from the vehicle headlights, the driver/person can identify vehicles from the headlights but at the time of high beam it is possible to get confusion which leads to accidents. To avoid this type of confusion, we introduced an algorithm which brightens the background light intensity or illuminates the night image so that vehicle and background will be visible to the driver. Generally, all the algorithms work on headlights to identify the vehicles. But it is also important to change the background and the huge spectrum of vehicles and to decrease the headlight intensity. We need a technique to change the illumination of the image. For this, we use the Gamma correction method to change the illumination of the night image. This approach can increase or decrease the values of pixels by not changing the grayscales middle range[4]. Once the darker image is converted into a brighter image, a pre-defined Haar cascade classifier is used to detect the vehicles in nighttime. Haar cascade classifier will be accurate for affected images because of illumination process. For the normal background images, the Haar cascade classifier gives the high performance[5]. Object detection has been improved in terms of speed with the applications of Haar features with the contribution of OpenCV for object detection framework[6]. OpenCV is a free open source, and it has many pre-defined functions[7]. We not only concentrate on classifying the image but also detect/estimate the locations of vehicles present in each image. However, due to the large variations in the lighting conditions and viewpoint distances, it is difficult to detect the vehicles perfectly. This paper presents the implementation and evolution of nighttime vehicle detection.

2 Literature Survey

For the final point of our research study, we had seen all the past research models and all their applications. One of the main and unique implementations is CycleGAN[8], which will give an efficient result but takes a large amount of time for the required output. By using the CycleGAN[8] concept, we can convert night image to day image. But it takes more time for converting night image to day image. And sometimes required output is not produced. This is one loophole for conversion of night image to day image.

Generally, for vehicle detection, there are many algorithms that are based on the headlight concept. But those algorithms are useful for detecting running vehicles.

Sometimes the vehicles are parked in places, as the vehicle is stopped the headlights are switched OFF. The headlight concept is not useful for detecting the vehicles which are not running. This is a drawback for the detection of vehicles in the nighttime.

By considering the abovementioned drawbacks, we used the Gamma correction[9] concept for converting night image to day image and Haar cascade classifier concept[5, 8] for detection of vehicles. In Gamma correction[9], by using the Gamma value, we will increase the brightness level of the night image. The output image is somewhat similar to the day image. It takes less time for the conversion process. And the classifiers which are used for vehicle detection will work in brighter images. So the vehicles which are not running can also be detected. This unique and efficient way of implementation is briefly discussed in the procedure.

3 Procedure

3.1 Image Transformation (IMT)

Illumination of the image plays a crucial role in this project. If we cannot change the illumination, then we cannot detect the vehicle. There were many algorithms to change the illumination of the image, but we used the power law transform (Gamma correction) to change the intensity or to bright the image. This Gamma correction is used in the image transformation (IMT) approach. This approach can increase or decrease the values of pixels by not changing the grayscales middle range[4]. Check the intensities of pixels in the image. It should be in between the range [0, 255] and [0, 1.0]. From there, use the below formula O = (I/G) ˆ I, where image is I and the Gamma value is G. O is the output. If 1 > Gamma value, then image will be darker, substantially darker than the input image. We cannot observe the information on the original image. If 1 < Gamma value, then image will appear lighter. When we are increasing the Gamma values, then the image starts up glowing slowly and the things in the images are getting visible clearly. If $G = 1$, it will have no effect on the input image. By using this, we convert the dark night image into brighter night image, where we can be able to observe the useful information which is not visible in the various illumination conditions[4].

Fig. 1 **a** Dark night image, **b** Illuminated image

Figure 1a is a normal night image, where the vehicle is barely visible and the headlights were OFF. After applying the Gamma correction on the image, we can see clearly the information of the vehicle in Fig. 1b.

3.2 Vehicle Detection (VD)

Recognizing the vehicles or objects in the image is very crucial. Many approaches like cascade classifiers and decision trees are used to train the distinct features of the image[7]. After increasing the brightness, our next goal is to recognize the vehicle in the image. To detect the objects/vehicles, we need classifiers. There are many classifiers to detect the objects, but we used an XML file called Haar cascade classifier. This file has some pre-defined patterns, those patterns search for the same patterns present in the image. Those will help to recognize the vehicles or objects[6]. For faster processing, we can change the image into gray image. With the help OpenCV cascade classifiers, we can track the vehicles. An alteration can be applied on the output image which is taken from the training sample in input with the help of OpenCV[7]. For the identification of the position of the vehicle in that illuminated image, we apply the trackers. Then, we draw a rectangle around the detected vehicle by using the identified location.

For detecting the vehicles, we use different type of patterns or features.

Edge patterns	
Line patterns	
Center–Surround patterns	

We apply these classifiers on the image using OpenCV to detect the vehicle. We can observe in Fig. 2a, b.

Figure 2a is the night image which is dark, after applying the IMT approach, we can observe the drastic change in the background of the image, and with the help of VD (vehicle detection) approach, the vehicle is detected in Fig. 2b.

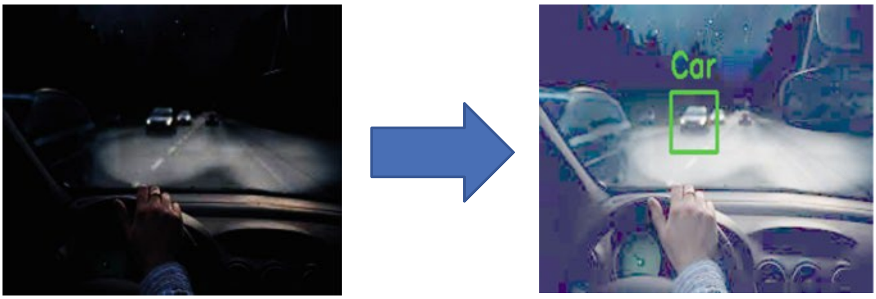

Fig. 2 **a** Dark image, **b** Vehicle detected image

3.3 Pseudo Code

Step 1: Start.

Step 2: Provide the input image.

Step 3: Apply Gamma correction on the input image.

Step 4: Increase the brightness level (Gamma value) of the image for an efficient output.

Step 5: Display the illuminated image (image with more brightness).

Step 6: For the vehicle detection, apply Haar cascade classifier on the new image (illuminated image).

Step 7: Find the exact position of the vehicle from the illuminated image.

Step 8: If the position is not found, then repeat the abovementioned steps (4, 5, 6, and 7).

Step 9: Display the detected vehicle output if the position is found.

Step 10: Stop.

4 Flowchart

To visualize our process of approach, we have given a flowchart (Fig. 3).

In Fig. 4a, we show our approach; after applying the Gamma correction and Haar cascade classifier, we check whether the location of the vehicle is detected or not. Here the location is an array detected by our approach which means it indicates the vehicle is present in the image. Otherwise if the location is not present, we will go back to the IMT approach and increase the Gamma value to increase the brightness and follow the steps again. Based on the location, we draw a rectangular box around the vehicle which is shown in Fig. 4b.

5 Results

By taking night image as an input image, we change the illumination and detect the vehicle as an output image.

From Fig. 5, we concluded that the vehicles were detected in the dark image by increasing the illumination and with the help of Haar cascade classifiers based on patterns but not using the headlights.

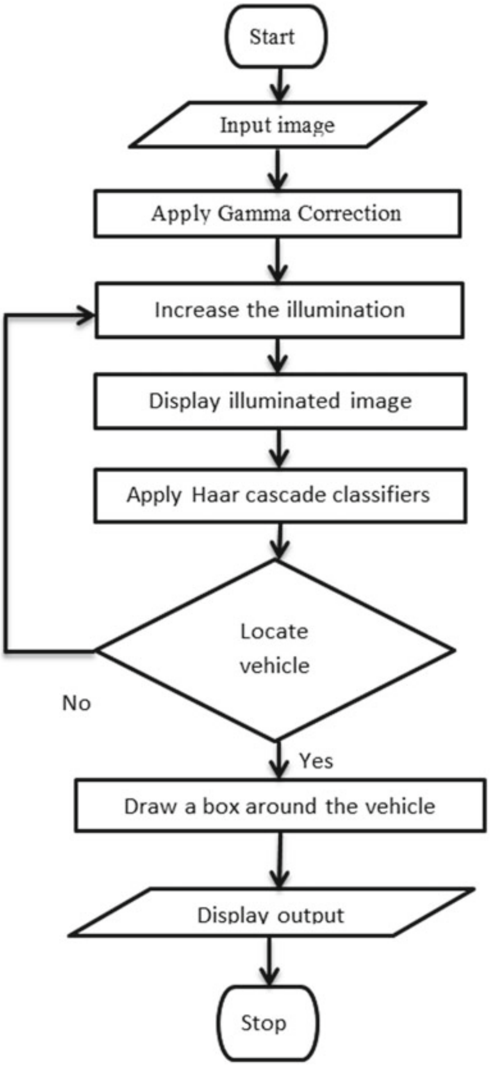

Fig. 3 Overview of the process

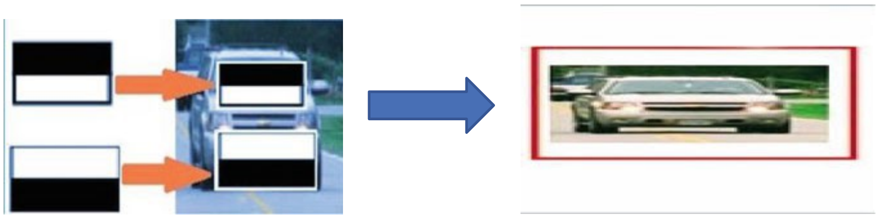

Fig. 4 **a** Classifiers applied on image, **b** Vehicle detected

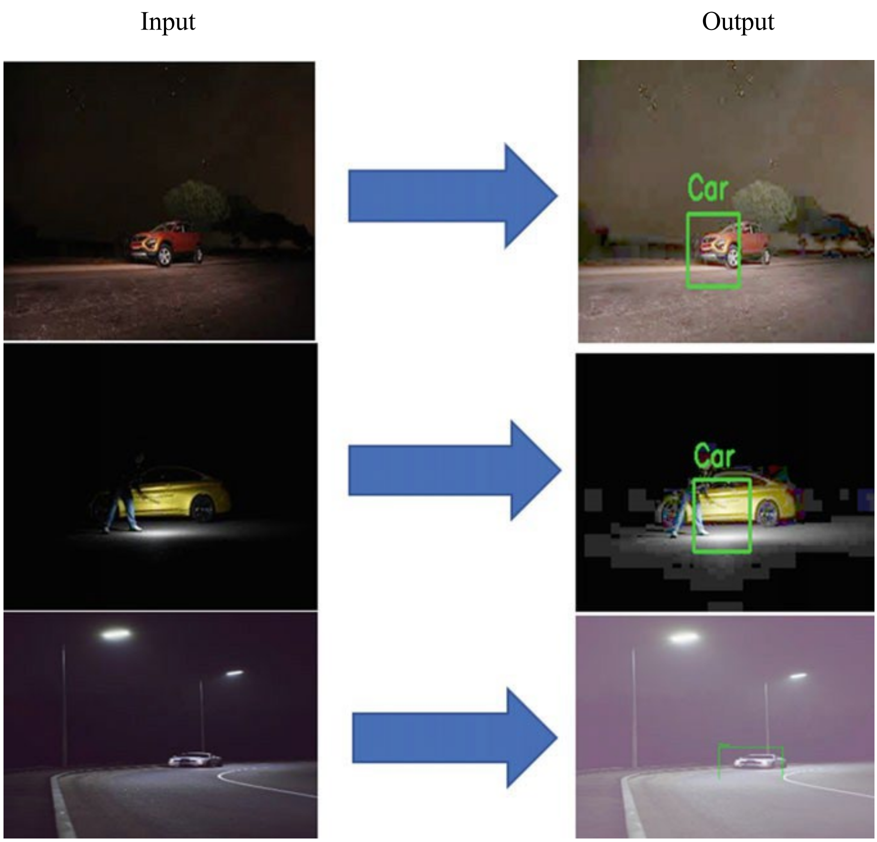

Fig. 5 Image showing the results from an input image by proposed approach

6 Conclusion

Nighttime vehicle detection approach is performed in our paper, which uses image transformation (IMT) approach and the vehicle detection (VD) approach. This main goal of this approach is to detect vehicles at night with darker/brighter lighting environment, but not by finding the headlights. The proposed IMT module uses power law transform to convert the nighttime images into daytime images by increasing the brightness. The VD approach detects the vehicle in the image. The Gamma correction is faster than CycleGAN to increase the illumination of an image. However, it is helpful to increase the detection rate as some of the vehicles are not detected because of long distance and will remain as a part of background of the image. In the future work, when the input image is given, these detection approaches will increase the detection rate and time taken to recognize the vehicles. We need to study in the future to improve the detection rate of vehicles in nighttime.

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