International Journal of Recent Trends in Engineering & Research
ISSN(ONLINE) : 2455-1457
IMPACT FACTOR : 3.344

Detection of Fog using Luminance and Gabor Filter

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Abstract-Nowadays modern vehicles are geared up with a digital camera to capture the scene in front of them. If these cameras are equipped with realization of different weather conditions this digital camera can support many applications as well as establish new ones. Huge parts of road accidents are occur during night time due to visibility alterations in night time. Hence adjusting of these lights of vehicles during night time is very necessary. So an efficient complete night fog detection system is proposed in this work. The proposed methodology used both backscattered veil and holo detection algorithms to characterize the density of the fog and estimate the visibility. In view that the halos round light sources depend on the gap from the camera and on the density and type of fog, combing this with Gabor filter makes it more robust.
Keywords: Back scattered veil, Around Light Sources, Gabor Filter and Night Fog.

I. INTRODUCTION

Digital camera established driver assistance techniques are more and more utilized in present vehicles. Good identified applications for instance the Lane Departure Warning, the high Beam Assistant or the Adaptive Cruise control and the speed limit understanding. All these purposes have in common that they find particular objects within the snapshot like lanes, lights or vehicles and site visitor's signs. More focus on distinguishing foggy weather and clear weather is done.

Worst Conditions like rain, fogs etc for driving are the essential concerns. These may cause problems like low visibility distance and low friction which may lead to affect the driver safety. Hence overcoming such limitations is a crucial challenge. Fog is legendary for its results on visibility, but the visual results of fog differ between night and day, which explain why different camera-based detection approaches are needed. The automated adaptation of the light intensity in fog remains to be an open trouble. Hence to increase the image contrast after reducing the fog an efficient system is proposed in this paper.

Different researches on this are done. Mario Pavlic et.al [01] proposed an efficient system for distinguishing fog images and fog free images. They made use of image descriptor and a classifier for this kind of classification. They used Gabor filter at different scales, orientations and frequencies for describing entire image globally using descriptors. The algorithm evolution is done on the day time images. Romain Gallen et.al [02] presented two main novelties in this paper. Initially the percentile of observed speed is estimated which is considered as reference speed. Second is these reference speed is modified in the worst weather conditions. The risk is thus reduced by modulating the crash severity by means of accident scenario. Romain Gallen et.al [03] proposed a work which involved two camera based methods for identifying night fog captured by multipurpose cameras in vehicle. First approach aimed at finding the fog around the vehicles. Second approach is to estimate halos around light sources. Both these methods are demonstrated taking the actual fog images. Gerhard Rigoll et.al [04] proposed a fog classification system which made use of gray scale images as input. High detection rate in both night time and day time is achieved by utilizing spectral features and a simple linear classifier. Researchers in [06], [07], [08], [09], [10] have also proposed different ADAS systems.

In the proposed work to restrict the accidents for the duration of foggy environment at night and to improve the assistance system of driver by adapting the light intensity during foggy nights an efficient system taking video as an input is proposed. Here the evolution of fog around the vehicle due to backscattered veil detection created by the headlamps is done. It works well when the vehicle is alone in a road with the absence of external light source. Evolution on the presence of fog due to the Detection of halos around source lights is the second approach. Estimation of external lights using Gabor filter is also done for improving the classifying stage result. This is explained briefly in the section below.

II.METHODOLOGY

The Proposed methodology is as shown in the Figure 1. As in the figure initially the video input is taken and divided into frames in frame generation block. The generated frame is then passed to pre-processing block one by one. In this block different pre-processing steps like frame resizing and RGB color space to YCBCr color space conversion is done. This step is then followed by two phases. In the Phase 1 the external light estimation using Gabor filter is done for calculating the angle of the external source light. Decision on foggy or fog free scene is done using the obtained spread spectrum send to classification stage. In phase 2 both halo and backscattered veil detection algorithms are used to characterise the density of fog and meteorological visibility estimation. This estimation is also passed to Classification stage. Both these phase outputs in the classification stage is compared to certain threshold to make a decision on whether or not a fog is present in the scene and to how much percent the light intensity should be increased in vehicle light source.

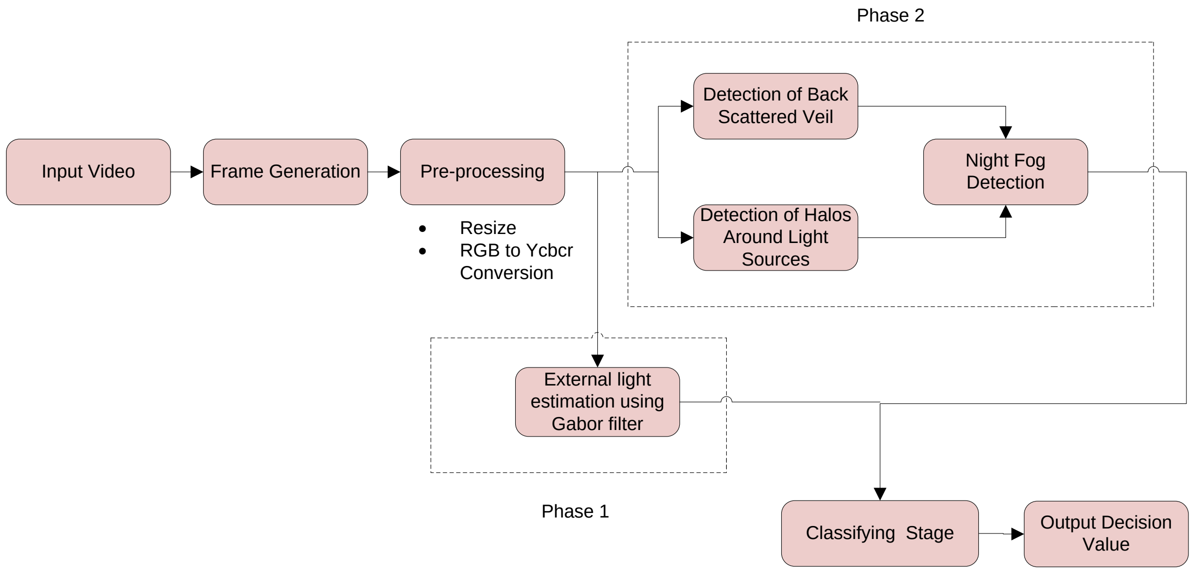


Figure 1: Block diagram of proposed System

2.1 PHASE1

Using this filter bank of different scale and orientation sampling of the input image frame is done. There by causing the filters to shift and rotated by the theta value. These Filters are arranged around the zero frequency in semicircular form in different frequency bands. Spreading of frequency occurs in foggy area where in the fog free scenes frequency doesn’t spread. In the case of fog scene the frequency components are concentrated on the zero frequency. Broad frequency spread frequency is found in the area where there is no fog.

The reason for this blurring and contrast enhancement is caused because of the presence of fog. As we all know that the sharp edges are modelled by high and low frequency and smooth edges consist of only low frequency the working out of these differences in spectra using efficient methods in image processing could help in distinguishing whether or not the fog is present by it to the classification stage for further decision to known whether the scene is foggy or fog free. The detailed description for the Gabor filter is given below,

The sampling is done by Gabor filter bank of oriented and scaled filters. The *i*th filter of the Gabor filter is as given below,

$$(f_x, f_y) = Ke^{-2\pi^2}(\sigma_x^2(f_x' - f_r)^2 + \sigma_y^2 {f_y}'^2 \qquad (1)$$

Where $f_x^1 = f_x \cos(\theta) + f_y \sin(\theta)$ and$f_y^1 = -f_x \sin(\theta) + f_y \cos(\theta)$.

Hence the filters are rotated by angle θ and shifted to the position f_r so that they are placed semicircular around the zero frequency at different frequency. This frequency spectrum is then passed to classifier stage [01] [04].

2.2 PHASE 2

This phase involves to algorithms. The first algorithm is to detect the presence of back scattered veil. Second algorithm is to detect the presence of halos around the artificial source lights present in the environment.

A) Backscattered Veil Detection

This system is based on the fact that the light emitted by the vehicle headlamps in the presence of fog scatters back towards the driver. The idea proposed here makes a comparison between reference image and the image captured by the camera using a correlation index. The reference image can be the image captured at lights on as seen in the fog image on a dark road. The procedure followed to generate such image can be of any type. Sample frame is generated by taking the mean of the frames generated by the videos. Because of the temporal stability the backscattered veil remains where as the reaming objects in the scene gets suppressed [03][02].

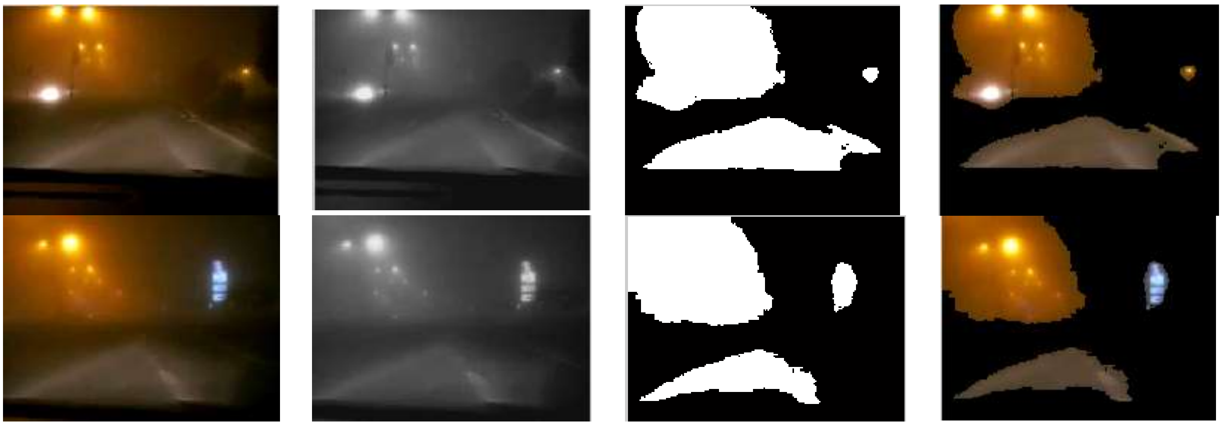
The input image is then compared with the reference images of this kind using an image correlation index. The reference Synthetic and reference image can differ in many parameters. Hence zero mean normalisation cross correlation (ZNCC) based score estimation is done. As both the images are dark outside the backscattering veil addition of bias in this score is done which decreases the discrimination power. Hence to overcome this problem the binary mask matching the backscattered veil is generated just to get that area and find the ZNCC score in that area. This information is then passed to classification stage to compare this correlation score with the threshold value to decide whether it ia a foggy scene or fog free scene.

B) Halos around Light Source Detection

We will not be able to see the backscattered veil if any light sources present in the road because of limited camera dynamic range. If the fog is present it creates a halo around the light source in the scene due to light scattering produced by the water droplets. In the scene it appears as the luminous shape around the source light and we can observe that the intensity of which decreases slowly away from the light source centre. Based on the different geometrical parameters the halo around the light source is detected and the output is passed to classification stage to know whether it is a foggy scene or fog free area. If only one source is present in the scene this step is not carried out instead directly Backscattered veil detection is done. Final classified result is then displayed based all these Phase 1 and phase 2 result to make a decision on whether or not the fog is present in the frame image [05]

III. RESULTS

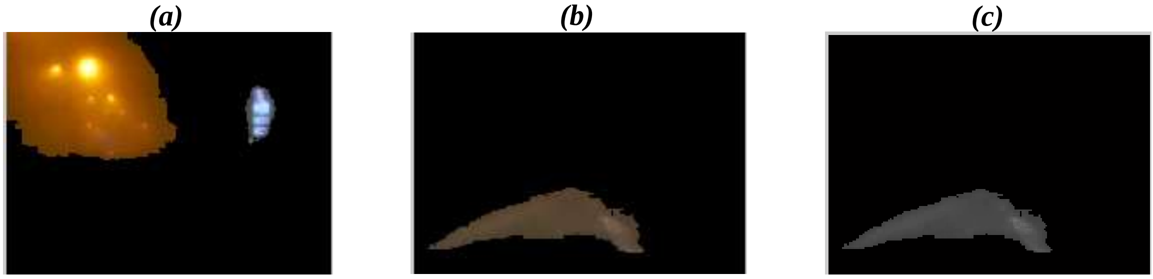
The results obtained at each stage are discussed in this section. Proposed work is evaluated on different videos and resultsobtained for few frames are discussed are shown here. Input Fog Video is divided into frames and passed into pre-processing block as in Figure 2 and 4 (a). The proposed image is converted into YCbCr plane and only Y luminance plane is picked for further processing as in (b). This Image is then converted into Binary image as in (c) and masked with the original image to get the segmented object as in (d). The Light source present in the frame is segmented as in Figure 3 and 5 (a). The validated Back Scattered Image is as shown in (b) and (c) depicts the Fog present in the image after Validation in the Classification stage in both Video 1 and 2.



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

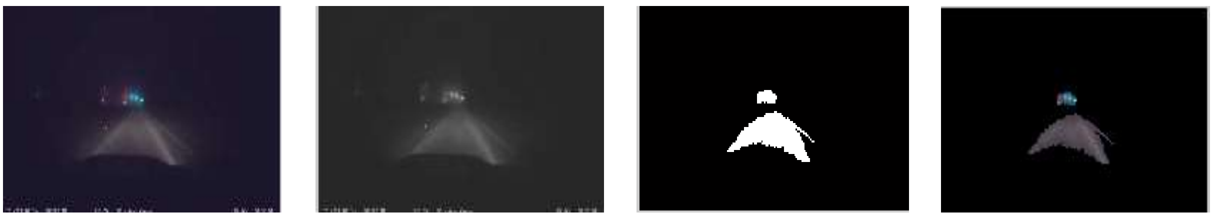
Figure 2: (a) Input Frame 142 and 322; (b) Luminance Image; (c) Binary Image; (d) Segmented Object in Current Frame in Video 1.

(a) (b) (c)



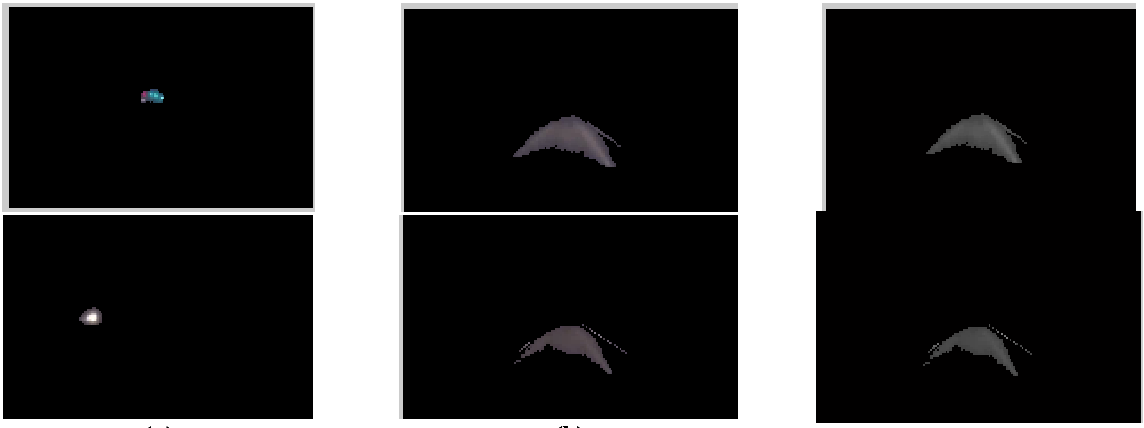
(a) (b) (c)

Figure 3: (a) Light Source Image; (b) Back scattered Veil Image; (c) Dense Fog in video 1



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

Figure 4: (a) Input Frame 334 and 574; (b) Luminance Image; (c) Binary Image; (d) Segmented Object in Current Frame in Video 2.



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

Figure 5: (a) Light Source Image; (b) Back scattered Veil Image; (c) Dense Fog in Video 2

IV.CONCLUSION

In this paper an efficient methodology to overcome the problems in night visibility in the presence of fog has been solved. Three algorithms for finding fog and fog free scene are used. The proposed work is evaluated on video sequences taken in the night with fog and without fog. Which mainly concern the driver safety and it can be also equipped in other ADAS systems. The detection is carried in two steps. It involved finding the back scattered veil and finding the halo around the light source with the help of Gaussian filter to decide on whether it a foggy or fog free scene. The proposed algorithm is evaluated on video datasets resulting to give good accuracy of 92% as in Figure 6. Future enhancement may include working on multiple video with more advanced algorithm to get more accurate result.

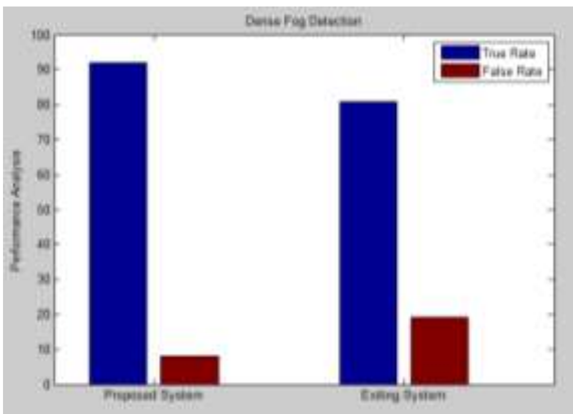


Figure 6: Comparison Graph for Expected and Proposed System

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