

# CERTAIN INVESTIGATION ON FOG DENSITY ESTIMATION AND IMAGE DEFOGGING ALGORITHM

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**Abstract :** Fog in images causes major problems in many computer vision applications such as video surveillance, navigation, object recognition, and remote sensing. Fog, haze and smoke are a big reason of road accidents. Accident rate can be reduced if robust and efficient algorithms are applied for road image fog removal. Haze removal techniques based on dark channel prior model have used different filters for estimating the transmission. We have studied effect of using different filters along with the fundamental mean and gaussian filters in the visibility enhancement in foggy conditions. The results show that the different filters have varied effect on visibility enhancement. According to our study bilateral filter perform better than the others.

**IndexTerms - Haze, Fog, Dark Channel Prior, Bilateral Filter**

## I. Introduction

Presence of fog in outdoor images usually degrades the quality of an image captured to larger extent. This leads to various problems in transportation that affects the economy of the nation. Accidents, unscheduled delays in transportation system are the common problems that occur due to the presence to haze. The degraded visibility also affects various computer vision applications such as surveillance, autonomous navigation systems, terrain classification that require vigorous detection of objects in the image. Haze occurs due to the presence of particles or water droplets in the atmosphere, whereas fog is caused due to presence of water droplets in the atmosphere.

In this paper we mainly focuses on haze that occur due to the presence of water droplets in air, that is fog. This is caused due to the phenomenon of scattering of light and absorption of light by tiny droplets of water present in the environment, due to which the contrast and the true color of the images degrades. Thus, it is required to remove hazy effect from the image to obtain clear or haze free image. Effects of hazy condition in the atmosphere increase exponentially from the scene points to the camera. Therefore, conventional filtering techniques based on space invariance fail to sufficiently remove the hazed effects from the image. The parameters that are mainly responsible for the occurrence of hazy image are airlight and direct attenuation. The amount of ambient illumination reflected along the line of sight by water droplets in the atmosphere is referred to as airlight whereas direct attenuation is the irradiance received from the scene point by the camera along line of sight.

The ambient illumination can be due to sunlight, skylight or ground light. Due to this, contrast and preciseness of color decreases. Haze removal is one of the stimulating problem in the field of image processing as it depends on unknown depth, which cannot be measured accurately. Thus it become difficult to completely remove haze from the scene, also if haze is completely removed, the image would not be visually compelling. Recently, dark channel prior model combined with haze imaging model for a single image have made significant progress in the field of haze removal technique. This dark channel prior model deployed on statistical analysis for outdoor scene images, according to which in an outdoor haze free image most local patches contain certain pixels that have very low intensity in at least one (red, green, blue) color channel. These, pixels are called as the dark pixels. In hazy images, these dark pixels intensity is mainly donated by the airlight in that channel.

## II. RELATED WORK

1. Survey Paper on Image Defogging Using Various Technique Bulbul Bandil, Vandana Vikas Tharke, Vikas Mahor (2018) Because of the adverse climate conditions like the nearness fog or heavy rain, images are effectively subjected to a wide assortment of disturbance amid acquisition, which may decrease visual impact and influence post-handling of the image. Images corrupted by mist fog adversely the nature of vision-based physical security framework. Writing review is an imperative for comprehension and increasing significantly more learning about the particular zone of a subject. The outdoor images caught in severe climate are corrupted because of the presence of fog, rain et cetera. Images of scenes caught in awful climate have poor contrasts and hues. This may cause trouble in distinguishing the items in the caught murky pictures. Because of fog there is an inconvenience to numerous PC vision applications as it lessens the perceivability of the scene. This paper exhibits an study about various image defogging techniques to expel the haze from the fog images caught in true world to recuperate a fast and enhanced nature of fog free images.

2. Inferring the Level of Visibility from Hazy Images Alexander AS Gunawan, Janson Hendryli (2017) In this paper, we provide a brief survey of methods dealing with visibility level of hazy images. The methods is divided into two categories: single-image approach and learning-based approach. The survey begins with discussing single image approach. This approach is represented by visibility metric based on Contrast-tonoise ratio (CNR) and similarity index between hazy image and its dehazing

image. This is followed by a survey of learning-based approach. We describe two contrast approaches, that is: based on theoretical foundation of transmission light, combining with the depth image using new deep learning method, based on blackbox method by employing convolutional neural networks (CNN) on hazy images and their visual evaluation. We also provide experiments of the representative methods based on social media dataset and comparing the results to visual evaluation of the dataset. This survey is our first attempt to estimate visibility level from social media images.

3. Comparative study on various single image defogging techniques Jaswinder Kaur, Prabhpreet Kaur (2017) Fog and haze are generally a huge cause associated with accidents. Fog reduces the visibility of scene. Fog is formed by the combination of airlight and attenuation. Airlight enhances the whiteness and attenuation reduces the contrast within the scene. Fog detection and removal is a challenging task as it depends upon unknown depth information. Various fog removal methods are used for removing the fog and improving the visibility of scene. This paper gives a review on the various fog removal techniques.

4. A novel image defogging algorithm based on multi-resolution fusion transform Zhuohan Cheng, Xin Xiang, Yaochen Shen(2017) An emerging trend in the field of image restoration is the removal of haze or fog from an image or video sequence to improve the quality of the image. Such image restoration techniques is widely used in applications like traffic monitoring and surveillance during hazy weather conditions, prediction and analysis of volcanic activities, etc. In this paper, we propose a novel algorithm based on a fusion model integrated with a multi-resolution approximation technique.

5. A review on various haze removal techniques for image processing Manpreet Kaur Saggu, Satbir Singh (2015) In this review paper, we have presented and compared a study of various fog/haze removal algorithms/techniques for image processing. Many algorithms are proposed so far for efficient fog removal. The dark channel prior based fog removal has provided quite promising results over the available techniques. Many researchers have also proposed various improvements in the dark channel prior so far to get better results. The joint trilateral filter based approach has shown more significant results over the available techniques. The overall objective of this review paper is to explore the short comings of the earlier presented techniques used in the revolutionary era of image processing applications.

### III. PROPOSED SYSTEM

The single image haze removal using dark channel prior deploy on statistical observation on various haze free images that majority of the local patches in haze free outdoor images have some pixels having low intensity, in at least one (red, green, blue) color channel. The low intensity value is approximately close to zero in that local patch. This low intensity can be due to the existence of shadows in the image or colorful objects with very low reflectance or due to the presence of dark objects.

Haze removal deploying dark channel prior model involves (a) estimation of airlight, (b) estimation of transmission, (c) estimation of scene radiance. The large amount of haze opaque region is used for estimation of airlight. Firstly, we select top 0.1 percent of brightest pixels, which are mostly haze opaque in dark channel. Then the pixels having high intensity out of these pixels are selected for atmospheric light. Estimation of transmission map deploying dark channel prior model is effective in recovering the true colors in the image and detecting the low contrast objects, but the problem in this is that recovered image obtained have some halos or block artifacts. To remove this artifact different filtering methods are used. Earlier authors have used soft matting method with imaging model, median filter, bilateral filter, and guided filter to obtain haze free image by refining the transmission as in raw estimation of transmission some halo or block artifacts remains in the image.

In this paper, we have investigated the qualitative results obtained using these filters along with mean filter and gaussian filter of kernel size  $(r,r)$ , where  $r$  is the patch size of the input hazed image. We have considered patch size  $15 \times 15$  on the following considered images. Mean filter is used to smooth local variations of the image, which results in noise reduction and blurring. In this filter, every neighborhood pixel value of the selected pixel is replaced by the mean value of the intensity of that pixel. Another filter being used is gaussian filter. It is a linear filter that involves convolution of Gaussian distribution function, where weights give high importance to pixels near edges that is it reduces edge blurring.

### IV EXPERIMENTAL RESULTS

In this section we present the results obtained using different gaussian, bilateral, guided and mean filters. We have used the input hazed image obtained from the pi camera. Gaussian filter is used for refined estimation of the transmission map in dark channel prior model. In this we observe that several halo and block artifacts remains in the haze free image. This degrades the quality of an image. Bilateral filter is used for refined estimation of the transmission map in dark channel prior model. Here, the results obtained are more clear as compared to gaussian filter and also due to its edge preserving property edges obtained are more clear. It recovers the edges of the objects present in the scene more precisely, as a result distant objects are recoverable. The problem here is halo or block artifacts are not completely removed, but the contrast of the image is relatively high than the other filters being used. Guided filter is used for refined estimation of the transmission map in dark channel prior model. Here we observe that results obtained are clear and doesnot contain halo or block artifacts. This filter is effective as well as efficient in various edge smoothing, dehazing applications. But in our results we also observe that edges are not as clear as in bilateral filtering, thus far by objects remain blurred or become unable to identify

Mean filter is used for refined estimation of the transmission map in dark channel prior model. Mean filter being used is of kernel size  $(r,r)$  where  $r$  is the patch size in the input hazed image. In this we observe that results obtained using mean filter is reasonably good with few halo or block artifacts but the contrast of the recovered image is low as compared to bilateral and guided filter that makes an image look more real, but edges are not as clear as in the case of bilateral filtering.



(i) Input hazy image



(ii) Dehazed image using Gaussian Filter



(iii) Dehazed image using Bilateral Filter



(iv) Dehazed image using Guided Filter



(v) Dehazed image using Mean Filter

## V.CONCLUSION

Haze removal is one of the stimulating issues in the field of computer vision and applications as it depends on unknown depth, which cannot be measured accurately. Thus it become difficult to completely remove haze from the scene, also if haze is completely removed, the image would not be visually compelling. In this paper we have investigated the difference in output of hazed image using dark channel prior model using different filters for estimating the transmission map. Combining the haze imaging model and the dark channel prior model for single image removes haze in the images effectively. As this dark channel prior model deploy on statistical based analysis, the method does not work on all images effectively especially in dense fog conditions. The result shown using different filters have varied effect on visibility enhancement and according to our observation bilateral filter perform better than the other filters.

## REFERENCE

1. J. Kopf, B. Neubert, B. Chen, M. Cohen, D. Cohen-Or, O. Deussen, M. Uyttendaele, and D. Lischinski, "Deep Photo: Model- Based Photograph Enhancement and Viewing," ACM Trans. Graphics, vol. 27, no. 5, pp. 116:1- 116:10, 2008.
2. K. He, J. Sun, and X. Tang. "Single image haze removal using dark channel prior." IEEE Transactions on Pattern Analysis and Machine Intelligence. 2011.
3. K. B. Gibson, D. T. Vo, T. Q. Nguyen, "An investigation of dehazing effects on image and video coding", IEEE Trans. Image Process., vol. 12, no. 2, pp. 662-673, Feb. 2012.
4. K. He, J. Sun, X. Tang, "Guided image filtering", IEEE Trans. Pattern Anal. Mach. Intell., vol. 35, no. 6, pp. 1397- 1409, Jun. 2013.
5. K. Tan and J.P. Oakley, "Physics Based Approach to Color Image Enhancement in Poor Visibility Conditions," J. Optical Soc. Am. A, Vol.18, no.10, pp 2460- 2467, Oct.2001.
6. C. C. Sun, H. C. Lai, M. H. Sheu & Y. H. Huang, "Single image fog removal algorithm based on an improved dark channel prior method" , IEEE International Symposium In Intelligent Signal Processing and Communication Systems (ISPACS), pp. 1-4, October 2016.
7. J. P. Tarel and N. Hautiere, "Fast visibility restoration from a single color or gray level image," in IEEE 12th International Conference on Computer Vision, 2009, pp. 2201–2208.
8. Q. Zhu, J. Mai, and L. Shao, "A fast single image haze removal algorithm using color attenuation prior," IEEE Transactions on Image Processing, vol. 24, pp. 3522–3533, 2015.
9. D. Pomerleau, "Visibility estimation from a moving vehicle using the RALPH vision system," in IEEE Conference on Intelligent Transportation Systems, 1997, pp. 906–911.
10. N. Hautiere, J.-P. Tarel, J. Lavenant, and D. Aubert, "Automatic fog" detection and estimation of visibility distance through use of an onboard camera," Machine Vision and Applications, vol. 17, pp. 8–20, 2006. Mittal, R. Soundararajan, and A. C. Bovik, "Making a completely blind image quality analyzer," IEEE Signal Processing Letters, vol. 20, pp. 209–212, 2013.
11. M. Yang and A. Sowmya, "An underwter color image quality evaluation metric," IEEE Transactions on Image Processing, vol. 24, pp. 6062–6071, 2015.