A REVIEW ON IMAGE HAZE REMOVAL ALOGRITHMS

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Abstract: Haze is an atmospheric phenomenon where turbid media obscure the scenes. Haze attenuates the lights reflected from the image and get mixed with some additive light in the atmosphere. Due to this it is very difficult for drivers to drive through haze. This review paper tells about different algorithms that are used to remove the haze from an image using image processing. These algorithms use different methods and parameters to remove haze from an image. By these algorithms we can overcome low visibility condition for the navigation purposes.

***Index Terms*–Haze removal, dark channel prior, low visibility.**

I. INTRODUCTION

Nowadays low visibility condition is a frequent occurrence. Due to fog and haze, visibility is impaired. Poor visibility causes flight delay, diversion, cancellation as well as automobile accidents. Driving at night in case of fog forms a challenging condition which may lead to a fatal accident. We have seen a drastic change in the environmental condition also pollution has aggravated the problem and proving to be fatal. This issue prevails on a larger scale in the industrial region but with the escalating development and industrialization, it won't take long to spread across the country. Thus, the problem is to deal with such situations in which human performance is limited by low visibility. The resolution of the human eye is 324 to 576 megapixels depending upon the angle of vision, but in the case of fog or other weather haze, the visibility is impaired. The system is designed to overcome this hazard. The system uses an infrared camera to obtain an enhanced image of the surrounding, which will help avoid accidents caused due to poor visibility. With their ability to visualize by detecting infrared rays irradiated from the subject, infrared cameras offer capabilities not available with visible-light cameras. Infrared camera with a multi-frame super-resolution processing function that uses software processing to increase the number of pixels and improves spatial resolution. Infrared cameras with high resolution are not only suitable for shooting subjects that are high and distant, they also enhance operation efficiency because they can shoot a wide area at once without decreasing spatial resolution. Advanced image processing techniques are used to improve the perceptual quality of images that lack the contrast or color depth perceived by the human visual system.A number of methods been proposed to speed up the processing time. Using median filter as the process,the visibility of a single image can be removed according to He's model for real time process it cannot made use of.Using He's dark channel prior method they have proposed a fast haze removal method. Computational time is significantly reduced by improving the method to estimate the dark channel. Our proposed dark channel estimation method uses a down-sampled image and do not need a soft-matting process. Experiments with haze images show that our proposed method is faster and an acceptable quality level compared with the existing He's dark channel method.

2. AN EFFECTIVE ALGORITHM FOR SINGLE IMAGE FOG REMOVAL

This paper uses degradation model and group sparse representation (GSR). This proposed is based on a classical physical model i.e., dichromatic atmospheric scattering model and the new degradation model is integrated into the group based sparse representation framework. The methodology used here is as follows, the proposed method is described in two main parts: Degradation model construction and image dehazing via degradation model and group-based sparse representation. Degradation model: Degradation modelling is an effective reliability analysis tool for products with failures caused by degradation. An example of this would be the light intensity of an LED that degrades exponentially with time and therefore an exponential model is appropriate for the analysis.

Group Based Sparse representation:
GSR is able to sparsely represent natural images in the domain of group, which enforces the intrinsic local sparsity and nonlocal self-similarity of images simultaneously in a unified framework. Moreover, an effective self-adaptive dictionary learning
method for each group with low complexity is designed, rather than dictionary learning from natural images before evaluating the proposed method, that is, degradation model construction stage, there are two crucial parameters that may influence the restoration performance. The first is the parameter β and the second is the size of the degradation operator H . To select the optimal values of these two parameters a series of experiments were conducted to determine the optimal value of β. The values $\beta = 0.2, 0.3, 0.5, 0.8$ are tested. The effects of parameter selection of β on the criteria of C and AG then calculate the average C and AG values for all test images, and the results show that $\beta = 0.3$ offers the optimal performance on the validate set. Second, to test algorithm with different sizes of the degradation operator H, the patches of 10×10, 20×20, 30×30, 40×40 are taken. It can be seen that when the size of H is 30×30, two criteria C and AG have the highest values. This evidence indicates that the best performance is achieved when the size of H is 30×30.
In this paper, a single image fog removal algorithm based on degradation model and group-based sparse representation is proposed. construct the degradation model using the classical dichromatic atmospheric scattering model, and recoverthe image via group-based sparse representation. Ultimately the hybrid degradation model and group-based sparse representation developed in this study effectively solve hazy images.

3. EFFICIENT METHOD FOR HAZE REMOVAL FROM IMAGE CAPUTERED IN FOGGY ENVIRONMENT

In this paper technique for enhancing the quality of degraded images consists of two phases, the first phase is used to remove fog from an image using a Fog removal prior knowledge of image after that Second phase is to enhance the quality of image for high visibility using FFT (Fast Fourier Transformation) This method is works for weather conditions like rains, smog, fog etc.

Decrease in quality of an image is caused by a scattering and deflection of light rays by water droplets and gases in the atmosphere Visibility is mostly decreased by spreading particles between image capturing device and object. Particles scatter light coming from the sun and reflected by an object to capture device lens, and the rest of the sky during the line of sight of the spectator, thereby reducing the contrast between the object and the background. The seasons of rain and winters are most harmful weather conditions for image capturing because of low visibility and low contrast the colour information also get destroyed, which results in making an image less analyzable and less recognizable. Pollution is also one of the major problem during good weather. Because the particles present in air can also degrade the quality of image seems to be like foggy weather.

The methodology used here is fog removal based on prior knowledge A fast method of foggy image enhancement is used. Firstly, the depth information of the foggy image is extracted according to the foggy image model and the prior knowledge. Secondly, the transmission ratio of the atmosphere light is estimated and adjusted, and the atmosphere light A is also estimated. At last, the Gama adjustment is used to get the final enhancement image. Comparing with other method, the speed is faster than traditional methods.

Quality Enhancement of Fog removal Image. The FFT is an efficient implementation of DFT and is used in digital image processing. It is used to convert any picture from its spatial domain to its frequency. As it is faster to perform any computation or to apply any filter in frequency domain rather than spatial domain. The calculation of the DFT is very expensive and hence to decrease the cost, the FFT came into existence. With the use of FFT the computational complications are decreased from N2 to log2N. For example, for an picture of size 256×256 pixels the processing time required is about two minutes on a general purpose computer. The same machine would take 30 times longer (60 minutes) to compute the DFT of the same image of size 256×256. Fourier Transform converts an image into its actual components and imaginary components, which is a depiction of the image in the frequency domain. Suppose we are giving an image in the form of input signal then the number of frequencies in the frequency domain is same as the number of pixels in the image or spatial domain. To convert the image into its spatial domain inverse transform is applied.

Fourier Transformation generates results as complex number and this numbers have greater range than spatial domain. Hence accuracy represent these values are stored as floats. Also range of coefficient generated by Fourier transformation is too large to displayed on the screen so these values are converted to another formatted as dimension values height*width for decrease the range and make able to displayed on screen . The results obtained from FFT are though clear along with that some more parameter for image enhancement are adjusted to make it more clearer.

This research paper provides an analysis and comparison proposes a fast fog removal method with a quality enhancement technique which can be used for next generation traffic and railway image processing to remove the weather effect from image. This technique can be used for better visibility and image processing of images which are degraded by weather effect. As the result shows proposed technique has been found more effective than other existing technique in the terms of quality and clarity. of conventional image enhancement techniques with proposed technique.

4. AN IMAGE BASE DEFOGGING USING DARK CHANNEL

This paper uses Gaussian-based dark channel the RGB and transmission map is estimated and a filter called Laplacian is Computed to the image. The traditional method was not enough to remove haze hence they used a physics based method i.e. Gaussian based method because original image has low intensity earlier method used polarization.
The methodology used here can be described as the image is loaded and the RGB component is Separated and Gaussian based dark channel prior is calculated and atmospheric light is assumed beforehand enhancing of the image is done by Laplace transform hence haze free image is obtained.

The image pixel is visualized using image tool for each output image to analysis the pixel count is the image. The image tool shows the pixel count of each RGB component present in the image. The Peak signal to Noise Ratio (PSNR) is used to calculate the maximum pixel values in the original image and the proposed method.

The PSNR value should be maximum in the proposed image compared to the original image. MSE (Mean Square Error), The MSE is used to calculate the error in the original image and the proposed image. The MSE value should be minimum in the proposed To establish a dehaze model, the RGB and Gaussian-based dark channel method was proposed. The further method consist of estimated transmission and Laplace Transformation to dehaze the image which is taken in poor weather conditions. The PSNR and MSE is calculated in the proposed method to know the performance in the original image and the proposed image.

5. SINGLE IMAGE REMOVAL USING LIGHT AND DARK CHANNEL PRIOR

In this paper the proposed method a simple but effective to remove haze from a single input image. This method is not only prior on dark channel, but also light. Based on dark channel prior (DCP), a new haze removal scheme and it is becoming popular because of its darkchannel statistics of outdoor haze-free images. Whereas, there are two problems in the scheme the cost of computing the transmission map using soft mapping is high and the atmospheric light is over-exposure when a bright area is shown in images. This paper proposes a novel dehazing algorithm with dark channel and light channel where the light channel is a kind of statistics of outdoor hazy images. Moreover, the guided filter is introduced to refine the dark channel and the light channel in this paper.

The methodology used in this paper is a novel haze removal method is proposed which is based on Dr.He's DCP scheme. Similar to DCP, we propose a novel prior-light channel prior-for single image haze removal. The light channel prior is based on the statistics of outdoor hazy images. We find that, in most of the local regions, some pixels (called light pixels) often have very high intensity in at least one colour (R,G,B) channel. In Dr.He's paper, he defines some pixels (called dark pixels) which often have very low intensity in at least one colour (R,G,B) channel in most of the local regions which do not cover the sky. And Dr.He points out that the intensity of these dark pixels in that channel is mainly contributed by the airlight in these hazy images. However, Dr.He estimates the global Atmospheric Light not the atmospheric light in each pixel (called atmospheric light image). We think the intensity of these light pixels in that channel is mainly contributed by the airlight in hazy images. Therefore, we can estimate atmospheric light image accurately by these light pixels. Combining Dr.He's DCP scheme, we can estimate the haze transmission by Dr.He's dark pixels and our atmospheric light image. Afterwards, we can recover a high-quality hazefree image integrating the haze imaging model with Dr.He's guided filter method. Almost in every algorithm of hazy removal, the atmospheric

Light A is think as the global atmospheric light which means the atmospheric light in each pixel is same. However by observing the image, we can't come to the conclusion that the atmospheric light in a light pixel is the same as it is in a dark pixel.

Similar to DCP, a novel prior-light channel prior-for single image haze removal is proposed. The light channel prior is based on the statistics of outdoor hazy images. The light channel prior is based on the assumption that the most hazy image patches contain some pixels which have very bright intensities in at least one colour channel.

In this paper, they have proposed a novel and powerful prior, called the light channel prior based on dark channel prior, for single image haze removal. The light channel prior is based on the statistics of outdoor hazy images and put forward Dr.He's scheme the result of Rahman's MSR algorithm. A new thought that the atmospheric light is an atmospheric light image. Combining the light channel prior, with of atmospheric light image and Dr.He's dark channel prior with the haze imaging model, single image haze removal becomes simpler and more effective. Since both dark channel and bright channel are a kind of fuzzy estimation, guided filtering is introduced to refine them precisely. Experimental results demonstrates that the proposed algorithm is capable of removing haze effectively and restoring images faithfully. With the improvement, the proposed method can be applied to video surveillance, intelligent traffic systems and remote sensing.

6. FAST DARK CHANNEL PROIR BASED HAZE REMOVAL FROM SINGLE IMAGE

Here this paper describes about the outdoor images may suffer from haze, and the clearness of the image is greatly lost. The haze removal, which is known as dehazing , is an important issue. In this paper they propose a fast haze removal method, which is an improving version of an existing method using dark channel prior proposed by He et al. They significantly reduce the computational time by improving the method to estimate the dark channel.Experiments with haze images show that the proposed method is faster and an acceptable quality level compared with the existing He's dark channel method. An image including haze is represented by a combination of direct light from an object, ambient light and haze. This uses the property that at least one of the RGB components takes a low intensity in the clear image. The value using one pixel (1×1 patch) instead of 15×15 patch which is one of the big difference here. Here the computation time is proportional to the image size. If the image size is large, it may take large computation time. Robust ambient light estimation: To reduce the computation time and improve robustness estimation, we estimate the ambient light by using coarse to fine strategy.They use a bicubic interpolation method to enlarge the down-sampled image to original size for applying estimated medium transmission t'(x). Though the estimation with one pixel is sensitive to noise, the noise is smooth out by the down-sampling. The use of one pixel for estimation of dark channels can significantly reduce the computation time. Here they keep the value of Haze removal rate ω is 0.95 and this is the main difference when compared to other papers. The proposed method here looks to generate natural colour images.

In this paper, we proposed a fast haze removal method, which is an improving version of the dark channel model proposed by He et al. In our proposed method, we significantly reduced the computational time by improving the method to estimate the dark channel. Our proposed dark channel estimation method used a down-sampled image and did not need a soft-matting procedure . Experiments with haze images shown that our proposed method is faster and acceptable
quality compared with He's method.

7. A NAOVEL WAVELET-BASED IMAGE DEFOGGING USING DARK CHANNEL PRIOR AND GUIDED FILTER

In this paper they tell us about the fog removal from images and videos has got tremendous importance in image and video processing for object detection, tracking and surveillance system, advance image editing, and many more which are poorly affected by the fog. It includes different methods like contrast enhancement, local color line model based and many more fog removal technique. Here they propose a novel defogging method where guided filter based dark channel prior (DCP) is applied on low–low (LL) band of discrete wavelet transformation (DWT) coefficient of the intensity rectified image which is obtained after homomorphic filtering. To improve the sharpness of the output, unsharp masking (USM) is applied on high–low (HL) and low–high (LH) bands of the DWT coefficient By applying contrast limited adaptive histogram equalization technique (CLAHE) to the inverse transformed image. Many systems like outdoor object detection, tracking and surveillance, navigation and many more are poorly affected by fog because the foggy atmosphere makes the visibility poor in terms of contrast, intensity, sharpness, and color quality. The two types of defogging techniques based on the number of frames are available from different applications: (i) Single frame based and (ii) Multi-frame based. In single frame based defogging technique, only one frame of a scene is used whereas in multi-frame based defogging technique, multiple frames of the same scene are used for removing fog. g. Single frame based defogging techniques have become more popular because multi-frame based techniques need prior information of the scene from the reference images. Though the single frame based techniques are recent and more popular, these also have some limitations like fails to give all scene information in dense fog and sky region, does not physically improve the depth but just enhances the visibility. The proposed algorithm can be separated into two units such as preprocessing and postprocessing unit whereas the main processing unit works based on the principle of novel DCP method. Dark channel is defined as described by He et al.The Haze removal rate ω lies between 0 and 1. In our work, it is considered as 0.95. Contrast enhancement limit is introduced to tune or to limit the level of contrast and it is to be set between 0.02 and 0.08.Quantitative performance analysis of different techniques is carried out by evaluating the quality metrics. In this paper the dark channel prior method along with guided filter is applied to LL band in wavelet domain of the foggy image for removing the fog and unsharp masking is applied to LH and HL bands for improving the sharpness of the image. The defogged image is retrieved by performing inverse wavelet transform on the processed wavelet coefficients.

Title	**Author**	**Year**	**Processing techniques**
An effective algorithm for single image fog removal	Xin Wang, XIN Zhang, Hangcheg Zhu	2019	Degradation model, GSR(group sparse representation)
Image based defogging using dark channel	Fareheen Fatima, Pavitra V	2018	Gaussian based dark channel prior
Fast dark channel prior based haze removal from single image	Yutaro Iwamoto,NaoakiHashimoti	2018	Fast dark channel
Efficient method for haze removal from image captured in foggy environment	Ashish Saxena, Vinod Mane	2017	Fogg image enhancement and fastfourier transform
Single image removal using light and dark channel prior	Yueshu Xu, XiaoqianqGuo	2016	DCP and light channel Prior

8.CONCLUSION

In this paper gives a concise survey on different dehazing strategies. In this paper the dimness layer present in the pictures caught in the terrible climate conditions is subject to the profundity of the scene and now and again it is variation in nature and furthermore in this paper we have talked about a few strategies in which the haze can be evaluated from the caught dim pictures and in the wake of assessing the profundity map and different dehazing techniques, a superior and improved dimness free pictures can be recuperated. In this paper we have depicted that the haze layer present in the caught info picture is subject to the scene profundity and it is variation in nature. Likewise in this paper we have tended to various strategy in which the murkiness can be evaluated from the caught murky pictures and in the wake of assessing the profundity guide and utilizing the picture arrangement model a superior and improved dimness free picture can be recuperated. Sometimes channels are additionally utilized so as to get a decent quality murkiness free pictures without evaluating the profundity.

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