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Improving Vision in Fog using yellow light

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Abstract: **The problem of visibility in the bad weather conditions is handled using yellow light. The foggy weather conditions are the cause of degradations in the image. All the necessary information is lost if the images are taken in a bad weather. Due to these weather conditions the performance of the cameras and outdoor surveillance systems are also affected. In order to reduce the degradations caused by the fog and the blur, we use yellow frequency which can give clarity in the image. Many algorithms have been implemented for this task. The introduction of yellow light gives better results than any of the other algorithms implemented.**

Keywords: *Fog, dark channel, spectrum, air light, no reference metric.*

1. INTRODUCTION

Image defogging holds an important place in the current technology of computer vision. In many situations defogging algorithms are needed, such as systems in which the scenes are automatically monitored, automatic guided vehicle systems, object recognition and the likes where the visibility is too low to get the images with clarity. Fog is a degradation caused by the particles in the atmosphere. Aerosols may either be liquid or solid particles. When the particles are liquid they become the cause for fog. The light rays after getting reflected from the object of study are attenuated before reaching the camera. The attenuation is caused because the particles that are present in the atmosphere absorb the light rays. The particles then start behaving as tiny point sources of light scattering the absorbed light in all directions. As a result before reaching the camera itself the useful information, that is, light reflected from the objects is lost. The contrast is reduced and the surface colors become faint. The degraded images lack visual radiance and in turn offer a poor view of the scene contents. The object is not clearly visible.

Imprecise vision is due to the degradation that is caused by numerous factors including haze, mist, fog, relative motion between the camera and the subject of study, the camera misfocus, atmospheric turbulence and the likes. The motive behind any algorithm which removes the imprecise vision is to get the image that has clarity with minimum number of degradations. There are many image deblurring algorithms which aim to find out the clear image using any of the base algorithms in both the spatial and the spectral domain. Till now the image deblurring algorithms does not utilize the addition of yellow light. With the introduction of yellow light the image which is obtained after deblurring has got the better visibility than without using it.

As the image blurring as well as fogging problems are ill posed problems, that is, in the mathematical equations of these two functions, the numbers of known's are less than the number of unknowns. Therefore it is a challenging problem to solve the mathematical model of the blur and fog. We can solve the image blurring and fogging problems by two approaches. In the first approach multiple images are used in such a way that the number of unknowns is reduced, so that, the mathematical models for both are solved. In the second approach a single image is taken and the equation is solved by using some knowledge beforehand known as prior. In the current work removal of degradations is done by using a dark channel prior by the addition of yellow light. The new no-reference image blur metric is used. The closer the value is to one, the clearer is the image. The output images used in the experiments got a lower value, which indicates a sharper and a clearer image.

2. LITERATURE REVIEW

The degradations caused by fog have been the subject of rigorous research in Image Processing. The defogging research is done using two different approaches, the first is image enhancement methods and the second is the image restoration methods [1]. The dynamic range and the contrast is increased if image enhancement methods are used examples of which include histogram equalization and a Retinex algorithm. Image restoration methods handle the luminance of an object by using prior information. In early scenarios multiple images of the same scene were required which were taken under different weather conditions [2, 3] or they had different degree of polarization to recover a foggy scene [4]. Tan [5] proposed to recover a foggy image by maximizing the local contrast. Fattal's [6] method made the assumption that the transmission and image shading were uncorrelated. He et al: [7] used the dark channel prior for estimating image transmissions which are refined by soft matting. In [8] given a single image the air light is taken to be constant over the whole image and is estimated. This is done by considering that in natural images the local sample mean of pixel intensities is proportional to the standard deviation.

The method of Kratz et al. is based on the view that the scene albedo and depth are statistically independent components. By using a Markov Random Field Model the image is factorized into scene albedo and depth [9]. Image defogging based on the MRF model has made significant progress [10-12]. In [13] the algorithm for restoration of images that are degraded by bad weather uses the principle of scattering. The approximation of distribution of radiance is done by a known variance.

3. PROPOSED APPROACH

In the proposed work the input is a foggy image and the output obtained is a clear image without any degradation. As a preprocessing step histogram equalization is done. After reading an input image its fourier transform is taken. The yellow light is then inserted, that is, the frequency of the yellow light is added to the spectrum of the image. The output got from this result is then considered as an input to the defogging algorithm. The base algorithm considered for the removal of fog is the dark channel prior. The dark channel prior considers some pixels of the image to have very low intensity values in at least one colour channel, i.e. the RGB channel. The mathematical equation of fog/haze is given by equation 1.

$$P(y) = Q(y)\, u(y) + A\,(1 - u(y)). \qquad (1)$$

Where P(y) is the degraded pixel, Q(y) represents the radiance given by that corresponding pixel, so , it represents the true value of the pixel that would reach the eyes of the observer in the case when haze/fog is absent, u(y) is a scalar in [0, 1]. The value of u(y) is in between 0 and 1 which means that the visibility is semi- transparent. A is the air light which is spatially constant. The dark channel provides an accurate description of the transmission.

A new no reference image blurs metric has been used to determine the quality of the output images. The closer the value of the image blur metric is to one the better is the result. The algorithm has been run on more than fifty images and every time the results were better of the images in which yellow light has been inserted.

4. RESULTS

The dark channel prior assumes that the image has some areas of very low intensity values that would give a dark channel. [7]With the addition of yellow frequency in the spectrum of the image the results obtained are far better than the ones not using the yellow light.

The five images shown below in figure 1 are a subset of fifty images taken on which the experiment is done.

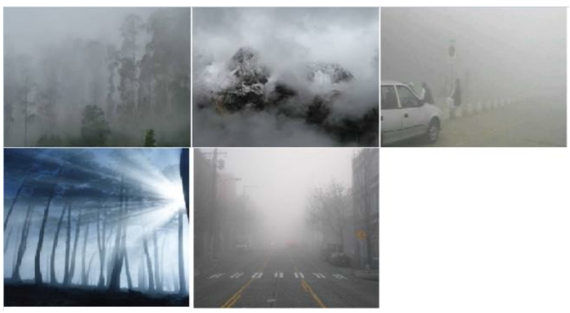

Figure 1. Images 1, 2, 3 are in the first row images and the images 4, 5 are in the second row.

Given below is a table which indicates the blur metric for checking the image quality without and with yellow light. Experimental results have shown that if we are introducing the yellow light than the result got are better than the ones that are not using it.

Table1: The values of no reference image quality metric without and with the insertion of yellow light on five images.

Image 1	Without Yellow Light	Blur	.3331
		Blur_hor	.3331
		Blur_ver	.2380
	With yellow Light	Blur	.0884
		Blur_hor	.0883
		Blur_ver	.0366
Image 2	Without Yellow Light	Blur	.3484
		Blur_hor	.3484
		Blur_ver	.3094
	With yellow Light	Blur	.1125
		Blur_hor	.1125
		Blur_ver	.0473
Image 3	Without Yellow Light	Blur	.2440
		Blur_hor	.2333
		Blur_ver	.2440
	With yellow Light	Blur	.1322
		Blur_hor	.1322
		Blur_ver	.0753
Image 4	Without Yellow Light	Blur	.3360
		Blur_hor	.3360
		Blur_ver	.1782
	With yellow Light	Blur	.1753
		Blur_hor	.1753
		Blur_ver	.1080
Image 5	Without Yellow Light	Blur	.1414
		Blur_hor	.1414
		Blur_ver	.1413
	With yellow Light	Blur	.0994
		Blur_hor	.0994
		Blur_ver	.0764

The figure 2, 3 and 4 indicates the overall quality of the five images, their horizontal as well as vertical components derived from the no reference image quality metric [14].

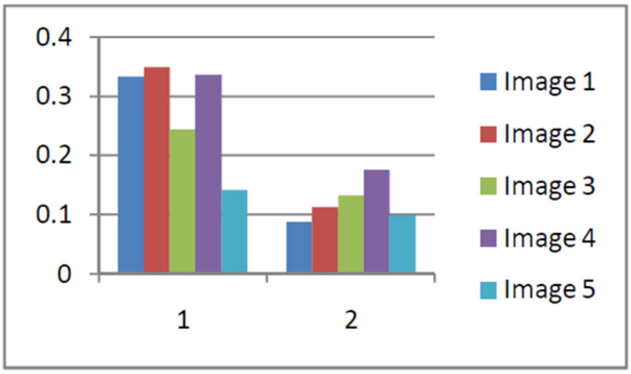

Figure 2. The overall quality of the five images derived from the no reference image quality metric

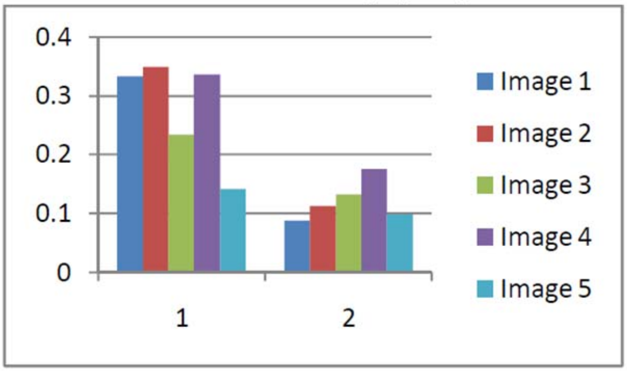

Figure 3. The horizontal component of blur derived from the no reference image quality metric.

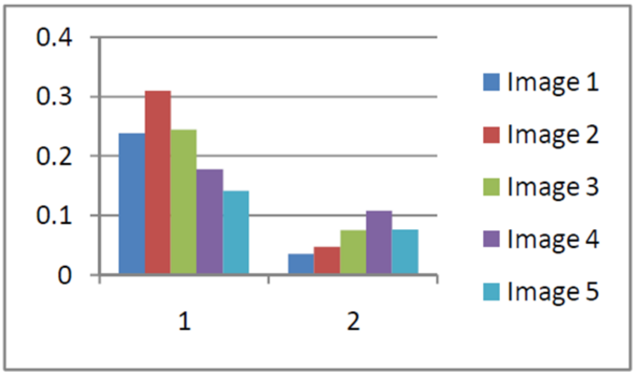

Figure 4. The vertical component of blur derived from the no reference image quality metric

The numbers 1 and 2 indicated in the horizontal components of the bar graph in the figures 2 to 4 show the group of five images each, without yellow light (1) and with yellow light (2). A new no reference image quality metric is used to indicate how clear the image is. The closer the value is to zero the better is the image. The values of the five images without yellow frequency and with yellow frequency are compared. The values of the no-reference image metric of the five images which use yellow frequency in the spectrum of the image is closer to zero which indicates a better and a clearer image.

5. CONCLUSION AND FUTURE SCOPE

The current work justifies that the use of yellow light in bad weather condition is an extra advantage over the bad visibility.Apart from getting a clearer image one more important finding is that the removal of fog also reduces the blurriness of the image. When yellow light is used, then it can reduce the blur effect much more than without using the yellow frequency in the spectrum of the image. The yellow light can pierce through the fog and in turn gives the additional information which is useful in reducing the blur content in the image.

In the current paper yellow light is inserted in the spectrum of the input image. Further we can add the concept of Curvelets in the current work which can represent edges better than the wavelets or be it any other mathematical transform. Another future work can also be the running of base algorithms in 3D scenario. If the algorithm works well for 3D images then the possibility of accidents on roads as well as railway tracks would be reduced.

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