Integrated Approach for Solving Haziness in an Image Using Dark and Bright Channel Prior

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Abstract: ***Haze is a natural phenomenon that reduces visibility, clouds scenes, and changes colour. Since image quality degrades it is an irritating issue for photographers. The removal of haze, called dehazing, Haze is also a threat to the reliability of many applications, like outside surveillance, object discovery, and aerial imaging. Removing haze from pictures is important in computer vision/graphics. But haze removal is tremendously challenging due to its ambiguity that is mathematical. Here we propose a new prior called "Bright Channel Prior" to de -haze single picture combining with the Dark channel prior. The bright channel prior, which inspired by the dark channel earlier, is a statistic of haze-free images which can be outside. It really is centered on a key observation - local patches in haze-free pictures that were outside include some pixels which have very low intensity in the absolute minimum of one colour channel. Using these priors with the imaging model that is haze, we can estimate the depth of the haze and regain a high quality haze-free image. Results on many different outdoor haze images present the power of the earlier that is projected. On the other hand, the DCP scheme has time consuming trouble as a result of matting that is soft. By using fast matting system using large kernel matting Laplacian matrices instead of time consuming soft matting in this paper the goal of planned dehazing procedure can also be able to improve quality and reduce calculation time of the picture simultaneously.***

Keywords: Dark channel prior, Bright Channel Prior, Image Dehazing, Soft Matting, Atmospheric Light, Haze Model, Fast Matting, Image Enhancement

1. Introduction

Computer vision system can be utilized for many outdoor uses, such as object detection [1], video surveillance [2], remote sensing, and intelligent vehicles. Nearly all computer vision jobs or computational photography algorithms assume that the input images are taken in weather that is clear and robust feature detection are realized in high quality picture. Unfortunately, that is not always true in many situations. The quality of a recorded image in bad weather is normally degraded by the presence of fog or haze in the atmosphere, since the incident light to some camera is attenuated and the picture contrast is reduced. This can be a major issue in many computer vision applications. The operation of many vision algorithms for example characteristic detection and photometric investigation will necessarily have problems with the low and partial contrast scene radiance.

Dehazing is the procedure to remove haze effects in shot images and reconstruct the first colors of natural scenes, which will be an useful pre-processing for input pictures and required for receiving high performance of the vision algorithm. Nevertheless, haze removal is an issue that is challenging because the haze depends on the depth that is unknown. Thus, many approaches are proposed through the use of added info or multiple pictures. Polarization based systems [3-5] remove the haze effect through several pictures shot with different levels of polarization. From multiple pictures are got in more constraints [6] of the exact same picture under different weather conditions. Depth-based systems need some depth info from user input signals or understood 3D models.

Dehazing is highly desired in computational photography and computer vision application. First, removing correct the color shift brought on by the atmosphere light and can significantly increase the visibility of the scene. Typically, the haze-free image is more pleasurable. Second, most computer vision algorithms, from low level image analysis to high level object recognition, typically assume the input image is the scene radiance. The functionality of many vision algorithms will inevitably have issues with the one sided and low - contrast scene radiance.

Recently, major advancement has been made by single image haze removal. The success of these approaches lies on using more powerful or premises priors. Tan [7] detects a haze-free image must have higher contrast compared with the input fuzzy picture and he removes haze by optimizing the local contrast of the picture that is restored. The results are compelling but may physically invalid. Fattal [8] estimates the albedo of the scene and the transmission which is medium under the premise that the transmission and the surface shading are locally uncorrelated. This tactic can create results that are remarkable and is physically sound. However, it cannot handle greatly bleary images well. Discovering the property of haze-free external pictures, He [9] proposed a fresh earlier--dim path past (DCP). The DCP is founded on the property of "dark pixels," which have a really low strength in a minimum of one colour channel, but for the skies area. Owing to its effectiveness in dehazing, most recent dehazing techniques [10] have embraced the DCP. The DCP-established dehazing techniques are composed of atmospheric light estimate four important measures, transmission map estimate, transmission map refinement, and image reconstruction. In this paper, we perform an in depth evaluation of the DCP-based systems in the four-measure perspective.

We notice you will find several review papers on image defogging or dehazing [11]. In five physical model- based dehazing algorithms are compared. In [12, 13], several improvement-based and restoration are investigated. In [14], haze removal algorithms that use depth and past advice are assessed. In [15], a comparative study on the four representative dehazing systems [16] is performed. In, many visibility improvement techniques are discussed. This survey is expected to assess researchers' efforts toward enhancing the first DCP system.

In this paper, we propose a route that is glowing and dark earlier for dehazing picture. The dark route earlier is founded on the data of outdoor haze-free pictures. We find that, in most of the local areas which don't cover the heavens, dark pixels very frequently has quite low intensity in at least one color (RGB) station. In bleary pictures, the atmosphere light mostly contributes the intensity of these dark pixels for the reason that channel. Whereas in bright route, the incoming radiance limits value of each color channel of a pixel, but there are pixels in a arbitrary image patch with values close to the upper limit for at least one colour channel. In the above observations we expect that, given an image patch, the maximum value of the r, g, b color channels should be approximately proportional to the incoming radiance Thus, these glowing and dark pixels can directly supply an accurate approximation of the transmission that is haze. Joining a haze imaging model and a matting method that is fast, we can recover a high-quality haze free picture and produce a great depth map.

The rest of the paper is organized as follows. In Section II Problem Statement, Section III Background, Section IV Remove Haze from Image based on Bright and Dark Channel Prior, Section V Experimental Results, Section VI Performance Analysis and Section VII Concludes the paper.

2. Problem Statement

Poor visibility degrades the performance of the computer vision algorithms like object detection, surveillance system, tracking and segmentation along with image quality. Poor visibility is because of occurrence of atmospheric substances which absorbed light in camera and between the object. They are able to be the water droplets that are there in the air. They continuously float in the air and these droplets are extremely small in size and leads to the filth of the picture when clicked in the terrible weather conditions like haze etc. The term “haze" is normally distinguished from the more common term "cloud" in that fog is low-lying. In order to overcome the degradation in the image, visibility restoration approaches are put on the image so as to obtain a much better quality of picture. Visibility restoration can be considered as the various processes that aim eradicate or to decrease the degradation that have occurred while the digital image had been captured. The degradation may be on account of various factors like relative camera- blur as a result of miss focus of camera, object movement, comparative atmospheric turbulence and others. In this project, we propose a new rapid dehazing method for real time image processing.

3. Background

A. Haze Modelling

In computer pictures and computer vision, the model popular to describe the formation of a fuzzy image is

$$I(x)=J(x)\ t(x)+A\ (1-t(x)) \qquad (1)$$

J is the scene radiance, is the international atmospheric light, where I is the strength that is observed, and t is the medium transmission describing the part of the light that isn't scattered and reaches the camera. The purpose of haze removal would be to recover J, A, and t from I In (1), the first term J(x)t(x) on the right hand side is called direct attenuation, and the second period A(1 t(x)) is called atmosphere light. Describes its decay from formerly propagate light, and the atmosphere light results in the medium and the scene radiance and leads to the shift of the scene colours. While the direct attenuation is a multiplicative aberration of the scene radiance the atmosphere light is an additive one. The transmission t can be expressed where the dispersion coefficient of d and the atmosphere is as when the setting is homogenous the scene depth. Where the spreading coefficient of the atmosphere and d is the scene depth. This equation implies the scene radiance is attenuated exponentially with the depth.

$$t(x)=e^{-\beta d(x)} \qquad (2)$$

Where the scattering coefficient of d and the atmosphere is the scene depth. This equation suggests the scene radiance is attenuated exponentially with the depth. We also can regain the depth as much as an unknown scale, if we can recover the transmission.

B. Dark Channel Prior

Dark channel prior is used for the estimation of atmospheric light in the picture that was dehazed to get the appropriate outcome. This technique is mainly used for non-sky patches, as at least of one colour channel has quite low intensity at some pixels. The low strength in the dark channel is mainly because of three parts:

- Colorful items
- Shadows
- Dark items

The dark channel earlier is founded on the next observation on outside haze-free images: In most of the non-skies spots, a minimum of one colour route has some pixels whose intensity is quite low and close to zero. The minimal intensity in this kind of spot is close to zero.

We define the idea of a station which is not light to officially describe this observation For an arbitrary picture J, its dark channel J dark is given by

$$J^{dark}(x)=min_{y\in\Omega(x)}(min_{c\in\{r,g,b\}}J^{c}(y)) \qquad (3)$$

where J c is a color route of J and is a local patch centered at x. A dark channel is the outcome of two minimal operators: is performed on each pixel (Fig. 2b) and is a minimum filter (Fig. 2c). The minimum operators are commutative.

Using the theory of a dark channel, our observation says that if J is an outdoor haze-free image, except for the skies area, the intensity of J's shadowy channel is low and tends to be zero:

$$J^{dark}\rightarrow 0 \qquad (4)$$

Our shadowy station earlier is partly inspired by the well-known dark-object subtraction technique popular in multispectral remote sensing systems. By subtracting a constant value corresponding to the darkest object in the scene haze is removed. We generalize this idea and propose a novel prior for natural image dehazing.

Figure 2: Dark channel haze free images (a) Haze free images (b) corresponding dark channel

C. Bright Channel Prior

In bright channel, value of each color channel of a pixel is limited by the incoming radiance, but there are pixels in an arbitrary image patch with values close to the upper limit for at least one color channel.

From the above observations we expect that, given an image patch, the maximum value of the r, g, b color channels should be roughly proportional to the incoming radiance. Therefore, we define the bright channel, Ibright for image I in a way similar to the definition of the dark channel:

$$I^{bright}(i) = \max_{c\in\{r,g,b\}} \max_{j\in\Omega(i)} (I^c(j)) \quad (5)$$

where $I^c(j)$ is the value of color channel c for pixel j and $\Omega(i)$ is a rectangular patch centered at pixel i. We form the bright channel image of I by computing Ibright (i) for every pixel i.

Figure 3: Dark channel haze free images (a) Haze free images (b) corresponding bright channel

D. Fast Matting

This is a fast algorithm for high quality image matting using large kernel matting Laplacian matrices. The algorithm is based on an efficient method to solve the linear system with the big kernel matting Laplacian. Using a large kernel improve the matting quality, reduce the time of the linear solver for convergence, and can accelerate the constraint propagation. To further speedup the algorithm, here use a KD-tree based technique to decompose the trimap that we can assign an adaptive kernel size –trimap.

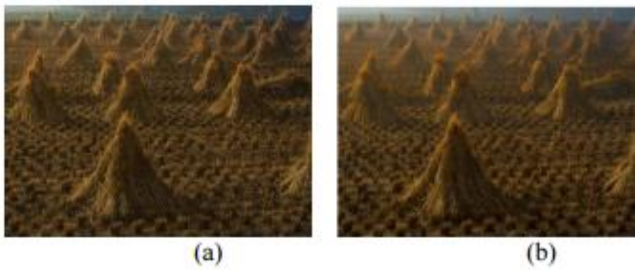


Figure 4: Comparison Between (a) Without refining and (b) Proper refining

4. Dehazing based on Bright and Dark channel prior

a. Estimating the Atmospheric Light

To estimate the value of A that was airlight in haze image formation model revealed in Equation [1], “brightest pixel” method is always being used, pixels with maximum intensity value in the input haze picture is taken as the value of the airlight A. But the fact is that the pixels with greatest intensities may be from a white object in the scene, so, this “brightest pixel” method cannot compute out a result that is reliable on a regular basis. The dark channel may be used to estimate the depth of the haze, so in case a reliable airlight vector A has much relation with the most haze- opaque pixel and contains “infinite” haze; dark channel can be used to estimate a more reliable value of the airlight. In the dark channel earlier algorithm, to estimate the airlight A, firstly we should find the top 0.1%brightest pixels in the dim channel, and these pixels are the most haze-opaque and comprise thickest haze pixels within yellow rectangle in the Shape 5(b). Afterward, among these pixels, the pixels with greatest intensity in the input signal haze image I are taken as the value of airlight A pixels within red rectangle in the Fig. 5(a). We should notice that the computed pixels may not be brightest in the entire input haze picture.

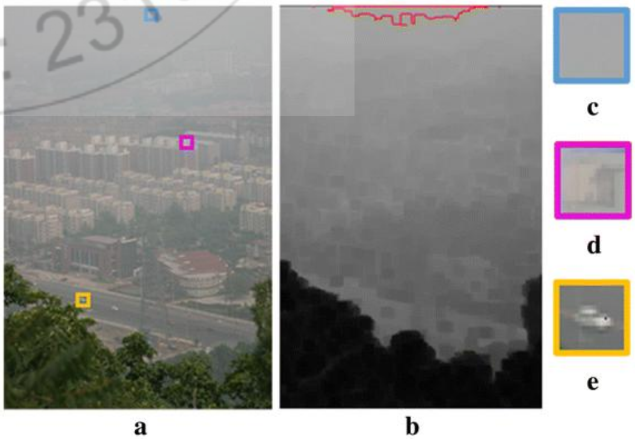


Figure 5: Estimating the atmospheric light. (a) Input image. (b) Dark channel (c) Patch from where our method obtains the atmospheric light. (d) and (e): two patches that have pixels brighter compared to atmospheric lighting.

b. Estimating the Transmission Map

Estimating the Transmission Map The transmission t is the medium transmission describing the part of the light that is not scattered and reaches the camera quite simply, transmission t expresses the relative piece of light that managed to survive the entire path between the observer and the target object in the scene. Consequently, transmission t is a very important value to estimate the thickness that is haze. The transmission map is computed using the equation

$$t=1-\omega * \frac{D}{A} \quad (6)$$

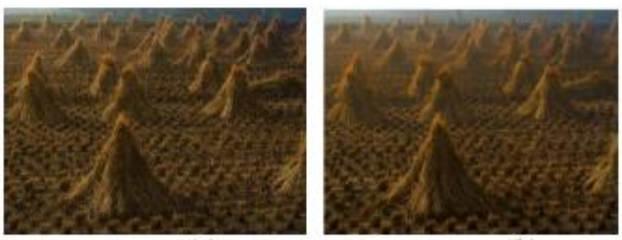
where is fixed as 0.95 here. W is the map that is weighted, D is dark station first where t is transmission map, and A is the atmospheric light. Afterward the transmission map is refined to remove the artifacts from the borders. Several techniques were proposed to refine the transmission map, including matting that was soft and directed combined bilateral filter. These techniques were employed on the transmission maps of the original foggy pictures and typically several procedures should be used to attain a good result, which could be computational intensive. For image haze removal, the time complexity is a critical problem that needs to be addressed. The algorithm impracticable may be made by high time complexity of dehazing.

(a) (b)

Figure 6: Result of computing raw transmission map. (a) Original haze image (b) corresponding raw transmission map

c. Fast Matting

This is a fast algorithm for high quality image matting using large kernel matting Laplacian matrices. The algorithm is based on an efficient method to solve the linear system with the big kernel matting Laplacian. Using a large kernel improve the matting quality, reduce the time of the linear solver for convergence, and can accelerate the constraint propagation. To further speedup the algorithm, here use a KD-tree based technique to decompose the trimap that we can assign an adaptive kernel size –trimap.



(a) (b)

Figure 7: Comparison Between (a) Without refining and (b) Proper refining

d. Recover the Scene Radiance

The atmospheric light and the transmission map, we can recover the scene radiance according to (1). But the direct attenuation term J(x) t(x) can be very close to zero when the transmission t(x) is close to zero. The scene radiance J that is directly recovered is prone to noise. Hence, were strict the transmission t(x) by a lower bound t0, i.e., we maintain a small number of haze in very dense haze regions. The closing scene radiance J(x) is recovered by

$$J(x)=\frac{I(x)-A}{\max(t(x),t_0)}+A \quad (7)$$

A typical value of is 0.1. Since the scene radiance is as dull as the atmospheric lighting, the image after haze removal.

5. Experimental Results

With the objective of cross validation 2 distinct images have been shot by us and passed to algorithm that was proposed. Subsequent section contains a result of one of the 2 selected pictures to show the improvisation of the proposed algorithm over the other techniques. Figure 8 has revealed the input image for experimental goal. The image has low brightness and appears to be effected by the haze a lot. The general aim would be to enhance the visibility of the image as well as reduce the computation time.

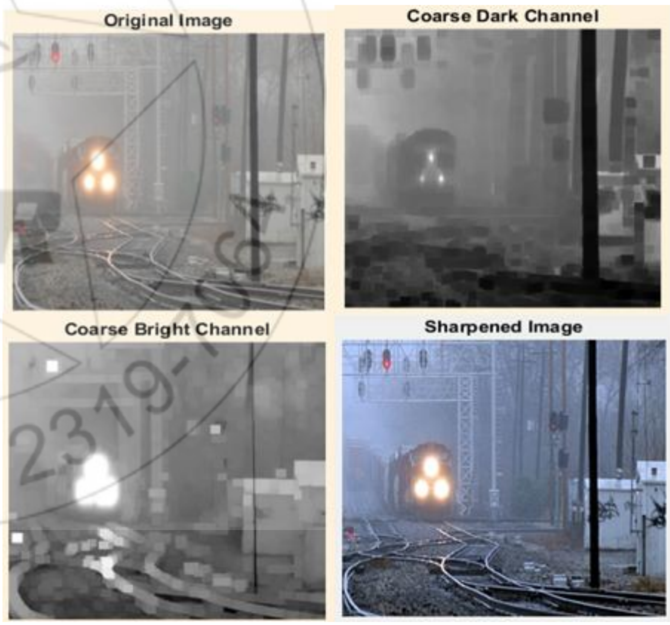


Figure 8: Original Image is an Input Image; Coarse Dark Channel; Coarse Bright Channel; Sharpened Image is an Output Image

6. Performance Analysis

This section contains the cross validation between existing and proposed techniques. MSE, PSNR, Brightness and Luminance are the performance parameters for digital images have been selected to prove that the performance of the proposed algorithm is quite better than the available methods. Table 1 has shown the quantized analysis of the mean square error. As mean square error need to be reduced therefore the proposed algorithm is showing the better results than the available methods as mean square error is less in every case.

Table 1: Mean Square Error

Image Name	Proposed Algorithm	Old Technique
Image 1	0.0297	0.0834
Image 2	0.0369	0.0824

Table 2 is showing the comparative analysis of the Peak Signal to Noise Ratio (PSNR). As PSNR need to be maximized as much as possible. Table 3 has clearly shown that the PSNR is maximum in the case of the proposed algorithm therefore proposed algorithm is providing better results than the available methods.

Table 2: Peak Signal -to- Noise Ratio

Image Name	Proposed Algorithm	Old Technique
Image 1	66.4427	58.9534
Image 2	62.4997	59.0082

Table 3 is showing the comparative analysis of the Brightness. It needs to be maximized.

Table 3: Brightness

Image Name	*Proposed Algorithm*	*Old Technique*
Image 1	0.59313	0.41814
Image 2	0.5167	0.32741

Table 4 is showing the comparative analysis of the Luminance. It needs to be maximized.

Table 3: Luminance

Image Name	Proposed Algorithm	Old Technique
Image 1	0.0022933	0.0016385
Image 2	0.0019845	0.0012793

7. Conclusion and Future Work

In this paper, an efficient method is introduced to improve image dehazing algorithm based on bright and dark channel prior is put forward, which can work well for the region which is inherently similar to the atmospheric light. In the improved method, atmospheric light is calculated more appropriately, and transmission can be refined more accurately and fastly by the fast matting. Therefore, color distortion and halos in invalid regions can be avoided. Finally, the restored images are obviously more natural, softer and clearer. It proved that our method has strong robustness and high availability, and can be widely applied to the real-time dehazing for videos and actual projects.

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