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Fast Image Dehazing By Using Fast Matting

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Abstract

This paper proposes a fast and better method for haze removal.Images of outdoor scenes often contain degradation due to haze, resulting in contrast reduction and color fading. For many reasons one may need to remove these effects. Unfortunately, haze removal is a difficult problem due the inherent ambiguity between the haze and the underlying scene. Haze removal techniques have in recent times shown a great role in a variety of vision applications. A single image haze removal scheme based on dark channel prior (DCP) is getting popular because of its satisfactory performance for most of cases. However, the DCP scheme has time consuming problem due to soft matting. In this paper, the objective of proposed dehazing methode is to decrease the calculation time and quality of the image simultaneously by using fast matting method using large kernel matting laplacian matrices instead of time consuming soft matting.

Keywords: Haze removal, Dark channel prior, Halo, Soft Matting, Transmission refinement, Fast matting using large kernel.

1. Introduction

As we know, atmosphere carries countless particles, such as dust and water-droplets, which will deflect light rays from its original courses of propagation. This defection effect will be greatly strengthened especially in bad weathers, such as haze, rain and snow. As the irradiance received by the camera from the target scene point can be heavily attenuated along the line of sight by the deflection, the resulting outdoor image will be seriously degraded. Such degraded images will have low contrast and faint colors, and they also lack visual vividness and appeal. So haze removal is highly desired in most computer vision applications. Light from the atmosphere and light reflected from an object are scattered by these droplets, resulting in the degradation of image quality. Thus it can be said that fog is result of addition of air-light and attenuation to an image, as expressed by the equation (1) given below:

$$\text{Fog} = \text{Direct Attenuation} + \text{Air-light} \quad (1)$$

Attenuation is the gradual loss in intensity of any kind of flux through a medium. Mathematically it can be expressed as:

$$\text{Direct Attenuation} = J(x).t(x) \quad (2)$$

Where J(x) is the Scene Radiance and t(x) is the Medium Transmission. The Direct Attenuation describes the scene radiance and its decay in the medium; it is a multiplicative

distortion of the scene radiance. When the atmosphere is homogenous, the transmission t(x) can be expressed as:

$$t(x) = e\text{-}\beta d(x) \quad (3)$$

Where β is the scattering coefficient of the atmosphere and d is the scene depth of the xth pixel. The above equation indicates that the scene radiance is attenuated exponentially with the depth. If we can recover the transmission, we can also recover the depth up to an unknown scale. Air-light is caused due to scattering of light. It adds whiteness to the scene. It is an additive one and is a function of the distance between camera and object. Mathematically the equation of air-light can be described in equation (4) as follows:

$$\text{Air-light}=A\ (1\text{-}e\text{-}\beta d(x)) \quad (4)$$

Where, A is global atmospheric light. Now,Using equation 1, 2, 3 and 4 the , the model of haze image formation is showed as below:

$$I(x) = J(x).t(x) + A\ (1-t(x)) \quad (5)$$

where I is the observed intensity, J is the scene radiance vector, A is the global atmospheric light and t is the medium transmission describing the portion of the light that is not scattered and survive the entire path between the observer and the target object point in the scene. A haze image formation model is built to perform the haze removal work. But dehazing issue is still an under-constrained problem if the input is only a single haze image. Therefore, many previous dehazing methods remove haze by combining the information provided by multiple images. But in most circumstances, dehazing relying on multiple images has much limitation on its application, so haze removal based on a single image has become more and more popular and made significant progress in recent years. The success of all recent single image dehazing methods lie in using a stronger prior or assumption., such as Tan's and Fattal's dehazing methods. But these methods still have their weakness points. The challenge is to appropriately estimate the model parameters, such as atmospheric light and transmission map.This paper proposes a single image haze removal method based on the dark channel which is proposed by Kaiming He in paper *Single Image Haze Removal Using Dark Channel Prior* which won CVPR 2009 prize. The dark channel prior dehazing algorithm provides many advantages over previous dehazing methods. In general, the DCP scheme has satisfactory dehazing results. However, three problems are found in the DCP scheme. First, halos happen if the transmission map $\sim t\ (x)$ is not refined. Second, the soft matting is used to refine $\sim t\ (x)$ to avoid the halo problem is very time consuming. This paper is attempts to avoid two problems of the DCP (dark channel prior) method;generation of halos and slow process. In the proposed method we are using fast matting using large kernel matting laplacian matrices instead of soft matting for the better and fast dehazing process.

2. Literature Review

Now a days haze removing based on a single image has made a big progress. Since in these methods only a single haze image is provided and no geometrical information of the input image or user interaction is required, to work out this under-constrained problem, a stronger prior or assumption is needed to be built firstly. Two famous single image hazing methods are Tan's single image dehazing method and Fattal's single image method for haze removal. But both methods fail to give satisfactory result. In 2009 Kaiming He proposed one single image image haze removal method based on the dark channel. The dark channel prior is based on a surprising observation on haze-free outdoor images: when we cut out the sky region of a haze-free image, it is very often that some pixels (called "dark pixels") in the rest part have very low intensity in at least one color (RGB) channel. In other words, the dark channel of a haze-free image has a very low intensity values and looks very dark. most dark channel intensities of haze-free images are very low and their dark channel looks very dark. Based on the research of Kaiming He, the low intensities of dark channel mainly result from three factors: shadows, colorful objects and dark objects.

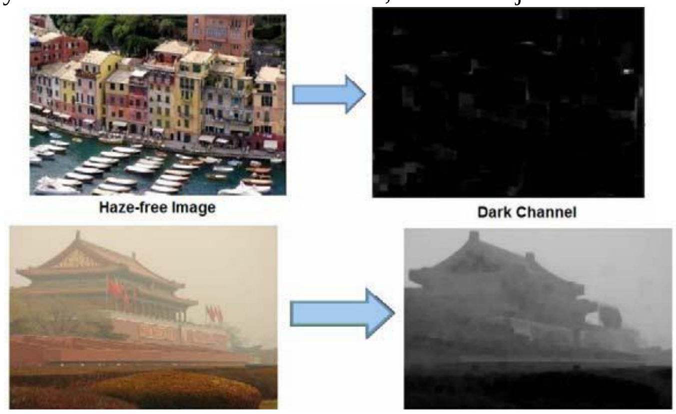


Fig. 1 the Comparison Between Dark Channel of Haze-free and Haze Imaging.

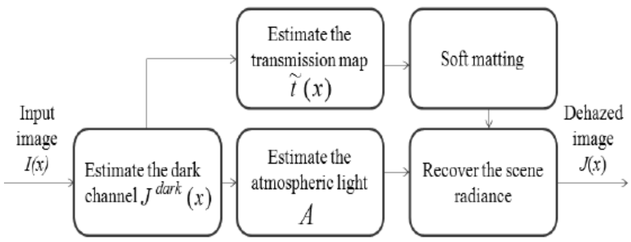


Figure 2. The flowchart of DCP scheme

The algorith for the DCP methode expalined as follows, *1.Dark Channel Prior***:** It is based on the observation that in most of the non-sky patches, at least one color channel has very low intensity at some pixels, and the image is defined as:

$$J_{dark}(x)=\min_{c\epsilon\{r,g,b\}}(\min_{y\epsilon\Omega(x)}(J_c(y)))$$

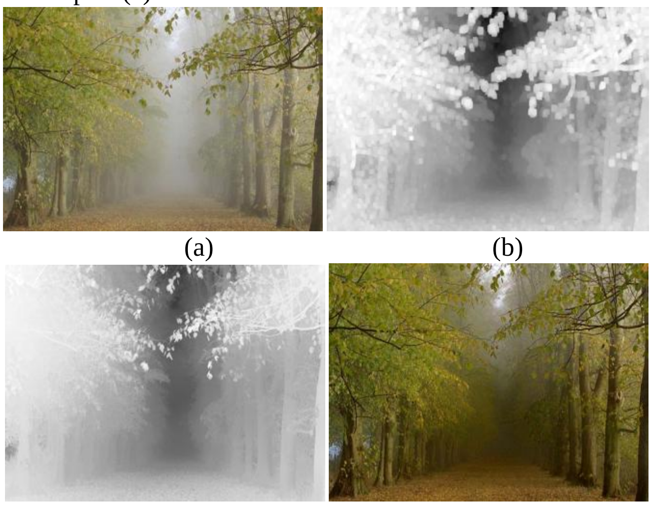
2. Atmospheric Light Estimation: We pick the top 0.1 percent brightest pixels in the dark channel

*3.Transmission Map Estimation***:** It directly provides the estimation of the transmission but it contains some block effects since transmission is not always constant in a patch. Hence, a soft matting algorithm is used to refine the transmission.

*4. Soft Matting***:** Refined transmission map is denoted by t(x). Rewriting t(x) and t'(x) in their vector forms as t and t', we minimize the cost function.

*5.Image Restoration***:** In this step, image is restored.

In the above algorithm refining of transition map using soft matting is a slow process. It will increase the calculation time. And halos may happen if the transmission map ~*t* (*x*) is not refined.



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

Figure 3. Haze removal result. (a) input haze image. (b) estimated transmission map. (c) refined transmission map after soft matting. (d) final haze-free image.

3. Proposed System

The system proposed in this paper uses Fast Matting Using Large Kernel Matting Laplacian Matrices for the refining of transmission map. This is a fast matting method and it will avoid generation of halos. This will increase the calculation speed.

Fast Matting Using Large Kernel Matting Laplacian Matrices:

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 large kernel matting Laplacian. Using a large kernel can accelerate the constraint propagation, reduce the time of the linear solver for convergence, and improve the matting quality. To further speed-up the algorithm, here use a KD-tree based technique to decompose the trimap so that we can assign an adaptive kernel size to each sub-trimap. Thus, the number of iterations can be.

(a) (b)

Fig. 4 Comparison Between (a)without refining and (b)proper refining

The proposed dehazing algorithm

In proposed dehazing algorithm (PDA), the following haze model is assumed:

$$I(x) = J(x) \cdot t(x) + A[1 - t(x)]$$

where $I(x)$ denotes the observed intensity, $J(x)$ the scene radiance, A the global atmospheric light, and $t(x)$ the transmission map. With the model in Eq. (1), the steps of PDA are summarized as follows:

1. Calculate the dark channel though the minimum filter as

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

where $I\ c\ (y)$ is one of three components $\{r, g, b\}$ in the input image and □(x) is a window centered at x .

2. Estimate the transmission map as

$$\tilde{t}(x) = 1 - \omega \times J^{dark}(x)$$

Where ω is a scaling factor.

3. Obtain the refined ~$t(x)$, $t(x)$, by the fast matting algorithm.

4.Estimate the global atmospheric light A by tracking back from 0.1% maxima of $J\ dark\ (x)$ to the maximum of the corresponding pixels in the input image

5.Recover the scene radiance as,

$$\hat{J}(x) = \frac{I(x) - A}{\max[t(x), t_0]} + A$$

Algorithm

1. Calculate the dark channel.
2. Estimate the transmission map.
3. Refining of transmission map.
4. Estimate atmospheric light.
5. Recover the radiance.

(a) (b) (d)

Fig. 5 (a) Input image, (b) Dark Channel, (c) After PDA

(a) (b) (c)

Fig. 6 (a) Input, (b) Dark Channel, (c) After PDA

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4. Results and Discussion

Here, two images are provided to verify the PDA:Cones and Toys. The first example is image toys , whose original image is shown in Figure 5(a) and the corresponding dark channel given in Figures 5(b) and in 5(c) output for the PDA given. And for second image toys, original image, its dark channel and PDA output given as 6(a), 6(b) and 6(c) respectively. Another comparison is given in the Figure7. There comparision of previous refining and proposed fast matting method is given. From that comparison we can easily understand the advantage of proposed matting method.

(a) (b)

Fig. 7 Comparison of (a) DCP method (b) PDA

5. Conclusion

This paper presented a single image dehazing algorithm overcome two drawbacks of DCP scheme: halo, slow process. To achieve the goal,the proposed dehazing algorithm (PDA) uses fastmatting method for the refinement. Two examples with different image size are provided for the analysis of PDA. In figure 7 comparison with previous method made, from the results its clear that the calculation time is reduced and the halos problem is solved. And comparison with the DCP scheme is made.Simulation results indicate that the PDA gives better result.

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