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AN EFFICIENT DEHAZING APPROACH

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ABSTRACT: Photographs of hazy scenes typically have low-contrast and offer a limited scene visibility. We describe a new method for single-image dehazing that relies on a generic regularity in natural images in which pixels of small image patches exhibit one-dimensional distributions in RGB space, known as color-lines. We derive a local formation model that explains the color-lines in the context of hazy scenes and use it for recovering the scene transmission based on the lines offset from the origin unlike traditional field models that consist of local coupling; the new model is augmented with long-range connections between pixels of similar color. This allows our algorithm to properly resolve the transmission in isolated regions where nearby pixels do not offer relevant information. An extensive evaluation of our method over different types of images and its comparison to state-of-the-art methods over established benchmark images show a consistent improvement in the accuracy of the estimated scene transmission and recovered haze-free radiances.

KEYWORDS: Image Dehazing, Dark channel prior, white balance, Atmospheric interference, Depth map based method.

I. INTRODUCTION

Computer vision is all about acquiring and interpreting the rich visual world around us. This is an exciting multi-disciplinary field of research with a wide spectrum of applications that can impact our daily lives. Today cameras are ubiquitous and the amount of visual information (images and videos) generated is overwhelming.

A digital image is a numeric representation of (normally binary) a two-dimensional image. Depending on whether the image resolution is fixed, it may be of vector or raster type. By itself, the term "digital image" usually refers to raster images or bitmapped images. In landscape photography, distant objects often appear blurred with a blue color cast, a degradation caused by atmospheric haze. To enhance image contrast, pleasantness and information content, dehazing can be performed. Images are often degraded by atmospheric haze, a phenomenon due to the particles in the air that scatter light. The intensity of the scattered light is related to that of the incident light by two variables: the photon's wavelength and the scattering particle's size.

In almost every practical scenario the light reflected from a surface is scattered in the atmosphere before it reaches the camera. This is due to the presence of aerosols such as dust, mist, and fumes which deflect light from its original course of propagation. In long distance photography or foggy scenes, this process has a substantial effect on the image in which contrasts are reduced and surface colors become faint [3]. Poor visibility degrades image quality as well as the performance of the computer vision algorithms such as surveillance system, object detection, tracking and segmentation. Poor visibility is due to occurrence of atmospheric substances which absorbed light in between the object and camera. Tarel and Hauti`ere [2009] also promote high image contrast yet circumvent the time-consuming optimization by computing the transmission explicitly, based on an envelope function that ensures positive output pixels[6].

Haze is an atmospheric phenomenon that obscures the clarity of the sky. All the atmospheric particles are in the range below of 1000 m. Atmospheric particles are fog, moisture, smoke, water droplets, dust, etc. Haze is caused by atmospheric particles suspended in the air. It occurs in many populated areas like industrial areas. Due to haze clarity of images will be degraded. Haze is a combination of two components Airlight and Direct attenuation.

$$\text{Haze} = \text{Attenuation} + \text{Airlight}$$

We begin by reviewing existing works on image restoration and haze removal. We present the image degradation model due to the presence of haze in the scene; we present the core idea behind our new approach for the restricted case of images consisting of a single albedo and report the results as well as compare it with alternative methods.

II. PROPOSED WORKED

Methodology describes our proposed approach and justifies it through geometrical interpretation of the equation in RGB color space.

Considering colors as points in the RGB space, Omer and Werman [7] showed that for natural images colors in a small patch should lie on a line passing through the origin. But due to noise and camera related distortions they form an elongated color cluster.

In case of hazy images, due to the additive airlight component, the line gets shifted from the origin by an amount a(x) in the direction of Aˆ (Fig2.1). It is assumed that t(x) varies smoothly and slowly in the scene except at depth discontinuities. The magnitude of atmospheric light also varies smoothly.

So, if we can estimate the line formed by the color points of a patch and the direction of atmospheric light, then by moving the line in the direction opposite to the atmospheric light vector, we can neutralize the effect of airlight by making it pass through the origin. The problem in this approach is that the line in the RGB space can be obtained only under certain assumptions. First, it is assumed that the patch contains pixels from an object with single reflectance value that would provide the direction of the line. Second, within the patch the surface normal and consequently the shading component vary sufficiently, otherwise the pixels will not form elongated cluster. So estimating the color line direction due to the reflectance value will be error prone. Now these assumptions may not hold in all the patches. So, we test the validity of these assumptions on each patch and ignore the patch if the assumptions don't hold. Therefore it is quite likely that for all the patches an estimate may not be obtained. For those patches we need to interpolate the estimate.

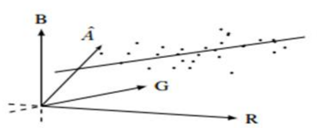

Fig: 2.1: Colors in a patch as points in RGB space.

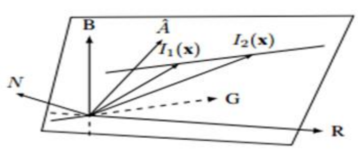

Fig: 2.2: The plane containing the color line and Aˆ can be computed from I1(x) and I2(x).

As already discussed we are supposed to get a line from the color points of pixels of a patch in the RGB space, which may have been shifted in the direction of the airlight. This color line and Aˆ lie on a plane. The normal to this plane can be obtained from cross product of two vectors representing the points lying on the line. The lines corresponding to different reflectance value (Jˆ) will form different planes with Aˆ. Since airlight direction Aˆ is constant throughout the image, we can compute Aˆ as the intersection of all the planes formed by the origin and the color line of each patch where airlight component is nonzero.

The possibility to handle both color images and gray level images since the ambiguity between the presence of fog and the objects with low color saturation is solved by assuming only small objects can have colors with low saturation. The algorithm is controlled only by a few parameters and consists in: atmospheric veil inference, image restoration and smoothing, tone mapping. A comparative study and quantitative evaluation is proposed with a few other state of the art algorithms which demonstrate that similar or better quality results are obtained [5]. Color line dehazing can be demonstrated as follows:

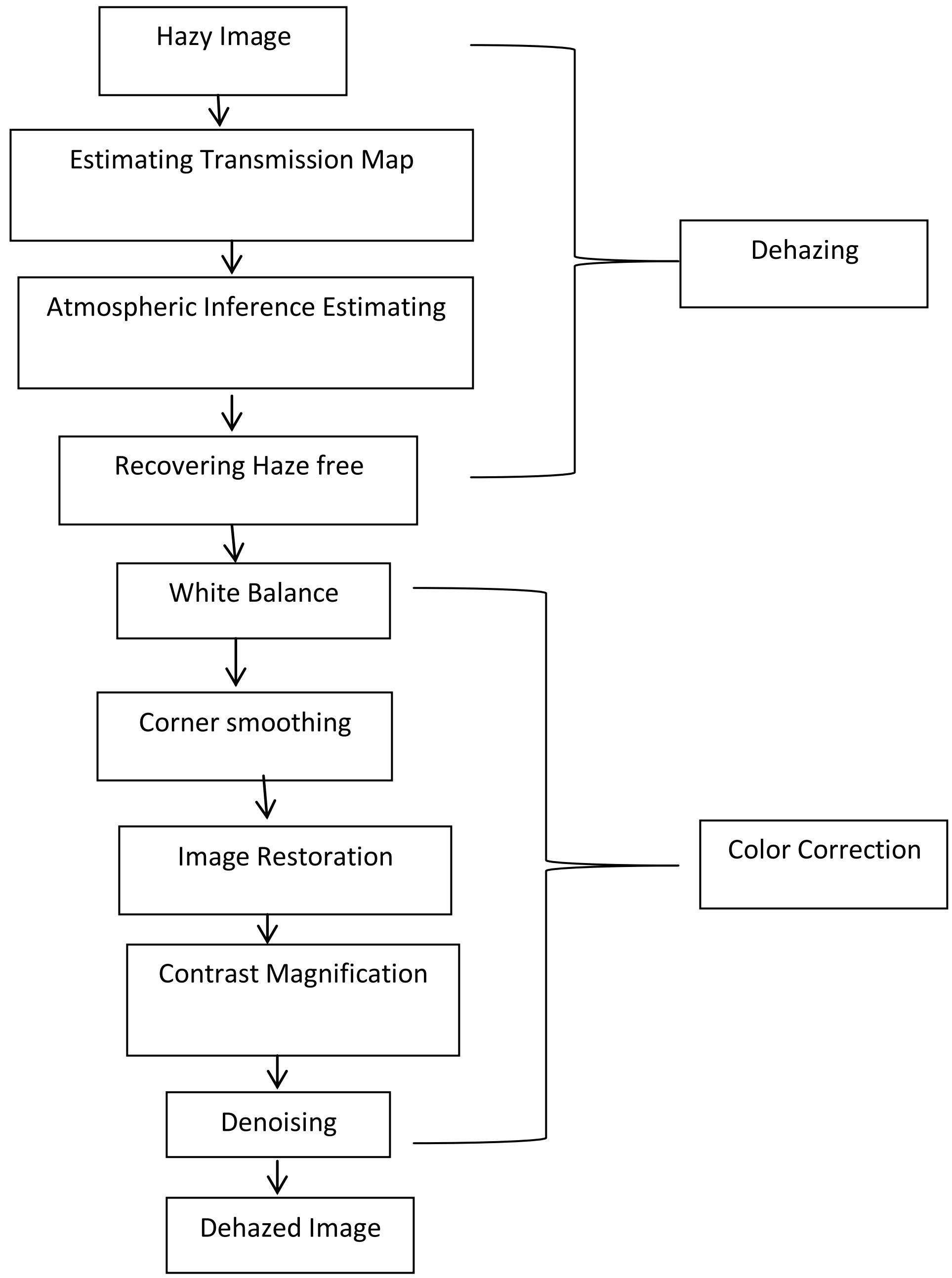

Fig: 2.3: Flow chart showing different ways of single image Dehazing

a. RGB COLOR MODEL

The RGB color model is an additive color model in which red, green, and blue light area dded together in various ways to reproduce a broad array of colors. The name of the model comes from the initials of the three additive primary colors, red, green, and blue. The main purpose of the RGB color model is for the sensing, representation, and display of images in electronic systems, such as televisions and computers, though it has also been used in conventional photography. Before the electronic age, the RGB color modelalready had a solid theory behind it, based in human perception of colors.

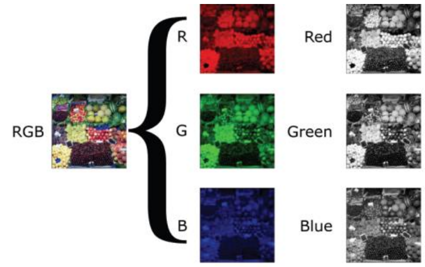

Fig: 2.1.1: Composition of RGB from # grayscale images.

b. METHODS BASED ON POLARIZATION

There has been a growing intrest in the analysis of images of scenes affected by weather. Polarization filtering has long been used in photography through haze [2]. In general, however, polarization filtering alone cannot remove the haze from images. The main idea of this aproach is to exploit two or more images of the same scene that have different degrees of polarization (DOP)[4]. The analysis of polarization filtered images has proven to be more useful.In this method two or more images of the same scene are taken with different polarization filters .The approach is to use the multiple images taken from the bad weather, the bsic idea of this approach is to exploit the differnce of two or more images of the same scene but they have different participating medium properties. The basic method is to take multiple images of the same scene that have different degrees of polarization, which are acquired by rotating a polarizing filter attached to the camera, but the treatment effect of dynamic scene is not very good. The shortcoming of this method is that it cannot be applied to dynamic scenes for which the changes are more rapid than the filter rotation and require special equipment like polarizers and not necessarily produce better results. Another approach is to use single images and demand the 3D model of the input images. The method is applicable for both gray and colored images scenes.

c. DEPTH MAP BASED METHOD

Depth map based method uses depth information for haze removal. This method uses a single image and assumes that 3D geometrical model of the scene is provided by some databases such as from Google Maps and also assumes the texture of the scene is given (from satellite or aerial photos). This 3D model then aligns with hazy image and provides the scene depth. This method requires user interaction to align 3D model with the scene and it gives accurate results. This method does not require special equipment's. Its shortcoming is that it is not automatic, it needs user interactions. This method is to use the some degree of interactive manipulation to dehaze the image, but it needs an estimation of more parameters, and the additional information difficult to obtain.

d. SINGLE IMAGE DEHAZING METHOD

A single optimized image dehazing method that estimates atmospheric light efficiently and removes haze through the estimation of a semi-globally adaptive filter. The enhanced images are characterized with little noise and good exposure in dark regions. The textures and edges of the processed images are also enhanced significantly [1].This method only requires a single input image . This method relies upon statistical assumptions and or the nature of the scene and recovers the scene information based on the prior information from a single image. This method becomes more and more researcher's interest.

e. Independent Component Analysis(ICA)

Outdoor images taken in bad weather conditions (e.g., foggy or hazy) generally lose contrast and fidelity, resulting from the fact that light is absorbed and scattered by the cloudy medium such as particles and water droplets in the atmosphere through the process of propagation. Reinstatement of images taken in these specific situations has caught increasing attention in the last years. This job is important in a number of outdoor applications such as remote sensing, intelligent vehicles, object recognition and surveillance.

Independent Component is a factual technique to isolate two added components from a signal. This technique accepts that the transmission and surface shading are measurably uncorrelated in neighbourhood path [8]. In Fattal proposed a single image dehazing technique which created a fog free image from the foggy image. The essential key thought of his work is to determine the air light albedo uncertainity and accepting that the surface shading and the scene transmission are uncorrelated. This methodology is physically legitimate and can create great results, however might be inconsistent since it doesn't function admirably for thick fog.

ICA is a statistical method to separate two additive components from a signal. Fattal uses this method and assumes that the transmission and surface shading are statistically uncorrelated in local patch. This approach is physically valid and can produce good results, but may be unreliable because it does not work well for dense haze. Fattal proposes to remove the haze from color images based on Independent Component Analysis (ICA), but the approach is time-consuming and cannot be used for grayscale image dehazing.

First, this approach performs an effective per-pixel calculation, different from the majority of the earlier methods that process patches. An appropriate per-pixel strategy reduces the amount of artifacts, since patch based methods have some limitations due to the assumption of constant air light in every patch. In broad, the assumptions made by patch-based techniques do not hold, and therefore additional post processing steps are necessary. Secondly, since do not estimate the depth (transmission) map, the difficulty of this approach is lower than most of the earlier strategies. Finally, this technique performs faster which makes it appropriate for real-time applications. Even compared with the recent effective implementation of Tarel and Hautière this technique is able to restore a hazy image in less time, while screening more visually plausible results in terms of colors and details.

III. DARK CHANNEL PRIOR

The dark channel prior [7] is based on the statistics of outdoor haze-free images. In most of the non-sky patches, at least one color channel (RGB) has very low intensity at some pixels (called dark pixels). These dark pixels provide the estimation of haze transmission. This approach is physically valid and work well in dense haze. When the scene objects are similar to the air light then it is invalid.

Factors contributing to dark pixels First, the dark pixels can come from the shadows in the image. Outdoor images are full of shadows, e.g., the shadows of trees, buildings, and cars. Objects with irregular geometry like rocks and plants are easily shaded. In most cityscape images, the windows of the buildings look dark from the outside, because the indoor illumination is often much weaker than the outdoor light. This can also be considered as a kind of shadows. See the first row in Fig. 3.1 for examples. Second, the dark pixels can come from colorful objects. Any object with low reflectance in any color channel will result in dark pixels.

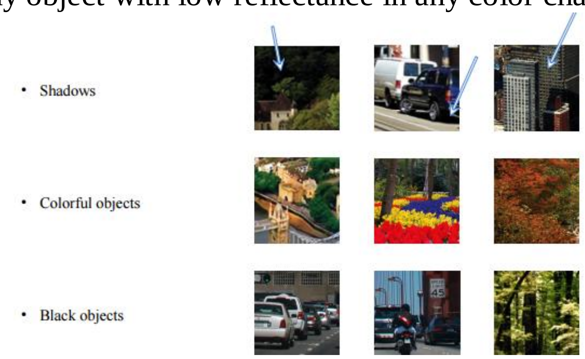

Fig 3.1: Shadows, colorful objects, and black objects contribute dark pixels.

A green color has low intensity in its red and blue channels, and a yellow color has low intensity in its blue channels. Outdoor images often contain objects in various colors, like flowers, leaves, cars, buildings, road signs, or pedestrians. See the second row in Fig. 3.1. The colorfulness of these objects generates many dark pixels. Notice that by our definition a dark pixel is not necessarily dark in terms of its total intensity; it is sufficient to be dark in only one color channel. So a bright red pixel can be a dark pixel if only its green/blue component is dark. Third, the dark pixels can come from black objects, like vehicles tyres, road signs, and tree trunks. See the third row in Fig. 3.1. These dark pixels are particularly useful for in-vehicle camera which oversees the road conditions. If an image patch includes at least one of these factors, this patch must have dark pixels. This is the intuitive explanation of our observation.

IV. RESULT AND COMPARISION

a. RESULT

The given below is result of single image dehazing using color lines. We have taken set of images in dataset.

RESULT 1:

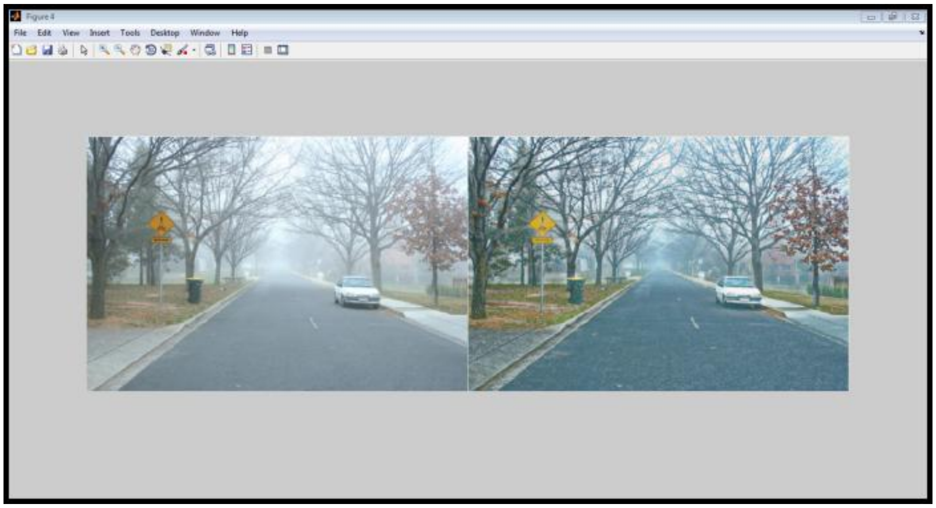

Fig: 4.1: Dehazed Imgae.

RESULT 2:

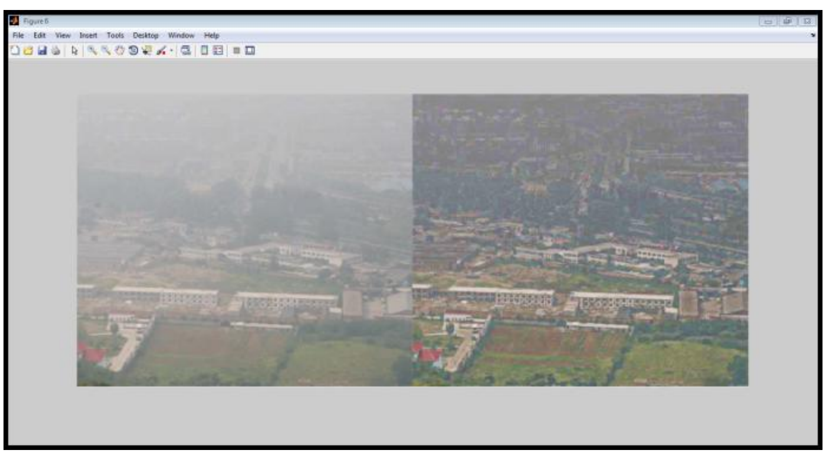

Fig: 4.2: Dehazed Image.

b. COMPARISION

We are comparing our result of single image dehazing using color lines with single image dehazing using dark channel and the result show that the single image dehazing using color lines is best and yielding its best result.

RESULT 1:

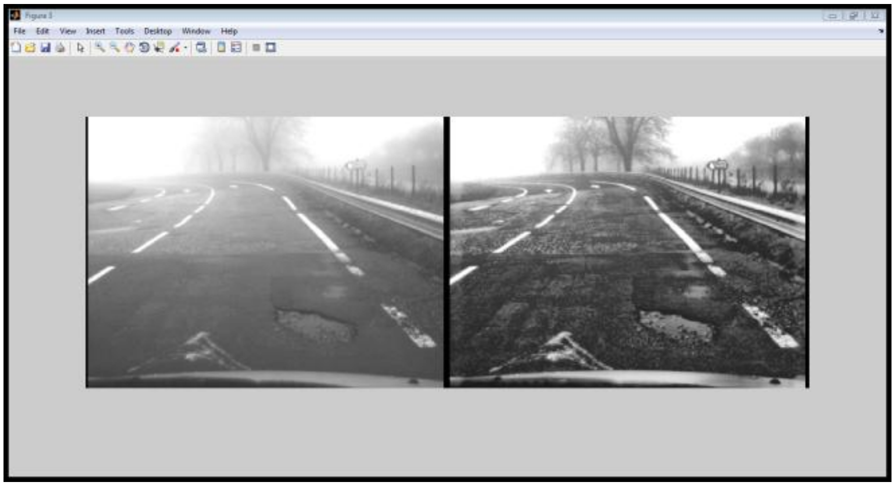

Fig: 4.3: Dehazed Image Dark Channel

V. CONCLUSION AND FUTURE WORK

a. CONCLUSION

We presented a new single-image dehazing method based on the color-lines pixel regularity in natural images. We derived a local formation model that reasons this regularity in hazy scenes and described how it is used for estimating the scene transmission.

The use of robust statistics allows us to cope with complicated scenes containing different surface albedos and the use of an implicit graphical model makes it possible to extrapolate the solution to pixels where no reliable estimate is available. Haze removal from images provides a clearer view of the scene, but we do not regard it as a default preference.

b. FUTURE WORK

Some problems are leaved for further research.

• Our method is based on simplified haze image model, in order to improve the dehazing results, more sophisticated atmospheric scattering physical model is needed.

• Gathering more images to extract trends and patterns between image pixel values and transmittance in order to improve haze-degree estimating.

• The assumed incident light source is uniform illumination (sunlight), it need to extend to non-uniform illumination.

• achieving higher processing speed by code optimization in order to meet the realtime processing request.

• Propose a reasonable way to judge the effect of dehazing. The paper mostly focused on stable or steady weather conditions such as fog, haze, mist and other aerosols. We believe that a major area of future work could be in developing models and algorithms for dynamic weather conditions such as rain, hail and snow and turbulence. The other area where there is a wide scope for future work is on the fast and accurate rendering of volumetric effects in participating media in general settings. We describe these areas (along with other smaller areas) of future work and propose possible (albeit speculative) research directions in these areas.

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