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Research on Traffic monitoring system using Improved FOG-Removing Method

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Abstract: Since foggy days are hard to forecast, the probability of a traffic accident happening on these days will be several times more than that on the usual days, highly reducing the traffic safety and greatly causing economic losses. In addition, dense fog is the main cause of multiple vehicle collision accidents. Since the traffic monitoring technique has been widely used in the traffic management, removing fog from the traffic video has become the hot research topic in recent years. First, this paper reviews the retinex method, commonly used to remove the fog in the traffic management. The proposed method fustly use Retinex algorithm to enhance the image, then the wavelet transform algorithm is used to enhance the details of the image, fmally a clearly image which are removed fog can be obtained after reduce the none - important coefficients. Through analyzing the PSNR (Peak Signal-to-Noise Ratio) of the image contrast, the images which are processed by our proposed method have the PSNR values higher than the traditional Retinex algorithm's.

Keywords: *Retinex Algorithm; fog; Recognition; wavelet transform; PSNR*

I. Introduction

Recent years, haze weather became very serious in China. This kind of common weather phenomena will produce whitening effect, will cause the image to degenerate, even fuzzy, which will bring the serious influence for the transportation system and the outdoors vision system. Therefore there is a new requirement to deal with to fog image clarity and realistic. With the continuous development of computer hardware and software technology, it became possible to remove fog from the massive images.

Global fog image enhancement method refers to the adjustment of the grey value is determined by the statistical information of whole fog image. There has no any relation with the adjustment point of the region. Such as Brian Eriksson [1] take advantage of the curvelet transform to automatic remove fog using the vanishing point detection based on curvelet.

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But the disadvantage of the algorithm is only relative to improve the quality of images, not in the true sense of removing fog from image. Retinex algorithm [2, 3] is a model describing the color invariance, it has the characteristics of dynamic range compression and color invariance, caused by uneven illumination and low contrast color image has very good effect.

Reduce the depth information of image is an important clue to restoration of fog images. According to the scene depth information is known, this recovery methods can be divided into two categories. One method is assumed scene depth information is known. This method fustly suggested by Oakley [4]. Another method is to use the auxiliary information extraction method. Interactive depth estimation algorithm and the known 3D model to get the scene depth, such as the Kopf method [5] is to obtain the depth of field using the known 3D model, so as to recover the fog image. However, this algorithm also has disadvantages: fustly the 3D model conditions are very serious, and this algorithm is not automatic, it is difficult to be run in real time.

Many researchers focus on how to solve completely removing fog for signal image according to the variation in the fog concentration. In this early work was done by [6]. Moreover, [7] and others under the assumption that the transmission of light is local not related with and the scene target surface shading part, to estimate the scene irradiance, and thus derived the propagation image. In this paper an improved fog removing method for the traffic monitoring image, which combining Retinex algorithm and wavelet transform algorithm is proposed. The proposed method firstly use Retinex algorithm to enhance the image, then the wavelet transform algorithm is used to enhance the details of the image, finally a clearly image which are removed fog can be obtained after reduce the none-important coefficients. The proposed method can effectively remove fog from the image taken in heavy fog weather. The paper structure is as follows: The first chapter is introduction; the second chapter introduces an improved fog removing method for traffic monitoring image; the third chapter discusses the implementation; the fourth chapter discusses the estimation results; the fifth chapter is conclusion.

II. LITERATURE SURVEY

In [8], proposed an algorithm based on independent component analysis. This algorithm estimates the surface shading and the medium under the assumption transmissions which are locally uncorrelated, and gets the image local albedo and restore image contrast. However, a distinct lack of enough color in heavily haze images makes heavily haze images cannot be handled well. [9] developed a system for estimating depth from a single organization). This template was degraded input image. Motivated by the fact that contrast is reduced in a foggy image, Tan divided the image into a series of small patches and postulated that the corresponding patch in image should have a higher contrast (where contrast was quantified as the sum of local image gradients). [10] made the observation that a haze-free image has higher contrast than a

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www.ijrms

hazy image, and was able to obtain good results by maximizing contrast in local regions of the input image. However, the final results obtained by this method are not based on a physical model and are often unnatural looking due to over-saturation. In [11] assumed every patch has uniform reflectance, and that the appearance of the pixels within the patch can be expressed in terms of shading and transmission. He considered the shading and transmission signals to be unrelated and used independent component analysis to estimate the appearance of each patch. Significant progress in single image haze removal has been made in recent years. In [12], He proposed a simple but effective image prior-dark channel to remove haze from a single input image. However, as the haze imaging model assumes common transmission for all color channels, this method may fail to recover the haze images. In [13], Tarel proposed an improved image defogging algorithm based on bilateral filtering.

To obtain good results by assuming that transmission and surface shading are locally uncorrelated. With this assumption, he obtains the transmission map through independent component analysis. This is a physically reasonable approach, but this method has trouble with very hazy regions where the different components are difficult to resolve. Lastly, a simple but powerful approach proposed to uses dark pixels in local windows to obtain a coarse estimate of the transmission map followed by a refinement step using an image matting technique. Their method obtains results on par with or exceeding other state-of-the-art algorithms, and is even successful with very hazy scenes.

A. *Theoretical level*

White balancing is an important processing step that aims to enhance the image appearance by discarding unwanted color casts caused by the atmospheric color. Due to the fact that haze is dominating the image, an average value is computed for the entire image. A straightforward biasing of the image average color towards pure white is employed. This step assures that atmospheric light color constant is equal to one and the normalized image values are in the range [0, 1]. As, when the light color varies in the image it is more robust to perform this bias operation using the local average value, as shown in Fig. 2b. Practically, the first input of the fusion process is computed based on the straightforward white balancing operation. Nevertheless, white balancing solely is not able to solve the problem of visibility, and therefore an additional input is needed to enhance the contrast of the degraded image.

B. *Weights of the Fusion*

The design of the weight measures needs to consider the desired appearance of the restored output. Since image restoration is tightly correlated with the color appearance, so the measurable values such as haze density, salient features and exposedness are difficult to integrate by naïve per pixel blending. Higher values of the weight determine that a pixel is advantaged to appear in the final image.

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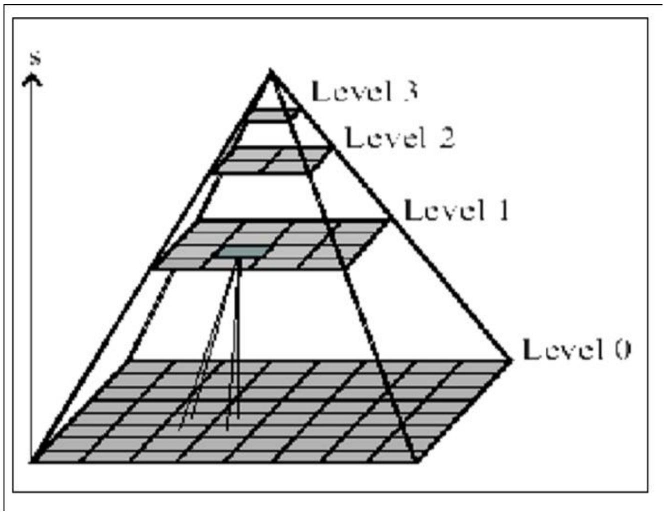

Fig.1. Pixel Pyramid Level

1) Pixel Level Fusion

This section focuses on the so-called pixel level fusion process, where a composite image has to be built of several input images. In pixel-level image fusion, some generic requirements can be imposed on the fusion result:

a) The fusion process should preserve all relevant information of the input imagery in the composite image (pattern conservation)

C. *Fusion Process*

The images are first decomposed using a Laplacian Pyramid decomposition of the original image into a Hierarchy of images such that each level corresponds to a different band of image frequencies.

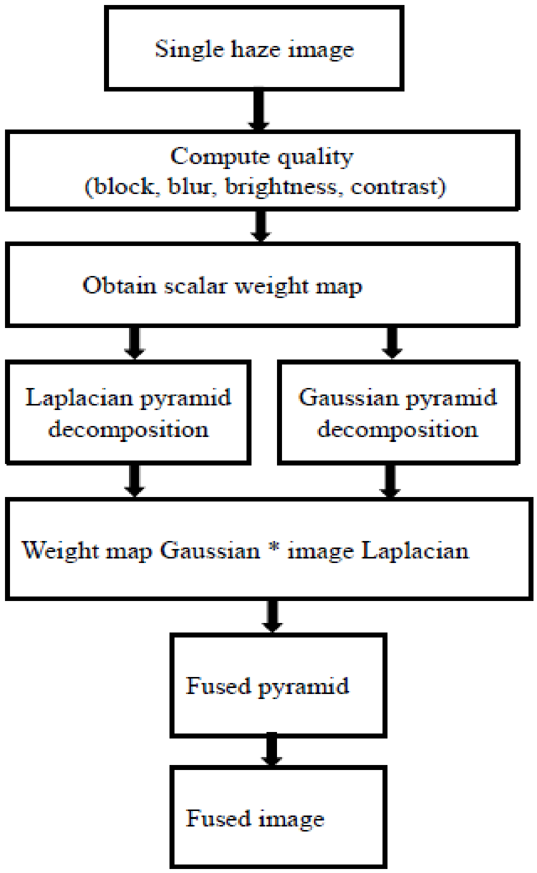

Fig.2. Flowchart of dehazing the image of foggy images

The Laplacian pyramid decomposition is a suitable MR decomposition for the present task as it is simple, efficient and better mirrors the multiple scales of processing in the HVS. The next step is to compute the Gaussian pyramid of the weight map. Blending is then carried out for each level separately [14].

III. Existing method

i. *An Improved Fog-Removing Method*

A. *The Retinex algorithm.*

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www.ijrms

Retinex algorithm has showed good effect on removing fog from image. Retinex algorithm is to reduce the effects of incident light on the image, and to strengthen the reflection image as follows:

$$R_l(x, y) = \log I_l(x, y) - \log[F(x, y) * I_l(x, y)] \quad l = 1, \cdots, n$$

Rl(x,y) is the output corresponding to the L channel, Il (x, y) is an input luminance image pixel value of the L channel, the parameter * is the convolution operation, the parameter n in the color channel number, F (x, y) represents the center / surround function.

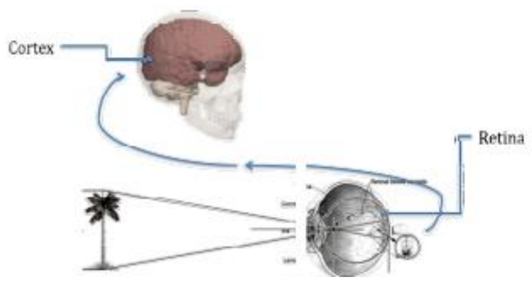

Figure 3: Human visual System (HVS)

ii. *The improved fog-removing method*

Retinex algorithm can enhance most of the information of image, however but since it just increases the overall outline, the details of the image are not outstanding. On the other hand, wavelet image enhancement by suppressing low frequency information of the image and enhanced image of high frequency information so as to enhance image details and outline of the image noise reduction at the same time. We propose an improved fog-removing method which has combined the merits of Retinex algorithm and Wavelet transform algorithm, this improved fog-removing method firstly use Retinex algorithm to enhance overall outline information of the image; then use wavelet image enhancement method to get high frequency information from the Retinex-ed image, finally a more clearly and fog-removed image can be obtained. We named this improved method as R + WT algorithm.

The steps of the R+WT method are as follows:

(a) Input the fog-image.

(b) Put the above fog-image into logarithm domain.

(c) To obtain the result image R(x,y) by using the above formulation (1) and (2).

(d) By using a linear stretch processing to make the above R(x,y) image size to be similar with the original image.

(e) Using wavelet transform method decomposed R(x,y) image into two layers.

(f) Then to increase the high frequency and suppress low frequency of the image from step (e).

(g) Output the result fog removed image.

IV. PROPOSED METHOD

A. Dark Channel Prior

The dark channel prior is based on the following observation on haze-free outdoor images: in most of the non-sky patches, at least one color channel has very low intensity at some pixels. In other words, the minimum intensity in such a patch should has a very low value. Formally, for an image J, we define

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

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Where J c is a color channel of J and Ω(x) is a local patch centered at x. Our observation says that except for the sky region, the intensity of J dark is low and tends to be zero, if J is a haze-free outdoor image. We call J dark the dark channel of J , and we call the above statistical observation or knowledge the dark channel prior.

The low intensities in the dark channel are mainly due to three factors: a) shadows. e.g., the shadows of cars, buildings and the inside of windows in cityscape images, or the shadows of leaves, trees and rocks in landscape images; b) colorful objects or surfaces. e.g., any object (for example, green grass/tree/plant, red or yellow flower/leaf, and blue water surface) lacking color in any color channel will result in low values in the dark channel; c) dark objects or surfaces .e.g., dark tree trunk and stone. As the natural outdoor images are usually full of shadows and colorful, the dark channels of these images are really dark! To verify how good the dark channel prior is, we collect an outdoor image sets from flickr.com and several other image search engines using 150 most popular tags annotated by the flickr users. Since haze usually occurs in outdoor landscape and cityscape senses, we manually pick out the haze-free landscape and cityscape ones from the downloaded images. Among them, we randomly select 5,000 images and manually cut out the sky regions. They are resized so that the maximum of width and height is 500 pixels and their dark channels are computed using a patch size15×15. Figure3shows several outdoor images and the corresponding dark channels.

Due to the additive air light, a haze image is brighter than its haze-free version in where the transmission is low. So the dark channel of the haze image will have higher intensity in regions with denser haze. Our dark channel prior is partially inspired by the well-known dark-object subtraction technique widely used in multi-spectral remote sensing systems. In spatially homogeneous haze is removed by subtracting a constant value corresponding to the darkest object in the scene. Here, we generalize this idea and proposed a novel prior for natural image dehazing.

B. *Haze Removal Using Dark Channel Prior*

Estimating the Transmission in bright area:

Here, we first assume that the atmospheric light A is given. We will present an automatic method to estimate the atmospheric light in Section 4.4. We further assume that the transmission in a local patch Ω(x)is constant. We denote the patch's transmission as˜ t(x). As we mentioned before, the dark channel prior is not a good prior for the sky regions. Fortunately, the color of the sky is usually very similar to the atmospheric light A in a haze image and we have:

$$\min_c\left(\min_{\mathbf{y}\in\Omega(\mathbf{x})}\left(\frac{I^c(\mathbf{y})}{A^c}\right)\right) \rightarrow 1, \text{ and } \tilde{t}(\mathbf{x}) \rightarrow 0,$$

Since the sky is at infinite and tends to has zero transmission, the Equation (11) gracefully handles both sky regions and non-sky regions. We do not need to separate the sky regions beforehand. In practice, even in clear days the atmosphere is not absolutely free of any particle. So, the haze still exists when we look at distant objects. Moreover,

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A Peer Reviewed Open Access International Journal
www.ijrms

the presence of haze is a fundamental cue for human to perceive depth [3, 13]. This phenomenon is called aerial perspective. The nice property of this modification is that we adaptively keep more haze for the distant objects. The value of ω is application-based. We fix it to 0.95 for all results reported in this paper. Figure5 (b) is the estimated transmission map from an input haze image (Figure 5(a)) using the patch size 15× 15. It is reasonably good but contains some block effects since the transmission is not always constant in a patch. In the next subsection, we refine this map using a soft matting method.

ii. *Soft Matting*

We notice that the haze imaging Equation (1) has a similar form with the image matting equation. A transmission map is exactly an alpha map. Therefore, we apply a soft matting algorithm to refine the transmission. Denote the refined transmission map byt(x).

Figure 4: Haze removal images

Levin's soft matting method has also been applied to deal with the spatially variant white balance problem. In both Levin's and Hsu's works, that is only known in sparse regions and the matting is mainly used to extrapolate the value into the unknown region. In this paper, we use the soft matting to refine a coarser To which has already filled the whole image. Figure 4 is the soft matting result using Figure 4 as the data term. As we can see, the refined transmission map manages to capture the sharp edge discontinuities and outline the profile of the objects.

V. RESULTS AND CONCLUSION

We propose an improved fog-removing method which has combined the merits of Retinex algorithm and Wavelet transform algorithm, this improved fog-removing method fIrstly use Retinex algorithm to enhance overall outline information of the image; then use wavelet image enhancement method to get high frequency information from the Retinex-ed image, fInally a more clearly and fog-removed image can be obtained. We evaluated the proposed R+WT method by using two evaluation methods, one is the subjective evaluation, and another is the objective evaluation. Both of these two evaluation methods have showed that the proposed 941 R+WT method is better than other traditional algorithms such as Retinex, and Dark Channel. Overall, the proposed R + WT method is more suitable for the fog haze weather image enhancement; especially improve the processing effect on fog weather's vehicle detection and license plate recognition. Using R + WT method processing, we can not only restore the most of the image information, but also reduce the noise of the image, it will be more convenient in the subsequent image processing. There are several future works we have to resolve. The one is we need to fInd a way to automatic control parameters based on the fog concentration. Another is to use R+WT method

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A Peer Reviewed Open Access International Journal
www.ijrms

tyr to remove fog from traffIc video so as to help the traffIc monitoring.

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