

Image Dehazing Based On Image Enhancement Algorithm

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Abstract. Image is main source for human to acquire information, therefore, accuracy of image information is very important. In real life, due to the reasons of haze in the image, which we have obtained is degraded. The degraded image not only reduces the application value of image, but also brings many negative influences to our real life. So, it is necessary to do research on image dehazing algorithm. The paper introduces simulation analysis based on kinds of enhancement algorithm, such as histogram equalization, homomorphic filtering, retinex etc. At the same time, it also introduces a new method to calculate dark channel prior, and summarizes its advantages and disadvantages through a series of the analysis of simulation. The paper proposes a fast and effective method to deal with the haze degraded image based on dark channel prior, in order to reduce the bad effect in the outdoor visibility system in foggy days. Experimental results demonstrate that it can efficiently remove the haze, enhance the details and color, and recover high quality haze-free images. At last, the paper introduces evaluation criteria of image dehazing algorithm.

Introduction

The image which acquired under fog conditions is seriously degraded. It suffers from poor contrast, low visibility and faint colors. It reduces the applications value of the image seriously. Image dehazing is an important problem in the field of image processing, and which has been an important researching direction in computer vision. Images acquired in bad weather, such as haze and fog, are blurred and seriously degraded by the scattering of atmosphere, which makes image color gray and drift, reduces the contrast, and makes object features difficult to identify. The bad weather not only leads to the variation of the visual effect of image, but also cause the disadvantage of post processing to image. It is always a hot topic in how to efficiently remove the influence of the haze and fog on optical images, or how to improve image quality and get useful information which users are interested in.

Image Contrast Enhancement Method for Fog Image

The images of outdoor scenes obtained in haze and other weather phenomena are usually have poor contrast and color fidelity. It must be difficult to estimate the objective using these blurred images, and it directly limited outdoor vision systems. Therefore, in order to effectively improve the fog-degraded image quality, reduce the effect of the fog, haze and other weather conditions, there is practical and theoretical meaning of images dehazing and visibility restoration fast and efficiently. Image enhancement methods are to enhance contrast and highlight the features of image, including histogram equalization, logarithmic transform, power law transform, sharpening, wavelet transform and so on. These methods are not removal of fog in the image, but instead of image as a clear processing. Histogram equalization is a method of contrast enhancement, and the contrast of fog image is lower. The histogram equalization can be used to make histogram distribution equilibrium, and the dynamic range of it is enlarged, so the contrast of it is enhanced.

Image Enhancement Based on Wavelet Transform

Wavelet analysis is a newly arisen subject and it has been applied to image processing very well. The application of wavelet and multi-scale analysis for contrast enhancement has made great progress. The details of fog image is equalized by multiple scales, and have a good sharpening effect. The decomposition component of image based on wavelet transform is image signal, which is decomposed into layers with different frequency bands. Each layer of wavelet decomposes into four subbands image [1], which are LL, LH, HL and HH. The horizontal and vertical direction are all low frequency for LL, the horizontal direction is low frequency and vertical direction is high frequency for LH, the horizontal direction is high frequency and vertical direction is low frequency for HL, the horizontal and vertical direction are all high frequency for HH. The third level decomposition based on wavelet transform is shown in figure 1, which shows that LL_i ($i=1,2,3$) is smooth image of original image, maintaining low-frequency part of image, LH_i ($i = 1,2,3$) maintain the vertical edges details of the original image, HL_i ($i = 1,2,3$) maintain the horizontal edge details of original image, and HH_i ($i = 1,2,3$) maintain the diagonal details of original image [2]. After image is decomposed, noise can be eliminated by filtering and then image is reconstructed to achieve the purpose of image enhancement. Figure 1 shows the third level decomposition of image based on wavelet transform.

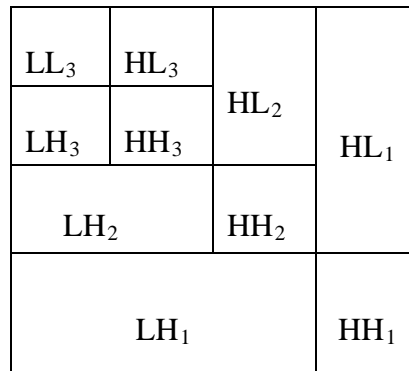


Fig.1. The third level decomposition of image based on wavelet transform

Image Enhancement Based on Homomorphism Filtering Algorithm

The homomorphism filtering algorithm is widely used in the field of image enhancement. The algorithm is a kind of image enhancement processing method, which combines the frequency filtering and gray transform. It is also a kind of image processing technology to improve quality by using compressed brightness range and contrast enhancement. The homomorphism filtering algorithm is shown in the figure 2.

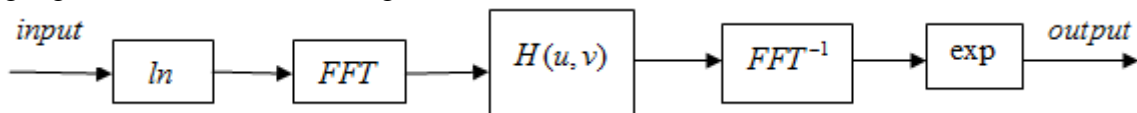


Fig.2. The homomorphism filtering algorithm

Image Enhancement Based on Retinex Algorithm

At present, the retinex algorithm is widely used in the field of image enhancement. Retinex algorithm is a model that has the characteristics of dynamic range compression and color invariance. Low contrast color image is caused by uneven light. It has good enhancement effect for low contrast color image, which can be compressed within a certain dynamic range. Therefore, the advantage of it is that contrast decreased image can be enhanced.

Image Dehazing Based on Dark Channel Prior Algorithm

Dark channel prior is the regularity of the statistic of non-haze image in the outdoor. In the local area, there are always pixels that we call pixels dark, and at least one color channel has a very low intensity value. In other words, the minimum of the local area of light intensity is a small value. The physical model of haze can be expressed as the formula (1).

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

In the formula, x is the coordinate points on the image, I represents the observed image which is captured under haze circumstances. t is a scalar, indicates the propagation rate along the light, without being scattered and absorbed part of the light which reaches the camera. A represents the color of atmosphere light, J represents irradiance of scene that no fog image to be restored. The goal of dehazing image is to recover image J from foggy image I .

For any image J , its dark channel can be expressed by the equation:

$$J^{dark}(x) = \min_{c \in \{r, g, b\}} (\min_{y \in \Omega(x)} (J^c(y))) \quad (2)$$

In the formula, J^c represents one color channel of J , a true color image has three color channels, which are R, G and B channels, and $\Omega(x)$ is a square area, x is the center of square area. We observed results, value of J^{dark} is always low and close to zero. If J is haze-free image in the outdoor, J^{dark} is dark channel color of J , also called dark colors prior[3-6].

Experimental Results

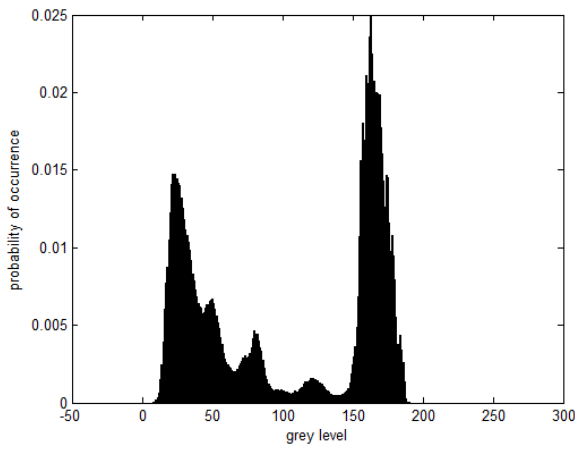
We can see the result of image dehazing from figure 3 to figure 6. As the use of histogram equalization of image processing for dehazing, to enhance image contrast will also cause the loss of image detail. In fact, the histogram equalization algorithm only changes the gray level distribution, although the image enhancement method can improve the visual effect, but usually can not remove the influence of haze effectively. From the effect of image enhancement based on homomorphism filtering algorithm, image dehazing sometimes leads to loss some information. We can see from figure 5(c), retinex algorithm is easy to cause the halo and artifacts, edge blur. The dark channel prior is good at the algorithm for dehazing, but the soft computing which is one part of the dark channel prior is so complexity that it will cost too much time to achieve the results, these disadvantages become the bottle neck of the algorithm in practical application. In contrast to these algorithms, we think the dark channel prior algorithm is better than others for dehazing.



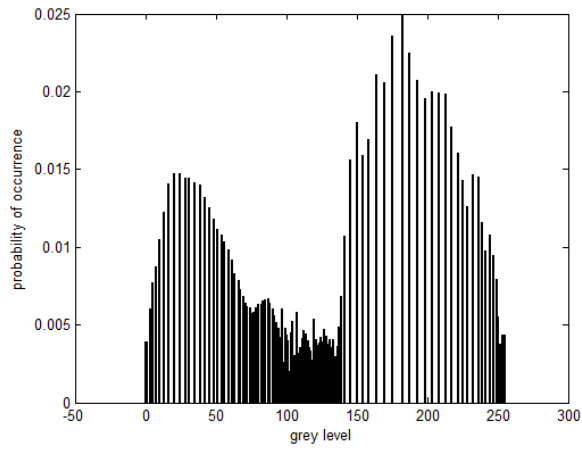
(a) color image



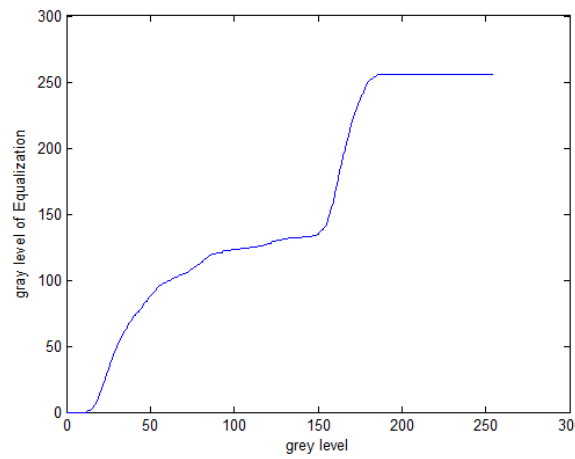
(b) gray image



(c) histogram



(d) equalization histogram



(e) curve of grey level



(f) equalization image

Fig.3. The result of image enhancement based on histogram equalization



(a)color image



(b) result image

Fig.4. The result of image enhancement based on homomorphism filtering algorithm



(a)color image



(b) gray image



(c) result image

Fig.5. The result of image enhancement based on retinex algorithm



(a) color image



(b) dark channel image



(c) transmittance image



(d) result image

Fig.6. The result of image enhancement based on dark channel prior algorithm

Conclusion

We analyze the experimental results of image dehazing by subjectively and objectively, which have shown that these algorithm can effectively handle with different hazed images. In the field of image dehazing, image quality and algorithm efficiency are two important indexes of algorithm evaluation. The purpose of image dehazing algorithm is to recover the clear image, at the same time, in order to avoid too clear and lead to distortion, it is needed to keep partial haze when depth of the scene is large, and can't evaluate algorithm by the simple standard, whether haze in the image is all removed or not.

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