Available online www.jsaer.com

***Journal of Scientific and Engineering Research*, 2019, 6(7):115-119**

Research Article

ISSN: 2394-2630
CODEN(USA): JSERBR

A Research on Defogging Methods with Single Image

Hongli Zhu, Yang Yang

School of Information and Electronic Engineering, Zhejiang University City College, Hangzhou, China
zhuhl@zucc.edu.cn, yangy@zucc.edu.cn

Abstract With the development of computer technology, computer screening technology is used in many fields such as medicine, transfer, insurance, and so on. In fact, wireless technology for pictures is a warm place for researchers at home and abroad. The effect of fogging distorts the images by releasing airborne airplanes, which reduces image sharpness, color information and color distortion, and significantly reduces the useful information in the picture. In this book, we understand the recovery process of a picture from two methods of physical and visual enhancement.

Keywords image defogging, dark channel prior, retinex algorithm

1. Introduction

Since the reform and opening up, the rapid development of China's economy has brought not only people's happy life, but also the deterioration of the environment. Especially the frequency of haze weather greatly reduces the clarity of images obtained by image observation systems such as monitoring system and satellite tracking system. In fog and haze weather, small suspended particles in the atmosphere cause a large amount of loss of reflected light in the atmosphere. Therefore, fog and haze weather will greatly reduce the content of visible light and visual field visibility, thus affecting the clarity and contrast of the acquired image, resulting in serious distortion of the image and greatly reducing the amount of effective information.

It can be seen that the haze weather always affects the effective amount of information we get from the haze image in our daily life. However, people can't solve the problem of environmental pollution thoroughly in a short time. Therefore, it is necessary for computer vision system to defog the obtained haze image, so as to improve the useful information of the image. So it can be seen that image defogging technology has become an indispensable part of people's life. It is widely used in military, medical, aviation, transportation and other fields [1].

2. Defoggıng Algorıthm based on Dark Channel Priori Prıncıple

A. Atmospheric Scattering Model

The atmospheric scattering model proposed by McCartney in 1975 is the most commonly used physical model in defogging algorithm. The physical model describes in detail the scattering of light reflected by objects due to suspended particles in the atmosphere in fog and haze weather. This makes light scatter to a certain extent in the process of propagation.

The expression of the physical model is as follows:

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

The I (x) in the formula represents the collected fog image, A represents atmospheric light value, t (x) represents the transmittance of the image, and J (x) represents the defogging image to be restored. Because most of the parameters in the formula are uncertain, we need some prior information to solve the equation.

B. Defogging Algorithms Based on Priori Principle

In recent years, with the unremitting efforts of researchers at home and abroad, single image defogging technology has made great progress based on prior conditions. This method can get good defogging effect at some time, but halo effect and color saturation often occur [2].

According to the statistics of fog-free images, it is found that there are always some low gray pixels in many areas of the image, so He proposed the dark channel priori theory [2]. This method calculates the atmospheric light value on the premise of obtaining the dark channel image, then calculates the transmittance by using the dark channel which has been obtained, and finally gets the fog image by using the atmospheric scattering model. This method has a good effect, but the operation process of this method is complex and the requirement for the processor is high.

C. Solution of Dark Channel

He statistics found that in a large number of fog-free images, there are some pixels with at least one color channel whose intensity value is very low or even tends to reach 0 . So we define dark primary color as:

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

In this formula, JC represents every pixel in the image, and Jdark tends to be 0. The implementation steps of the above formula in the program are as follows: first, set a gray image of the same size as the original image and initialize it, then put the smallest RGB value in each channel into the corresponding position of the initialized gray image, and finally, enter the gray image. The result of minimum filtering is dark channel image.

The main factors of dark passage in real life are: a) the shadow of natural scenery such as buildings, cars and trees. b) For some colorful scenery, there are some channels with very low values in the RGB channel of the image. c) Shadows and colored scenes are very common in nature, but their dark passages are always dark.

Atmospheric light value refers to the most opaque and brightest pixels in the image. However, this is not the case. When there is a large area of sky in the image or the image is illuminated by strong light, the calculation of atmospheric light value A will be inaccurate.

To solve this problem and improve the accuracy of atmospheric light value A, we can use dark channel images to eliminate such errors. Therefore, we can select the location of the pixels whose brightness is the first 0.1% in the obtained dark channel image, and then find the corresponding maximum brightness point in the original foggy image according to the location as the atmospheric light value of the image [3].

The atmospheric light value A can be calculated by the above method. We can divide the two sides of formula1 by the atmospheric light value A at the same time to form the following formula:

$$\frac{I^{C}(\mathrm{x})}{A^{C}} = t(\mathrm{x})\frac{J^{C}(\mathrm{x})}{A^{C}} + (1 - t(\mathrm{x})) \quad (3)$$

Then we assume that the transmittance in each window is constant, which is defined as t(x). Then we find the minimum value of formula 3 on both sides twice and get the following formula:

$$\min_{y\in\Omega(\mathrm{x})}\left(\min_{\mathrm{C}}\frac{I^{C}(\mathrm{y})}{A^{C}}\right)$$
$$= \hat{t}(\mathrm{x})\min_{y\in\Omega(\mathrm{x})}\left(\min_{y\in\Omega(\mathrm{x})}\left(\min_{\mathrm{C}}\frac{J^{C}(\mathrm{y})}{A^{C}}\right) + (1 - t(\mathrm{x}))\right. \quad (4)$$

According to the dark priori principle, Jdark=0 can be deduced as follows:

$$\min_{y\in\Omega(\mathrm{x})}\left(\min_{\mathbf{C}}\frac{J^{C}(\mathrm{y})}{A^{C}}\right) = 0 \quad (5)$$

Formula 5 is introduced into Formula 4 to derive the estimated value of transmittance t(x), as follows:

$$\hat{t}(\mathrm{x}) = 1 - \min_{y\in\Omega(\mathrm{x})}\left(\min_{C}\frac{I^{C}(\mathrm{y})}{A^{C}}\right) \quad (6)$$

However, in fact, even in clear and cloudy weather, there are certain particles in the atmosphere, which make people feel the depth of field. Therefore, in the case of fog removal, a fog removal factor can be introduced. Formula 6 can be revised as follows:

$$\hat{t}(\mathrm{x}) = 1 - \omega \min_{y\in\Omega(\mathrm{x})}\left(\min_C \frac{I^C(\mathrm{y})}{A^C}\right) \tag{7}$$

In order to achieve fast defogging of a single image, we mainly studies the method of replacing soft matting with guided filtering of transmittance. The principle of guided filtering is to first propose the features of foggy images, and then refine several eigenvalues of foggy images. This filtering method is a linear filter, which can enhance the details of the image. Directed filtering can directly call functions in MATLAB, and the operation speed is fast. It can greatly reduce the image defogging time, and can also solve the "halo" phenomenon caused by sudden change in depth of field. The defogging efficiency has been greatly improved.

Formula 3 can be converted into the following formula by calculation:

$$J(x) = \frac{(I(x) - A)}{\max\left(t(x), t_0\right)} + A \tag{8}$$

From the above method, we can get the atmospheric light value of the image and the optimized t (x), which are brought into formula 2.8 respectively. After calculation, we can get the defogged image J (x).

However, when the transmittance is very small, it will lead to a larger J (x) value of the defogging result, which will lead to over-exposure in some parts of the picture. Therefore, we will set a threshold to maximize the transmittance in order to prevent the transmittance from being too small.

3. Implementation of Algorithm

The imread function is used to extract information from the original image, and the extracted information is transformed to facilitate subsequent matrix operations. The code is as follows:

```
Img_name = imread ('2.jpg');%   picture reading
I = double (img_name) / 255;
```

Use size () function to read image size, set up a gray image space with the same size as the original image, the code is as follows:

```
[h, w, c] = size (I);%  image size reading
Win_dark = zeros (h, w);%  channel initialization
```

By finding the minimum value in each channel and assigning it to the grayscale image set in step 2, the dark channel image of the image can be obtained. The code is as follows:

```
for i=1:h
for j=1:w
win_dark(i,j)=min(I(i,j,:));%  Solution of Dark Channel
end
end
```

Using the minimum filter to filter the dark channel image obtained in step 3, there is ordfilt2 function in the function library of MATLAB which can be called directly. The code is as follows:

```
Win_dark = ordfilt2 (win_dark, 1, ones (9,9),'symmetric');
```

Solve the atmospheric light value, in order to avoid halo phenomenon, find the brightest point in the dark channel and record its position. The value of the point in the original figure is A. The code is as follows:

```
A = max (dark_channel);
[i, j] = find (dark_channel== A);
i = i (1);
Jj= j (1);
A = mean (I (i, j,:);
```

To solve and optimize the transmittance, this paper studies how to filter the transmittance to enhance the edge details [12]. The guided filter function can be called directly in the software, and the code is as follows:

```
Transmission = 1 - W0 * win_dark / A;
Gray_I = I (:,:, 1);
P = transmission;
R = 80;
EPS = 10 ^ - 3;
Transmission_filter = guided filter (gray_I, p, r, eps);
```

Setting threshold to prevent distortion of defogged image caused by low transmittance, and calculating the restored image, the code is as follows:

```
t0=0.1;
t1 = max(t0,transmission_filter);
for i=1:c
for j=1:h
for l=1:w
dehaze(j,l,i)=(I(j,l,i)-A)/t1(j,l)+A;
end
end
end
```

4. Experimental Result

In the algorithm, we use the minimum filter to filter the dark channel image. In this process, the filter radius R is worth setting, which has a certain impact on the processing results. Experiments show that the results of the algorithm become more and more unsatisfactory with the slow change of R value. According to the statistics, the setting range of this value is generally between 5 and 25, and the general choice of 5, 7, 9 and so on will achieve good results. The fog removal effects of the original map and the minimum radius of 5, 7 and 9 are shown below.

Figure 1: Minimum filter radius effect comparison chart

Defogging factor W has a great influence on the defogging effect. The results of this study are the fog removal results when w = 0.5, w = 0.95 and w = 1.5 respectively.

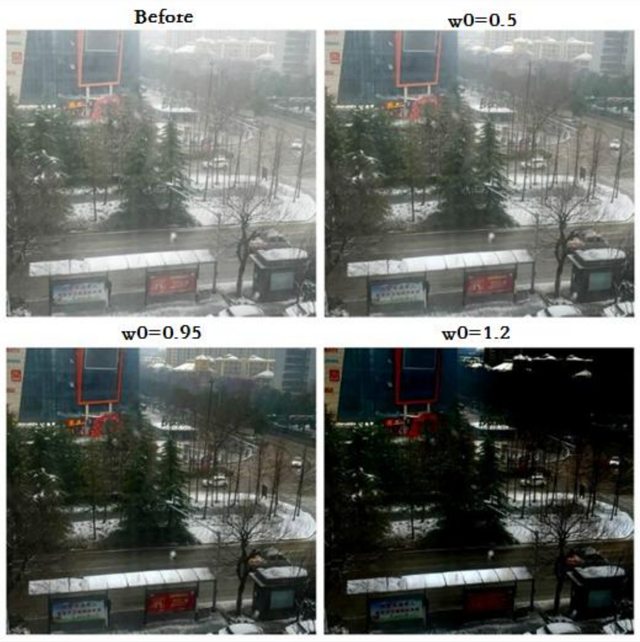

Figure 2: Comparisons of defogging factors

References

[1]. Bi Xiaojun, Pan Tiewen, "An image enhancement method based on improved teaching-learning-based optimization algorithm," Journal of Harbin Engineering University, 2016, 37(12):1717-1721.

[2]. Jung, S. W. "Enhancement of Image and Depth Map Using Adaptive Joint Trilateral Filter," IEEE Transactions on Circuits and Systems for Video Technology, 2013, 2(2):258-269.

[3]. Wang Mengliu, Chen Heping, Liu Xia, "Research on Smoke Detection algorithm using dark channel prior," Computer Applications and Software, 2014(11):231-234.

[4]. Xin Liua, He Zhanga, Yiu-ming Cheungc, Xinge Youd, Yuan Yan "Tang. Efficient single image dehazing and denoising: An efficient multi-scale correlated wavelet approach." Computers & Graphics. 2017 (162): 23-33.

[5]. Provenzi E, Fierro M, Rizzi A, et al., "Random spray retinex: A new retinex implementation to investigate the local properties of the model," IEEE Transactions on Image Processin., 2007,16(1):162-471.

[6]. Demirel, H., Anbarjafari, G., "Image Resolution Enhancement by Using Discrete and Stationary Wavelet Decomposition," IEEE Transactions on Image Processing, 2011, 5(5): 1458-1460.