

Review of Two Typical Image Defogging Algorithms and Related Improvements

Chen Kong

School of Electronic Engineering, Xidian University, Xian, Shaanxi 710119, China.

Abstract

The current Hebei haze is the negative result of industrial development. The image defog algorithm arises accordingly. Due to the scattering effect of the atmosphere, the overall images collected in the haze weather are gray and white, so it is difficult for human eye to distinguish the image content. However, the repaired image processed by the defog algorithm can be collected by other image algorithms for subsequent recognition processing. This paper mainly introduces the two types of image demogging algorithms with the best feedback: Retinex image enhancement algorithm and dark channel prior algorithm, and uses matlab implementation for image processing comparison and analysis, and finally gives the optimization idea, and optimized image comparison.

Keywords

Image Defogging; Retinex; Dark Channel Prior; MATLAB; Image Processing.

1. Introduction of the image defogging algorithm

1.1. Introduction of the Retinex algorithm

The term Retinex known as Retina-cortex theory is an image enhancement algorithm based on color permanence by Edwin.H.Lang in 1963 [1]. Its basic idea is that people perceive the color and brightness of a point does not only depend on the absolute light of the point enters the human eye, but also on the color and brightness around it. The color of the object is determined by the ability of the object to reflect the long, medium, short wave light, namely red, green and blue light, rather than by the absolute value of the intensity of the reflected light [2]. The color of the object is not affected by illumination non-uniformity and has consistency, namely color constant.

The basic assumption of it is that the original image S is the product of the light image L and the reflectance image R , as shown in formula _ 1 below:

$$S(x, y) = R(x, y) * L(x, y) \quad (1)$$

The purpose of the Retinex-based image enhancement is to estimate the illumination L , from the original image S to break down the R , to eliminate the effect of uneven illumination to improve the visual effect of the image. In processing, the image is usually transferred to a log domain, thus converting the product to and, as shown in Equation 2: $s = \log S, l = \log L, r = \log R$,

$$\log(S) = \log(R * L), \log S = \log R + \log L, s = r + l \quad (2)$$

At the core of the Retinex method is to estimate the illumination L , to estimate the L component from the image S and remove the L component to obtain the original reflection component R , as shown in formula 3 below:

$$l = f(s), r = s - f(s) \quad (3)$$

There are many classical algorithms: Retinex has a path-based algorithm, center/ surround-based algorithm, but scale Retinex (SSR), multi-scale Retinex (MSR), Retinex, adaptive smoothing Retinex are essentially similar.

1.2. Introduction of the dark channel prior defogging algorithm

The Dark Channel Prior, dark channel prior algorithm is a famous algorithm in the field of defog in the CV circle. His author He Keming found a rule [3]: in the RGB three-color channel of each pixel of each image, there is always a channel with a low gray scale value. Based on this prior knowledge, the authors propose a defogging algorithm for dark channel priors.

This defog model is shown in formula 4, where $I(x)$ is fog image, $J(x)$ is the expected fog free image, A is atmospheric light value, $t(x)$ is transmission rate, so $J(x)$ by knowing A and $t(x)$.

$$I(x) = J(x)t(x) + A(1 - t(x)) \quad (4)$$

For any one of the input images, the mathematical expression of its dark channel is shown in formula 5:

$$J^{dark}(x) = \min_{y \in \Omega(x)} (\min_{c \in \{r,g,b\}} J^c(y)) \quad (5)$$

First divide by A on both sides of formula 4 to obtain formula 6 as follows:

$$\frac{I^c(x)}{A^c} = t(x) \frac{J^c(x)}{A^c} + 1 - t(x) \quad (6)$$

$\tilde{t}(x)$ Assuming that the transmission rate within the window is a fixed value, then seeking the minimum value for formula 6 in a window obtains formula 7 as follows:

$$\min_{y \in \Omega(x)} (\min_{c \in \{r,g,b\}} \frac{I^c(y)}{A^c}) = \tilde{t}(x) \min_{y \in \Omega(x)} (\min_{c \in \{r,g,b\}} \frac{J^c(y)}{A^c}) \quad (7)$$

According to the dark channel expression formula. 5, formula 8 is obtained as follows:

$$\tilde{t}(x) = 1 - \min_{y \in \Omega(x)} (\min_{c \in \{r,g,b\}} \frac{I^c(y)}{A^c}) \quad (8)$$

However, according to the paper, there are particulates even in the bright scene air. In order to prevent the fog removal from being too completely and the restored scene is unnatural, the parameter $\omega=0.95$ is introduced, the smaller the weaker the fog removal effect, and the final formula 9 is as follows:

$$\tilde{t}(x) = 1 - \omega \min_{y \in \Omega(x)} (\min_{c \in \{r,g,b\}} \frac{I^c(y)}{A^c}) \quad (9)$$

The A, paper: first took the top 0.1% pixels from the dark channel according to the brightness bridge, then find the positions of these pixels, extracted the sum of these pixels RGB three-channel values from the original fog image according to these positions, and then calculate the average of all these values as the atmospheric light value A .

With $t(x)$ and A you can recover fog-free images based on Equation 4, but given that too small $t(x)$ causes large J , threshold protection against $t(x)$, when $t(x) < t_0$, $t(x) = t_0$, where $t_0=0.1$. Recovery formula 10 is shown as follows:

$$J(x) = \frac{I(x)-A}{\max(t(x),t_0)} + A \quad (10)$$

2. The MATLAB implementation

2.1. Retinex defogging algorithm implementation

According to the Retinex paper, I simply wrote the code to achieve the viewing effect. As can be seen, Retinex indeed has an obvious effect on the fog image, and has a certain correction effect on the right of the color. As can be seen, while becoming less foggy, the color is not only enhanced, but also the edge information is strengthened. However, Retinex also has certain limitations. From the comparison between both sides and the center of, the center is clearly brighter than both sides, while from, the overall brightness is significantly reduced a lot, so the naked eye is darker and uncomfortable.

2.2. Dark channel prior defogging algorithm implementation

According to the introduction of the dark channel prior. As can be seen the defogging effect of the dark channel prior is also very good, but unfortunately the algorithm has no color correction effect.

3. Foogging algorithm optimization

From the experimental comparison in the second section, the dark channel is better than Retinex, in the defogging effect, but in the color correction, Retinex is better. So the author puts forward a simple optimization of demogging algorithm [4]: first use Retinex color correction of the original picture, and then process the color modified image with the dark channel prior algorithm.

The optimization experiment results is clearer than Retinex. The color correction effect of Retinex causes its overall darkness, but the optimized processing is still better than the two algorithms alone [5].

4. Conclusion

Although image defogging is not a research hotspot in computer vision tasks. In fact, a large number of researchers are constantly researching new methods to solve this challenging problem. Specifically, image defogging algorithms can be roughly divided into the following two categories.

Defogging algorithm based on image enhancement. The starting point of defogging algorithm based on image enhancement is to remove image noise as much as possible and improve image contrast, so as to restore a clear image without fog.

Defogging algorithm based on image restoration. This series of methods are basically based on the atmospheric degradation model. The defogging effect based on the atmospheric degradation model is generally better than that based on image enhancement.

Image enhancement has the advantages of low complexity and easy implementation, but its restoration quality restricts the popularity of this kind of algorithm. In contrast, the physical model is more targeted. The flexible parameter estimation strategy also gives this kind of method more room for improvement.

CNN has made great progress in some tasks in recent years. Naturally, there is a lot of related work based on CNN. Although the deep learning model has a certain recovery ability, it is not robust in the real scene. At the same time, the computational efficiency of image defogging algorithm and the evaluation metric of image defogging effect need to be further studied.

References

- [1] Land, E. H.. (1978). The retinex theory of color vision. *Scientific American*, 237(6), 108-128.
- [2] Land, E. L.. (1986). An alterna tive technique for the computation of the designator in the retinex theory of computer vision.
- [3] He,K.,Jian,S.,Fellow,IEEE,& Tang,X.. (2011). Single image haze removal using dark channel prior. *IEEE Transactions on Pattern Analysis & Machine Intelligence*,33(12),2341-2353.
- [4] Sun, X., Sun, J., Zhao, L., & Cao, Y.. (2014). Improved algorithm for single image haze removing using dark channel prior. *Journal of Image and Graphics*.
- [5] Bingbing,Z., Shengkui, D., Wanyuan, S., Zhang Bingbing, Dai Shengkui, & Sun Wanyuan. (2016). Fast image haze-removal algorithm based on the prior dark-channel rapid defogging algorithm based on dark protopriori models. *Chinese Image Graphic Graphics*, 18 (2), 47-55.