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Remote Sensing Image Dehazing Algorithm Based on Wavelet Coefficient Weighting

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Abstract. This paper introduces the principle of the defogging algorithm and the steps of the algorithm implementation. According to the simulated image and result, the data is recorded, and the wavelet coefficient weighting is applied to evaluate the effect of remote sensing image de-clouding. Compared with the homomorphic filtering algorithm and Retinex algorithm, the wavelet coefficient weighting is applied to the remote sensing image. The effect of cloud treatment is very good.

Key words: remote sensing image; boundary layer; entropy; weight.

1. Introduction

The remote sensing imaging process is extremely vulnerable to cloud fog. The cloud cover area in remote sensing images directly affects the image analysis, analysis and use of images, thus reducing the effective utilization of images. If the efficiency of the processing is higher than the previous method, we can use an algorithm that can process the value online, using the physical model as a reference, using the fast processing method proposed by Tarel J P. and N. Hautiere, the speed can be Guaranteed, but there is no other type of method for accuracy and effect. So they will maximize the contrast of the scene color in the fog image to achieve the effect of removing the fog.

2. Wavelet coefficient weighting algorithm

Two-dimensional discrete data can be used to represent the information of a digital image, and its resolution characteristics are limited in this way. Using the multi-resolution feature of wavelet analysis theory, if the scale space is V_{m-1}, the approximation coefficient C_{m-1} can be considered as a parameter in the image, and this parameter is in the V_{m-1}. In the process, high-pass and low-pass filters are used, and the two-dimensional discrete wavelet processing is performed on the whole image, which represents the filtering process in the vertical and horizontal directions. Figure 1 shows the process of a wavelet transform. The C_{m-1} processed object's row and column filtering results are the C_m of the mth layer, so the vertical, horizontal, and diagonal detail coefficients of the m layer can be simply represented by D_m^H, D_m^v, D_m^D . The decomposition of wavelets can also be considered as the decomposition of approximation coefficients. Here you can know that you want to approximate the coefficient and the detail coefficient, you need to wavelet transform the image.

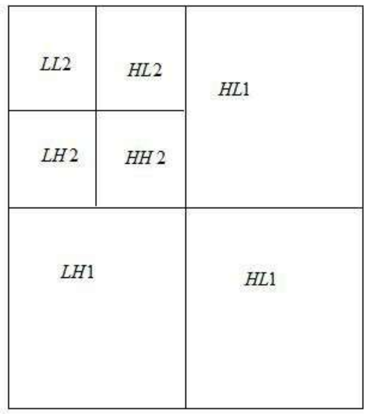

Figure 1. 2D wavelet decomposition map

3. Retinex algorithm

According to the Retinex theory described in the relevant literature, the reflected light imaging R(x, y) and the incident light image L(x, y) can be used to represent an image I(x, y). Show:

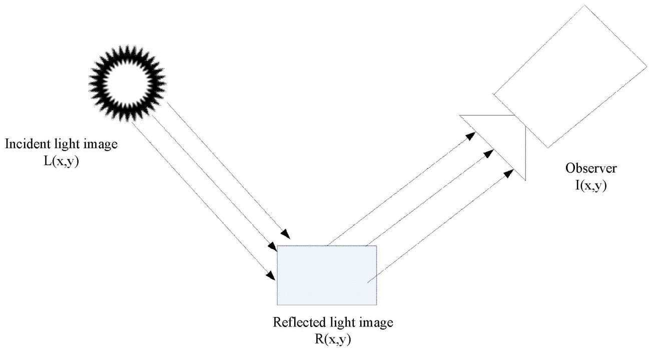

Figure 2. Image imaging diagram of Retinex theory

When the light illuminates the object, it will have a certain reflection. We can understand the formation of the reflection by observing the change of the I(x, y) image. The specific formula can be expressed as follows:

$$I(x, y)=R(x, y) \bullet L(x, y) \quad (1)$$

$$\log I(x, y)= \log R(x, y)+\log L(x, y) \quad (2)$$

Then

$$\log R(x, y)= \log I(x, y)- \log L(x, y) \quad (3)$$

$$R(x, y)=\exp(\log I(x, y)- \log L(x, y)) \quad (4)$$

Multiplication is a relatively complicated method, which is very inconvenient to use in our daily life. If we can switch to the method of addition, we will greatly improve the efficiency of processing in use. At this time, we can use the pair. number.

The operation method is used to change its operation form. In this way, the reflected image R(x, y) of the scene image can be converted into an incident image by using an algorithm, and then the image after the influence of the cloud weather can be obtained, thereby seeing The originally blurred edges or details are clear, and the color of the original picture is not lost in color, which is very similar to the physical picture.

The wavelet coefficient weighting algorithm I have described is similar to this algorithm. It is necessary to divide the acquired initial image into two different components. But Retinex theory is completely different in terms of algorithm processing. One is processing in the spatial domain, and the other is in the frequency domain.

4. Determination of the number of dividing layers

The experimental results show that the processing results of different wavelet functions are almost the same. In the following experiments, we choose the type of wavelet function as sym6'. The selection of parameters is mainly to determine the number of boundaries and weights. When it is necessary to determine the number of wavelet decomposition layers, firstly, the total number of decomposition layers of the wavelet is first. In order to reasonably divide the scene, cloud and background information into low-level, high-level and approximation coefficients as much as possible, the value of the boundary layer l is as small as possible. The big change, for each different l, removes the high-level detail coefficients, saves the low-level detail coefficients and approximation coefficients, and then reconstructs them to evaluate the cloud effect. When the number of dividing layers is small, the detail coefficient contains a lot of scene information, but the information loss is more serious after processing. When the number of dividing layers l increases, the scene information is slowly transferred to the lower detail coefficient, and the cloud noise remains in the high-level detail coefficient. It can be seen that the cloud effect is improved after processing. The amount has also increased. When the number of dividing layers is very large, some cloud noise will remain in the low-level detail coefficient, making the de-clouding effect incomplete, so that information recovery cannot be restored; therefore, it is necessary to select the number of dividing layers when the entropy is maximum.

5. Determination of weight coefficient

In the experiment, the weight of the high-level detail coefficient is first taken as 0. If the cloud noise is not included in the approximation coefficient, the weight is selected as 1, otherwise the constant less than 1 is selected. Here, the weight of the lower-level detail coefficient is mainly studied. The low-level detail coefficient mainly includes scene information, and the weight is set to an amount greater than 1, so that the scene information of the image is highlighted. The higher the frequency of the detail factor, the greater the weight, the more prominent the detail, the higher the sharpness, and the greater the standard deviation and the average gradient. However, if the weight of the selection is very large, the scene will be inconsistent with the original information, and even cause the image to be distorted, so that the information is lost. Therefore, choosing entropy to determine the weight of the lower detail coefficient is the best choice.

6. Homomorphic filtering

When the model parameters and output quantities of the input port change regularly, the principle is represented by a homomorphic filtering system. In the image, a filtering method that can change the frequency, illumination and edge synchronously is based on incident light and reflected light, which is also the basis of an image template. We can find out from the experimental process of the illumination component and the reflection component that the gray scale is a fixed variable, which is mainly a state that the light component often reflects, and the relationship between it and the low frequency information in the frequency domain is equal. of. The gray level of the image can be determined by the degree of change of the incident light. However, the relationship between the reflected light and the edge features of the material is very close, and is the same as the high frequency information in the frequency domain. The level of ability of the image contrast must increase the intensity of the reflected light. In summary, the transfer variable of the homomorphic filter is generally less than 1 or greater than 1. The condition is that the former is in the low frequency range and the latter is in the high frequency range. The process diagram of the homomorphic filtering principle is shown in Figure 3.

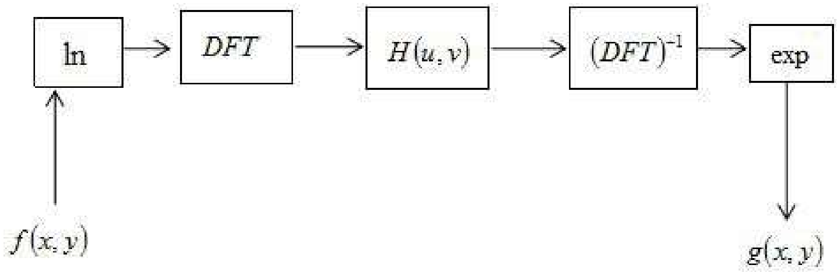

Figure 3. Homomorphic filtering principle process diagram

7. Comparison of different algorithm processing

The remote sensing image is processed according to the above method. The effect shown in Fig. 4 is the comparison of the wavelet coefficient weighting algorithm, the homomorphic filtering and the Retinex algorithm on the parameter changes during the experimental processing analysis. From the data collected by the whole experiment, the wavelet Compared with other algorithms, the coefficient weighting algorithm shows more effective results in cloud processing. It can be concluded from the data analysis in Table 1 that after using the above several methods for image processing, it can be clearly found that the processing result of one of the three images is the best, and the image light is presented. The display is the darkest, and the value of the image entropy is the largest. These two phenomena directly indicate that the wavelet coefficient weighting algorithm is most effective in cloud removal, and it also restores the required information. The result is the best.

(a). Wavelet coefficient weighting (b). Retinex (c). Homomorphic filtering

Figure 4. Comparison of results of various algorithms for processing experimental pictures

Table 1. Comparison of results of various algorithms for processing experimental pictures

Algorithm	Brightness	Contrast	Entropy	Gradient
Original image	104.51	50.38	3.73	9.68
Wavelet weighting	104.41	59.40	3.76	18.47
Retinex	122.81	67.03	3.35	25.85
Homomorphic filtering	145.56	61.25	2.74	17.92

As shown in Fig. 4 and Table 1, the results of the analysis and the experimental operation when comparing the different number of layers and weights of the experimental diagram are respectively determined. For some important parameters, there should be certain results, that is, in the image. The choice of l is 7, the weight of the detail coefficient and the approximation coefficient should be selected as 1.5 and 1, respectively. The result graph and parameters are shown in Fig. 5 and Table 2. It can be seen that the wavelet coefficient weighting algorithm has obvious advantages in remote sensing image defogging.

(a). Wavelet coefficient weighting (b). Retinex (c). Homomorphic filtering

Figure 5. Comparison of various algorithm processing results

Table 2. Comparison of data processing results by various algorithms

Algorithm	Brightness	Contrast	Entropy	Gradient
Original image	99.85	49.87	3.43	2.02
Wavelet weighting	100.74	56.39	3.61	3.89
Retinex	123.20	67.41	3.13	9.32
Homomorphic filtering	143.20	59.21	2.50	6.02

8. Conclusion

This paper expounds the basic theory of wavelet transform, and also analyzes the advantages and disadvantages of wavelet transform. Based on the multi-resolution analysis theory of wavelet transform two-dimensional discrete transform, the algorithm of wavelet coefficient weighted transform is discussed. The homomorphic filtering algorithm and the basic theory of the Retinex algorithm. Based on the simulated images and results, the data is recorded to evaluate the image to cloud effect; and compared with the other two filtering algorithms.

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