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Improved SIFT feature matching

Lifen Li [a], Yu Li [b]

School of North China Electric Power University, Baoding 071000, China;

[a]lilifen70@163.com, [b]kumbaya1@163.com

Abstract

in order to improve the matching rate and detection speed of UAV images, an improved SIFT algorithm, Markov distance and cosine similarity matching algorithm is proposed in this paper. The improved wavelet transform method is used to preprocess the image, the circular neighborhood dimension reduction is used to improve the speed of the algorithm, and the Markov distance and cosine similarity are combined to improve the matching accuracy of the algorithm. The images taken by UAV are collected in the experiment, and the experimental results show that the accuracy and speed of the improved algorithm in the image processing are obviously improved.

Keywords

SIFT ,Wavelet transform, cosine similarity.

1. Introduction

In recent years, the image processing technology related to UAV aerial photography has received the attention of a wide range of scholars, and the image matching technology is the most important link. Image matching consists of 3 steps: etection, description and matching process. SIFT algorithm is a classical local feature matching algorithm. It was put forward by Lowe of Columbia University in 1999 and improved in 2004[1]. However, the SIFT algorithm is too complex, resulting in too slow speed to meet the real-time performance. In reference 2, it is proposed that the dimension reduction can be realized by four concentric ring regions with equal area. The speed of the algorithm is indeed improved, but the accuracy is decreased. In reference 3, a matching algorithm combining SIFT algorithm and Mahalanobis distance is proposed. Although the matching accuracy is improved, it has little effect on the pictures affected by fog. In reference 4, parallax gradient constraint and maximum vector angle criterion are used to achieve accurate matching. Although the matching accuracy is improved, the matching speed is not optimized. Therefore, although there are many matching algorithms at present, they are suitable for none. In this paper, an improved wavelet transform method is proposed to improve the quality of aerial image, feature extraction and matching, which improves the contrast of the original picture, and an improved SIFT algorithm is proposed to improve the speed of the algorithm by using concentric circle region to reduce the dimension, and to optimize the matching process by using cosine similarity and Mahalanobis distance.

2. Image Preprocessing

The two-dimensional image taken by the camera contains all kinds of noise, and when the UAV shoots the scene in the high altitude, it receives the influence of the weather, which leads to the decline of the image quality and brings interference to the subsequent feature point extraction and detection. Therefore, in order to preprocess the original image, an improved wavelet transform method will be proposed to decompose and reconstruct the original image.

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2.1 Improved Wavelet Transform Method

The image quality degradation, contrast reduction, image distortion and gray-white effect can be caused by the weather effects such as distance and illumination of the aerial image taken by the unmanned aerial vehicle.

Considering that the air image feature matching and feature extraction are mainly interested in the target and there are no special requirements for the background, too bright background or too dark image blur are the reasons why the image object is not clear after preprocessing, so wavelet transform is used, and Laplace filter is used for image enhancement in the high frequency part after wavelet decomposition, so that the target and the background can be separated. Finally, wavelet reconstruction will be used to reintegrate the picture. The specific steps of the algorithm are as follows:

The low frequency coefficient and high frequency coefficient are obtained by wavelet decomposition of the image.;

Laplace filter is used to enhance the high frequency coefficient.

carrying out wavelet reconstruction on the processed high-frequency coefficient and the original low-frequency coefficient to obtain a reconstructed image;

The structure obtained by the improved wavelet transform is compared with that shown in Fig. 2 -1 and 2-2. It can be seen that for the target region of interest, the picture obtained is clearer, the contrast is clearer, the noise is less, and there is no phenomenon of too bright or too dark on the target.

The signal-to-noise ratio (SNR) (SNR) of the original image and the image using the improved wavelet transform method are calculated respectively. the results show that the SNR index of the original image is 0.1738, and the SNR index of the original image and the image processed by the improved wavelet transform is 0.2158. The SNR index of the original image is 0.1738, and that of the image processed by the improved wavelet transform is 0.1738.

SNR mainly describes the influence of noise on the image. The larger the SNR value, the smaller the influence of noise on the image and the better the image quality. The results show that the image processed by the improved wavelet transform has less noise and better effect than the original soft and hard threshold image.

Fig 2-1 Original Image.

Fig 2-2 Processed Image

3. Improved SIFT Feature Matching Algorithm

SIFT(scaleinvariational feature transform)algorithm is an algorithm for extracting local feature points of image. An improved SIFT feature matching algorithm is proposed. Since the feature vector generated by SIFT algorithm is 128D and the calculation is complex, the algorithm can not satisfy the real-time requirement of real-time. Matching accuracy. As shown in figure 3 -1.

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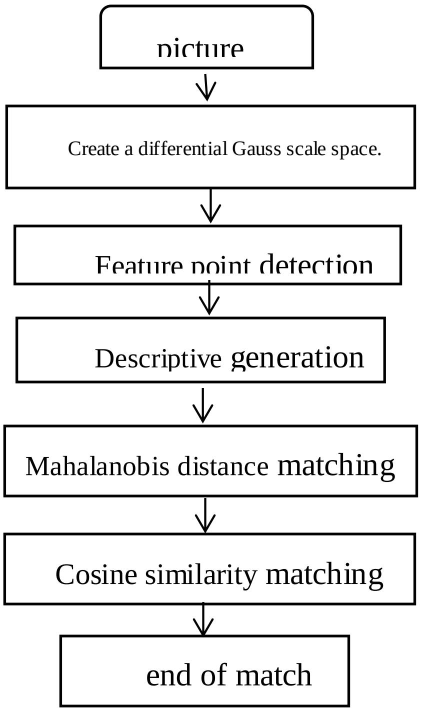

Fig 3-1 Improved Algorithm Flow Chart

3.1 Improved SIFT algorithm

Considering that the SIFT algorithm finally generates 128D eigenvector, the execution speed of the algorithm is too slow, which seriously affects the efficiency and can not meet the real-time requirements. Therefore, this paper improves the execution speed of the algorithm by reducing the dimension of the eigenvector and uses the circular region to expand the neighborhood of the description in order to ensure that the accuracy is not affected. At the same time, the circle itself has rotation invariance, which can accelerate the execution speed of the algorithm without considering the adjustment of coordinate axis. The algorithm is as follows: the window with radius of 10 is taken as the neighborhood range of the feature point, and five concentric circles are divided outward with the radius of 2 pixels. The gradient histogram is used to calculate the algorithm. The accumulated values of the 12 gradient directions of each concentric circle form a seed point and finally generate a 5x12 = 60-dimensional feature vector.

3.2 Feature matching of multiple constraints

In the process of feature point matching, there may be a lot of mismatching points. SIFT's first feature matching using the nearest neighbor algorithm will still give a relative nearest neighbor as its matching point. These matching point pairs are obviously wrong, and the single matching constraint condition is very fragile. Because Markov distance takes into account the size of pattern feature parameters and the correlation between features, its performance is usually better than Euclidean distance in pattern recognition. Therefore, this paper combines Markov distance and cosine similarity to match feature points. Finally, good results are obtained in the experiment.。

For the sample space composed of n points $Z=\{(x_1, y_1),\ldots,(x_n, y_n)\}$, Arbitrary sample point $Z_i=(x_i, y_i)$ to sample mean $\mu=(\mu_x, \mu_y)$ The Markovian distance is defined as ： $MD_i=\sqrt{(z_i-\mu)^T C_Z^{-1}(z_i-\mu)}$ Type center： C_z^{-1} Is a covariance matrix.， μ for the sample mean, the definitions are as follows：

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$$C_z = \left[\sum_{i=1}^{n} \begin{bmatrix} x_i - \mu_x \\ y_i - \mu_x \end{bmatrix} [x_i - \mu_i \quad y_i - \mu_i] \right] / n \tag{1}$$

$$\mu = [\mu_x \quad \mu_y] = \frac{1}{n} [\sum_{i=1}^{n} x_i \quad \sum_{i=1}^{n} y_i] \tag{2}$$

In the matching process, the Markov distance of the feature points is calculated first, and the cosine similarity of the two feature vectors is further judged if the threshold is less than the set threshold. If the cosine similarity is greater than an empirical threshold, the pair of matching vectors are accepted, otherwise the pair of vectors are eliminated.

4. Experimental Results and Analysis

In order to verify the effectiveness of the proposed improved algorithm, the SIFT and the improved algorithm proposed in this paper will be tested in terms of running time, the number of correct matching points and the matching accuracy, respectively. The experimental platform of this paper is to call opencv3,4,2 visual function library, matplotlib drawing library, numpy scientific operation library, TensorFlow deep learning framework for jupyter notebook (ipython),. The running environment is Intel Core i5 ≤ 6500 3.20GHz, memory is 4. GB's 64-bit Windows10 operating system , with the following results

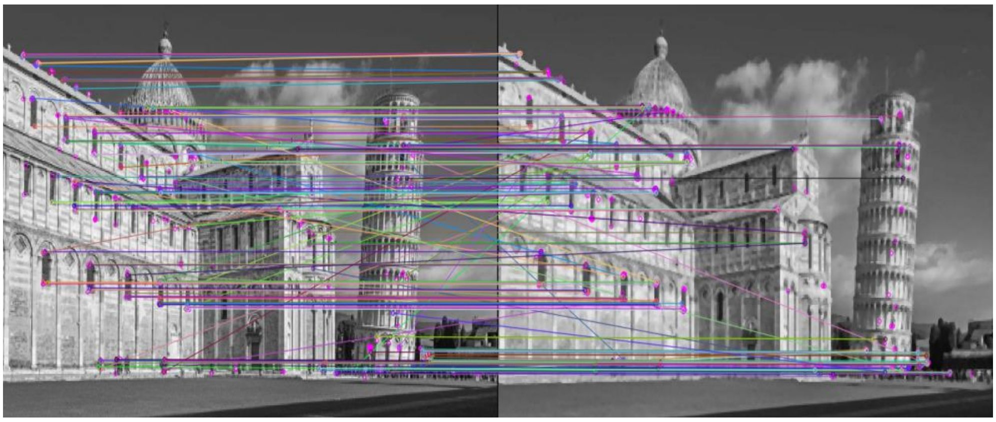

Fig 4 - 1 Traditional SIFT Algorithm

The results of SIFT feature point detection in the figure above can be said to be satisfactory. The left and right two images are producing about 200 key points, but the average time is long and the average time is about 701ms.

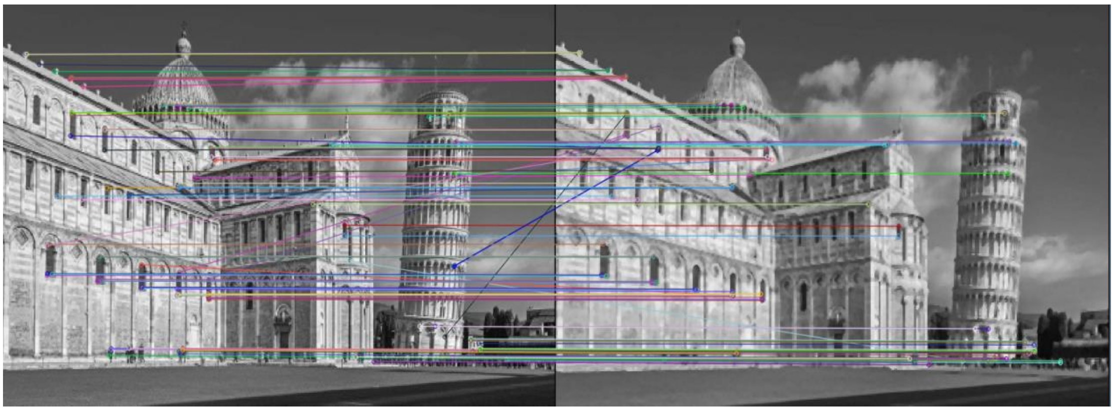

Fig 4-2 Improved Algorithm in this Article

The number of feature points and the logarithm of feature matching are counted, and the results are shown in the table below.

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Table 1 Matching Rate

algorithm	Matching points	Number of correct matches	Matching accuracy
Traditional SIFT	200	174	87.28%
the algorithm of this paper	131	124	94%

After multiple measurements were taken, the average run time was compared and the results are shown in the following table

Table 2 Run Time

algorithm	image preprocessing (ms)	feature extraction (ms)	feature matching(ms)	Total operation (ms
Traditional SIFT	/	376	325	701
the algorithm of this paper	21	212	210	443

It can be seen that the improved SIFT algorithm proposed in this paper can greatly improve the running speed of image matching.

5. Conclusion

The traditional SIFT is satisfactory in terms of the results, but it can not meet the real-time requirements of UAV aerial photography. In this paper, an improved wavelet transform algorithm is proposed to preprocess the aerial image, combined with the improved SIFT algorithm, which uses the circular description region to reduce the dimension of the feature vector, and uses multiple constraints to match the final feature points. The algorithm proposed in this paper effectively reduces the matching time and improves the accuracy of feature point matching.

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