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Research on Workpiece Image Registration based on SIFT Algorithm

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Abstract

With the development of digital image processing and computer vision technology, image registration technology has become an extremely important technology in the field of image processing. In recent years, many scholars at home and abroad have carried out in-depth research on image registration, and proposed a variety of effective image registration methods. The most classical one is scale invariant feature transform (SIFT) proposed by Lowe. SIFT features keep good invariance under the conditions of image rotation, angle transformation, affine transformation and scale scaling. As an important part of image registration, feature matching has always been a hot topic. The main work of this paper is image registration based on SIFT algorithm, which aims to search and match feature points.

Keywords

Sift; Feature descriptor; Image registration.

1. Introduction

With the development of digital image technology, computer vision, as a new field, has been paid more and more attention. As the carrier of visual information, image will gradually expand its proportion in human social life. As a basic problem in image processing, image registration aims to find the optimal geometric space mapping between two or more images with the same target scene under different imaging conditions [1]. The fusion of different image information can better satisfy people's perception and needs of external information. Generally speaking, "registration" is used between two images, and the process of searching for the same feature is called "matching".

Through the registration of two images, multi-mode information fusion becomes possible, which can further obtain the depth of field information from the existing data, monitor the scene changes, and identify and track the dynamic objects. Image registration has important applications in military, remote sensing, image Mosaic, image fusion and artificial intelligence. Because image imaging mechanism is different, however, in the process of image acquisition, illumination and the different Angle of view, and the change of the target itself, resulting in there are great differences between images obtained, for these differences larger image registration, still faces big challenge, not a generic method for all types of image has better matching effect. Most of the current research is still focused on one aspect of the problem, such as a particular type of image. However, it is still a difficult problem to study the image registration with few repetitive regions, large scale variation, brightness variation, image distortion and large noise. To sum up, along with the social development and the progress of science and technology, people rely on image information is more and more big, the processing of image information and processing requirements gradually improve, and image registration as the basis of image processing and processing link, the registration is good or bad directly affect the

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progress of the follow-up work, the different types of image for rapid and efficient registration, became an urgent subject, has great realistic significance and use value[2].

1.1 Research status at home and abroad.

With the development of computer vision technology, image registration technology has developed rapidly in recent years and its application scope has been gradually expanded. Image registration technology originated from the United States in the 1970s. The United States military first proposed this technology in the navigation of weapons and equipment projection. However, due to the United States military's assistance to this project, the image registration technology has made rapid progress. With the progress of science and technology, the acceleration of computer processing speed, image processing technology has been unprecedented development, attracting the attention and attention of many scholars, get rapid development. Zitova divided image registration into two categories in her paper: The first is the region-based image registration method. The second type of image registrationis is based on feature .

1.2 main research contents.

Firstly, this paper studies the basic principle and application of SIFT algorithm and applies it to the workpiece image involved in this paper. Good image registration performance is obtained. The research contents are as follows:

(1) Background and significance of image registration.

(2) Conduct a detailed study on the principle and steps of SIFT algorithm, and conclude the key elements of the realization of SIFT algorithm: key points and feature descriptors. Only when the appropriate key points are extracted and feature descriptors are used to accurately describe the key points can SIFT algorithm play its best role.

(3) Completion of workpiece image registration.

2. SIFT algorithm.

2.1 SIFT algorithm Introduction.

SIFT is an algorithm used to detect local features of images. It is often used in the key step of image feature extraction. By obtaining extreme value points in the DOG scale space and describing these feature points, it can obtain vectors with local features of a set of images with scale, direction and coordinates [3].

For SIFT algorithm, its implementation process is relatively complex. The realization process of SIFT algorithm can be roughly divided into three steps:

(1) find the key points in the scale space and check whether the key points are stable. At the same time, it is necessary to delete some unstable points and points that are greatly affected by the disturbance of edge factors, so as to prevent them from causing adverse effects on the matching.

(2) express the information of the key points found, including the position and scale of the key points.

(3) the last step is image matching. In essence, the feature points with key information are matched. The key points obtained from the two images are verified by some algorithm to complete the image matching.

The basic implementation architecture of SIFT algorithm is shown in figure 1.

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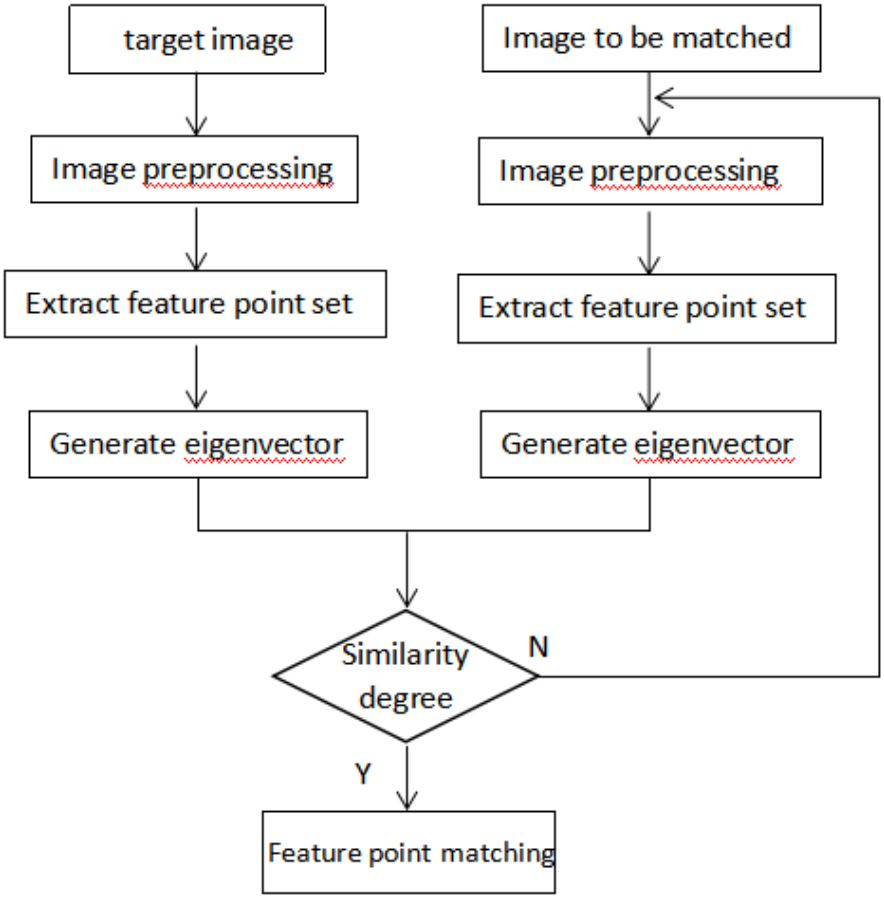

Figure 1 SIFT algorithm basic architecture

SIFT algorithm uses Euclidean distance to match the feature points of image. Although the more number of feature points, the more complete and comprehensive expression of image information, but also improve the probability of error matching, will make the algorithm calculation time increase and operation efficiency reduce, not in line with the actual production requirements of real-time, so it is not necessary to blindly extract a large number of feature points.

SIFT algorithm is a kind of algorithm to extract feature points in an image through scale space, which has nothing to do with the size and rotation of the image, so the extracted SIFT feature points have a good tolerance for image rotation, translation and other transformations.

SIFT algorithm is widely used in target recognition because it can calculate the position and direction of image target through several feature points even in a huge feature database. SIFT algorithm has the following characteristics

(1) It has good uniqueness, and the extracted image feature points have rich information, which has a good effect for a large number of data registration.

(2) Multiplicity, even when there are only a few objects in the image, it can extract a lot of data information of the image.

(3) It has good expansibility, and its input and output parameters and results are diverse, which can be used in combination with other operators.

(4) At the same time, if there is a real-time need, it only needs to optimize SIFT algorithm to meet the requirements.

In the actual image acquisition, there are usually many external interference factors such as mechanical vibration of equipment, different external light, etc., while SIFT algorithm has good robustness for the following situations: (1) translation and rotation of the target; (2) change of environmental light; (3) noise, etc.

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2.2 SIFT algorithm in detail.

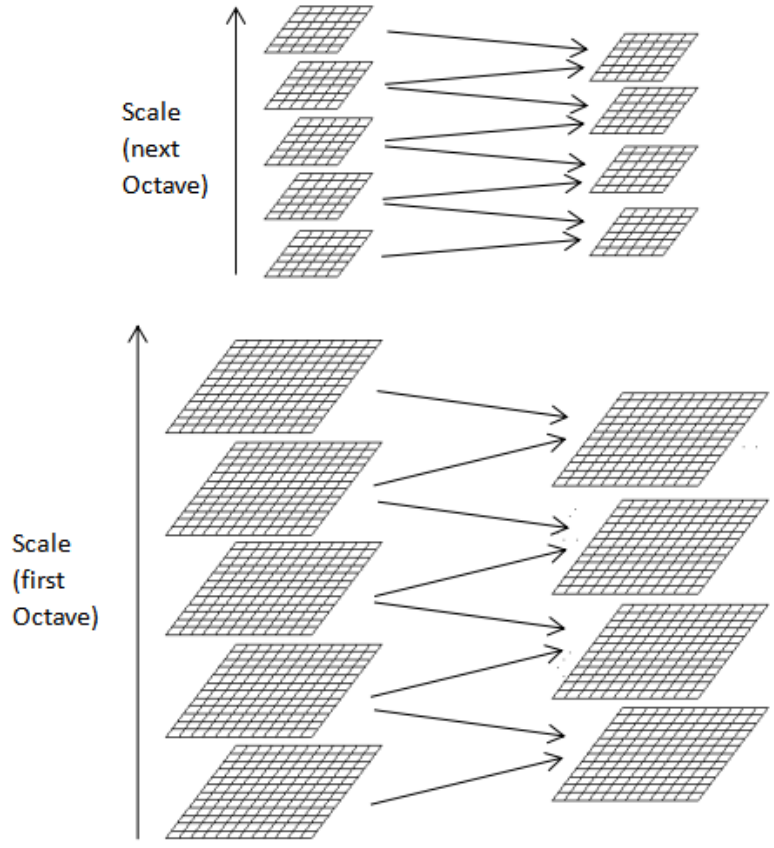
2.2.1 The gauss difference scale space is established

The basis of scale space is to introduce the concept of scale to get images at different scales, and then find out the more representative features in the images. Images at different scales correspond to different image sizes and sharpness, which is very similar to the difference caused by distance changes when people observe things with their eyes. The distance corresponds to the scale. If you look closely, you can find detailed information about things; if you look far away, you can grasp the overall information of things [4].

The gaussian kernel can generate a unique kernel in multi-scale space. The gaussian convolution kernel is used to define the scale space of a two-dimensional image, as shown in equation (2-1).

$$L(x, y, \sigma) = G(x, y, \sigma) * I(x, y) \tag{2-1}$$

When we need to get a difference image, we need to subtract different images, which is essentially subtracting two adjacent layers of images from each group in the gaussian pyramid. The diagram is shown in figure 2.



a) Gaussian b) DOG

Figure 2 Gauss pyramid generation diagram

2.2.2 Feature point detection

After the construction of the gaussian pyramid, the next step is to detect the feature points in the gaussian difference pyramid, and the feature points are also partial extremum points, so it is also to find the extremum points. According to the content of section 2.3(1), gauss pyramid is located in a three-dimensional space (two-dimensional plane image plus the group of image dimensions to form a three-dimensional). The retrieval of extremum is carried out in scale space. All pixel sampling points in the image need to be compared with 8 adjacent points in the image of its own layer and 9 pixels in the corresponding upper and lower two layers of the image, that is, a total of 26 pixels need to be compared to determine their size, so as to ensure the accuracy of the monitoring points. Figure 3 shows the retrieval method of extremum points.

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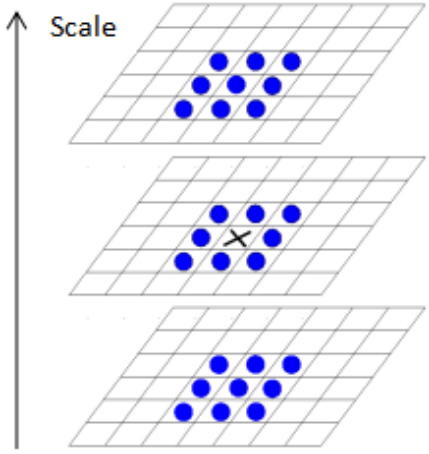

Figure 3 Gaussian difference space extremum point retrieval method

2.2.3 Feature location

Because the extremum is detected in a discrete space, it is not continuous, so it cannot be located, then we need to use the method of sub-pixel interpolation to calculate the actual extremum.

In the calculation of DOG operator, the stability of feature points is enhanced due to its strong edge response. In addition to eliminating the low contrast points, it is also necessary to find the edge extreme value points and eliminate them. Generally, the improper edge points are removed by Hessian matrix, and the stability of the point is determined by calculating the principal curvature of the detected points [5].

2.2.4 Distribution of feature points

For SIFT algorithm, it is because of the existence of the main direction that it has a strong tolerance for image rotation, because the main direction is fixed, will not change due to the rotation of the image. The pixel gradient and direction near the key point can be expressed by formula (2-2) as follows:

$$m(x,y)=\sqrt{[L(x+1,y)-L(x-1,y)]^2+[L(x,y+1)-L(x,y-1)]^2}$$
$$\theta(x,y)=\arctan\frac{L(x,y+1)-L(x,y-1)}{L(x+1,y)-L(x-1,y)} \quad (2\text{-}2)$$

At this time, the gradient and direction information of all pixels around the key point has been obtained after calculation, and then it is represented by statistics. The key point has 360 degrees in a week. If all directions are counted, the calculation will be multiplied. Therefore, the statistics are simplified and divided into 8 directions every 45°[6]. See figure 4.

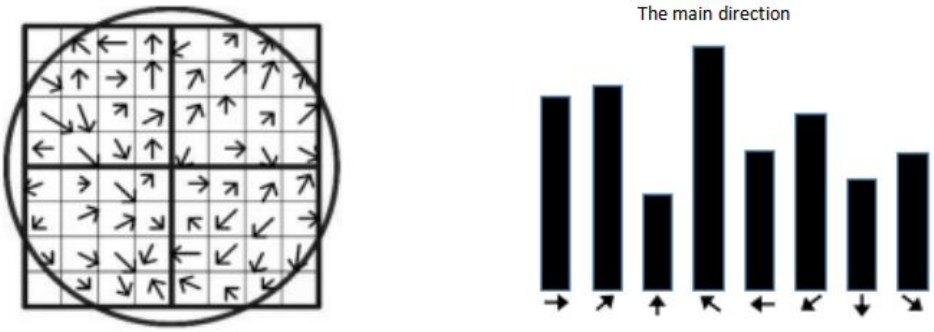

Figure 4 Key point direction histogram

2.2.5 Eigenvector descriptor generation

After the above calculation steps, an image feature point with scale, position and direction can be obtained. The next step is to describe all the feature points obtained, including the key points and the

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information about its nearby points. It is the only abstract description of the local information of the image. The generation process is as follows:

(1) determine the description area. The description area determines the impact rate of nearby pixels on the key point. SIFT takes an area of size and divides it into uniform subareas.

(2) rotate the main direction to the coordinate axis. This step is to make the feature descriptor rotationally invariant to the image.

(3) direction gradient of subregion. Each region point of the 16 sub-regions has 8 directions, and the weighted accumulation of the gradient can reach the neighborhood gradient direction diagram as shown in figure 5.

Through the above three steps, a key point with dimensional feature description vector is generated, which contains the gradient size and direction information. At the same time, in order to not be affected by changes in light, alignment must be normalized.

3. SIFT algorithm to achieve image registration

3.1 Hardware and software platform.

Hardware platform: the experiment in this paper was carried out on shenzhou notebook, Intel core i5-8250u processor, frequency 1.80ghz, memory 8GB, graphics card for NVIDIA Geforce.

Software platform: Win10 operating system, the programming software used for MatlabR2018b.

3.2 Image registration.

Two network reference images are adopted, with certain rotation Angle and certain registration difficulty.The reference figure is shown in figure 5.

Figure 5 Reference figure

SIFT was used to find all the feature points of the two images. See figure 6.

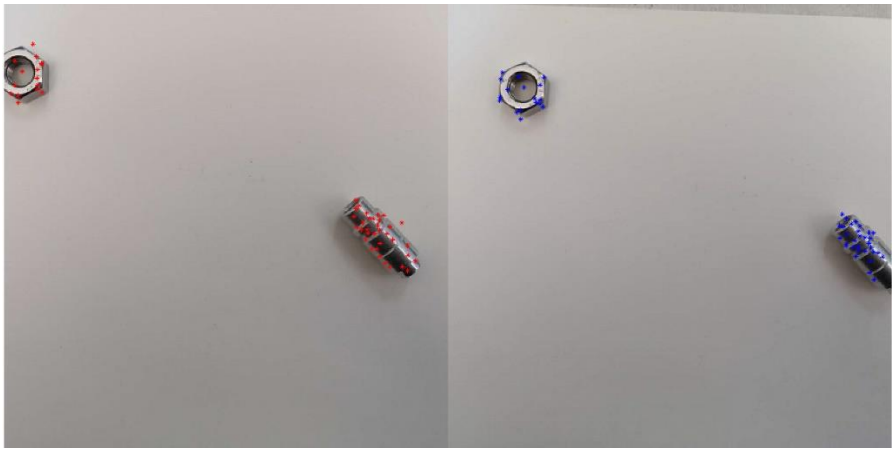

Figure 6 Feature point display

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Next is the feature point wiring diagram.See figure 7.

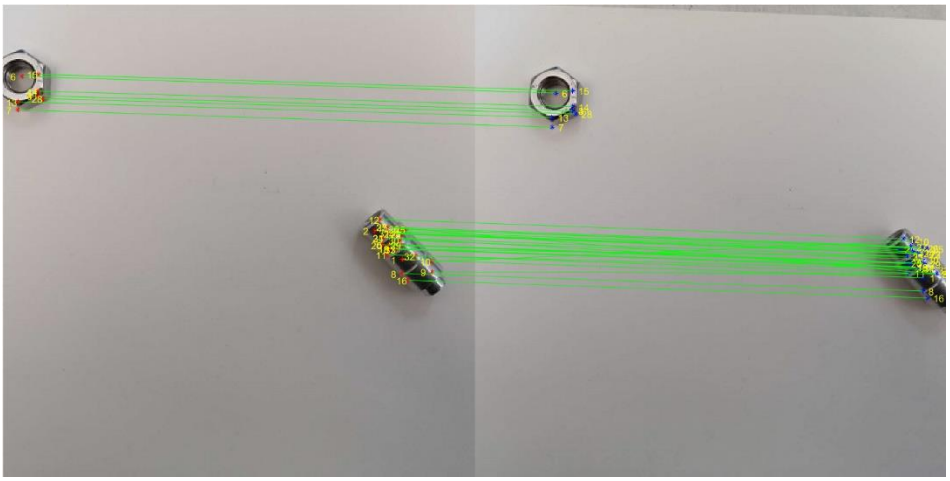

Figure 7 Feature point wiring diagram

Among them, there will be wrong feature point line. figure 8 shows SIFT matching feature points that can be used as registration control points after screening.

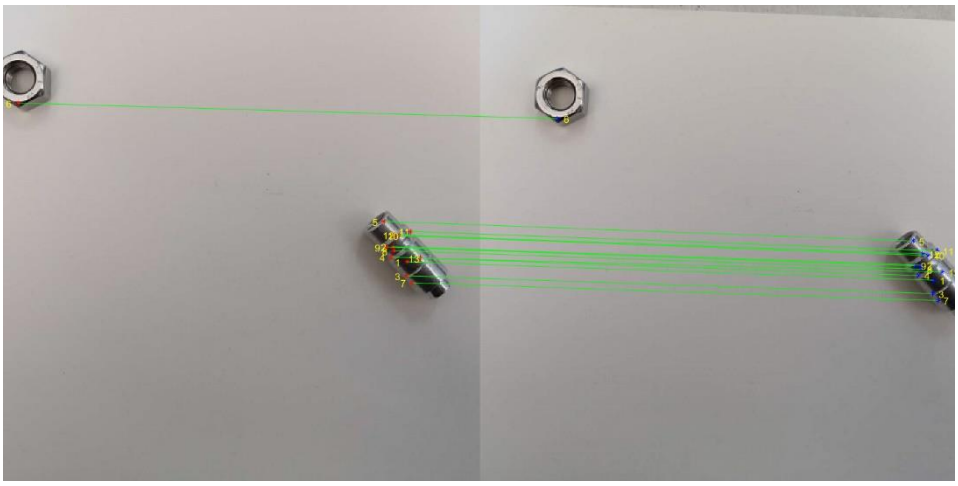

Figure 8 The filtered matching results

The final image after registration is shown in figure 9.

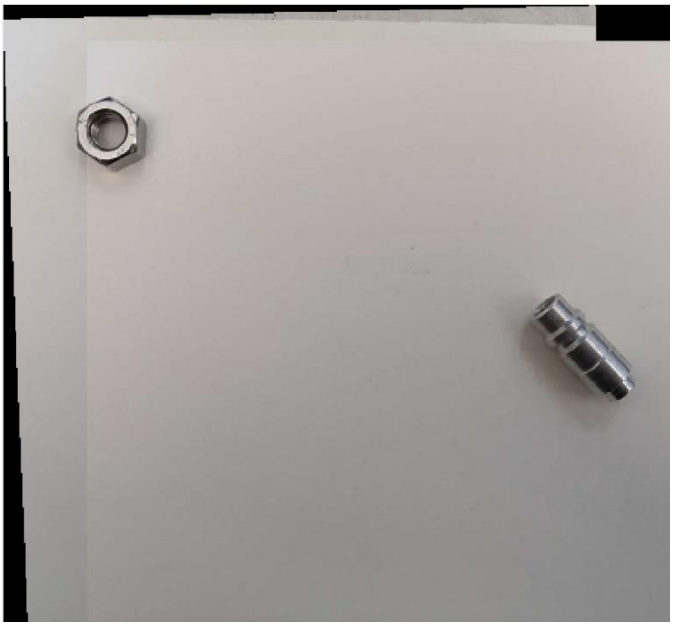

Figure 9 The image after registration

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4. Summary

Image registration technology has become a research hotspot in the field of image processing in recent years. It is the basic problem of image processing and the key to image Mosaic, fusion, 3d reconstruction, navigation and tracking. In recent years, many domestic and foreign scholars have done a lot of work around image registration, and put forward a variety of efficient image registration methods. The main work of this paper is to use SIFT algorithm to complete the registration of 2 images.

The main contents of this paper include the following points:

(1) the research background and domestic and foreign research status of image registration are introduced in detail

(2) the SIFT algorithm principle and implementation steps are discussed in detail.

(3) complete the image registration process.

In this paper, SIFT algorithm is studied in detail and used to complete image registration. In order to better image registration, there are still many problems to be solved. For example (1) how to reduce the dimensionality of SIFT, it is known that the reduction of dimensionality will greatly reduce the running time. (2) if the dimension is reduced, will it lead to the inaccuracy of the descriptor? And so on are to be discussed and studied in the future.

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