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Study and Implementation of Image Stitching Based on SIFT Algorithm

Xiaolei Yu, Zhenyu Yi, Erjuan shang, Peijiang Chen*

School of Automobile, Linyi University, Linyi, 276000, China

Abstract: **Along with the development of the field of image processing, the demand to obtain wide visual angle and high resolution image is constant and growing, the technology of image stitching is important and used widely. The existing stitching algorithms are analyzed, and the characteristics of SIFT algorithm is introduced. By using the feature points extraction and matching operation ability of SIFT, it can find stable critical points. According to the feature points matching of SIFT, the image stitching can be realized. Through the analysis of the experiment, the reliability and stability of the image stitching method are verified which can be used in many fields.**

Keywords: Image stitching; SIFT algorithm; Image matching; Visual angle

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*Corresponding Author: Peijiang Chen

1. Introduction

With the popularization of digital camera equipment, digital image has been applied in many research aspects. In many scientific research projects, the high resolution images over human vision are often used. Owing to the limit of distance, some very large objects cannot be photographed with a photograph. So people proposed image stitching technology, ordinary images were seamless stitched to get ultra wide viewing angle and even the panorama, so that ordinary camera can be used to achieve a wide field of view of the scene to get a wide view of the scene image. Image stitching technology in the field of virtual reality, computer vision, computer graphics and image processing has important value and has a great application prospects and practical application value.

About the image stitching methods can be broadly divided into the method based on model, the method based on transform domain, gray correlation method and the method of characteristics. How to improve the efficiency of image stitching, reduce processing time and enhance the adaptability of the stitching system is always the focus of the study.

The research work of this paper is mainly aimed at the research of image matching and fusion technology for image stitching [1]. The existing matching algorithms are introduced. By comparing the existing algorithms, image stitching algorithm based on the SIFT algorithm is selected. Using this algorithm and the weighted average algorithm can realize the image stitching [2], splicing process and results are analyzed and the existing problems are analyzed.

2. Image stitching based on SIFT algorithm

2.1. The method of image matching

1) The Method Based on Gray Level Information

Image registration method based on gray image uses the gray information of the image [3]. According to the corresponding relation model, each pixel is transformed into corresponding points, and the parameter values of the transformation model which makes the similarity evaluation function value reach the extreme value can be found using a specific method of search. This method does not need image segmentation and feature extraction, which has high precision and good robustness. But the method is very sensitive to the change of the gray level, and it doesn't make full use of the characteristics of the gray level statistics and relies heavily on the gray level information of each point.

2) The Method of Transform-domain

Phase correlation method is a classical method of image registration based on transform-domain. By using the method of Fourier transform, the image is transformed from spatial domain to frequency domain. The method of transform-domain has the characteristics of non-sensitivity to noise, high computational efficiency, mature fast algorithm and easy hardware implementation. In general, this method can provide a good initial registration parameter for image stitching.

3) The Method Based on Image Feature

The method based on image features, first of all, processes the registration of two images and extracts the specific feature set which meets the requirements of the application. These features are used as the control structure to find the mapping relationship between the two images control structures. After feature extraction the number of feature points will be greatly reduced, so it can improve the speed of registration, but the registration results largely depend on the extraction accuracy of feature point and the accuracy of the feature points matching. Feature point extraction methods mainly have Harris corner detection algorithm [4] and SIFT algorithm [5].

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Harris corner detection method is widely used in the matching based on image features. The method has the characteristics of high registration accuracy, small amount of computation and no limitation of image rotation angle. But there are also some shortcomings, when the information of image edge is less, it can not get the desired effect. The characteristic points of the two images are scanned in the scale space and the color difference space using the SIFT algorithm based on scale invariant feature transform. Through the performance of the Laplacian pyramid, the interference of scale transformation can be removed and the key points in the image displacement are locked down. According to the main direction of the neighborhood gradient this point in the direction of the information can be represented. The key points of SIFT standard size can be born into. Finally, this rule can be used to match. The simulation selects a method based on the characteristics of the SIFT algorithm to achieve image stitching.

2.2. SIFT algorithm

This subject adopts Scale-invariant feature transform (SIFT) algorithm, it is an algorithm used to detect and describe the local characteristics of the image in computer vision, find the extreme points in scale space and extract the location, scale and rotation invariant.

The description and detection of local image features can help identify the object and the SIFT feature is based on local interest points on the object and has nothing to do with the size of the image and rotate. For light, noise and some visual angle change, the toleration of this algorithm is quite high. Based on these characteristics, they are highly significant and relatively easy to capture, it is easy to identify objects and there is a little mistake in a large database of features. Using the SIFT feature descriptor, the detection rate of partially obscured objects is very high, only 3 or more SIFT objects are needed to calculate the position and orientation of the object. Under the condition of the current computer hardware speed and the small characteristic database, the speed of identification is closed to the real time operation. SIFT features of large amount of information is suitable for rapid and accurate matching in the massive database.

The performance of image registration, target recognition and tracking is influenced by the characteristics of the target's own state, the environment of the scene and imaging characteristics of imaging equipment. In a certain extent, the SIFT algorithm can solute several problems, such as rotation, scaling and translation of the target, image affine transformation, projection transformation, light effect, occlusion, noise, and so on.

3. Image stitching technology overview

Image stitching is mainly composed of four steps: image acquisition, geometric correction, image registration and image fusion. The stitching process is shown in Figure 1.

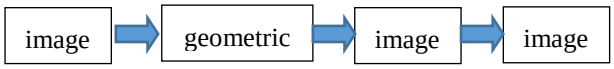

Figure 1. The process of image stitching.

Image acquisition is a method to obtain the scenery or scene image, the method should be used as far as possible for helping generate the final image. Image geometric correction is the image geometric operation, shape and spatial position of object can be changed in the image. Image registration is a key step in image stitching. In this step, the point-to-point mapping relationship between different views in one scene should be calculated, which is often called as the "Corresponding transformation", these transformations can be expressed as translation, rotation, affine and projection. Finally, in order to improve the visual effect of image rendering, the image need smooth processing, which is called as image fusion. Namely, smooth function is used to remove the overlap of regional gap in image synthesis. To sum up, each link in the image stitching is contacted closely and influenced each other. A good image stitching system can integrate various technical aspects, improve the efficiency of image stitching, reduce processing time and enhance the adaptability of stitching systems according to the actual application.

3.1. Image acquisition

For the image processing system, image acquisition is the first step. In practical applications, designing an image acquisition system with high performance cost ratio is cared by people. The rotation, shake and exposure time of the camera can not be ignored, and photos should be scanned by the scanner to be used for image processing, which will bring a certain amount of noise and image distortion, directly affecting the rest of the link. The application of digital camera can improve the image resolution, image quality and receive easily by computer, which reduces the possibility for introducing the noise and image distortion.

The different method of image acquisition can cause the difference of inputting image directly, the stitching results and the follow-up algorithm are also different. Image acquisition decided on camera state. Generally, there are three cases [6]:

(1) Rotating camera shoot by using a tripod
(2) Panning shoot by using of special devices
(3) Taking pictures by hand hold

3.2. Image noise suppression

Image noise can be understood as a variety of factors that interfere with people's visual perception, which also can be understood as the deviation between the real signal and the ideal signal. Generally speaking, the noise is unpredictable random signal, which usually uses the method of probability and statistics to analyze. Noise is very important on the image processing, which affects all the part of image processing, especially in the input image. Noise

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suppression is a key problem in the collection. If the input is accompanied by a large noise, it can affect results on the image stitching processing and output.

Noise suppression methods mainly have the following [7]:

1) Mean Filter

Mean filter is actually used to replace each pixel value in the original image with the mean. The mean filtering method is a way that selects a template which is composed of a number of pixels adjacent, and the value of the pixel can be replaced with the mean of the pixels in the template.

2) Median Filter

Median filtering is a processing technique based on the order statistics theory, sorting data in the template is its core algorithm. If there was a noise in the dark spot, there will be ranked in the process of the most right or left of the data sequence. The final data sequence is generally not noise values, so the purpose of noise suppression can be achieved.

(a) Image a (b) Image b

Figure 2. The original image.

3.3. Image registration

Image registration is the key technology of image stitching. The image registration is a processing that can determine the transform parameters between images according to some similarity measures, two or more images which were gotten in same scene from different sensors, different perspectives or different times are transformed to the same coordinate system to get the best matching on the pixel layer [8]. There is a difference from acquisition of images by different sensors or the same sensor at different times, different viewpoints. Therefore, it is necessary to process image registration before image fusion for eliminating the differences between the fused images. Accuracy of image registration directly determines the results of image fusion quality.

3.4. Image fusion

In some cases, due to the shooting time according to the environmental conditions, vision, location of the difference, the two images to be stitching overlap area may have a greater difference. If the images are superimposed simply, stitching plots obtained in the stitching position will exist obvious seams and phenomenons of fuzzy and distorted overlapping regions. In order to obtain seamless high clear image, the appropriate fusion strategy must be selected. Fusion strategy choice should meet two requirements: the collision boundary transition should be smooth, split seam should be eliminated; the information of the original graph should be tried to ensure no loss.

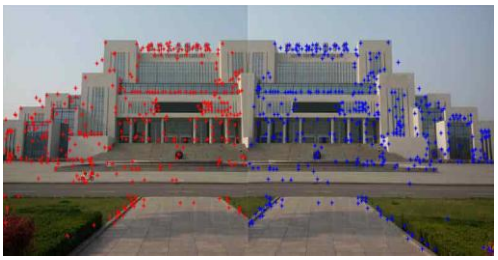

Figure 3. Image corner detection.

4. Experiment of image stitching

4.1. Implementation of image stitching

The experiment of the image stitching is implemented based on the MATLAB platform, the M language programming of this platform could be used to create a model and construct image signal processing system. Using the SIFT algorithm to find the feature points of interest in stitching images and further filtering out more stable key points of interest, through the weighted average algorithm the panorama can be completed.

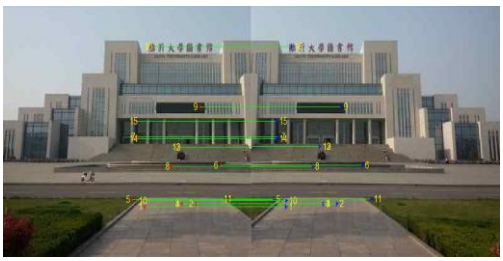

Figure 4. Image strong feature points matching.

The experimental process and results are shown as follows, stitching effect is good, the picture of the synthesis is clear, the result is in line with the expected requirements.

The pictures of this experiment were taken by the rotation of camera; the two images are collected shown in Figure 2. The image corner detection result is shown in Figure 3. Matching the original image a and b, and taking strong feature points, the result is shown in Figure 4. Image stitching result is shown in Figure 5.

4.2. Results analysis

The experimental results show that the stitching process of the SIFT algorithm based on the feature points is completely automatic, and the effect is ideal. Due to the unique advantages of the SIFT algorithm, it can also maintain a reliable performance and good compatibility in some conditions such as radiation transformation, perspective transformation and noise interference. However, this method also has the shortcomings of false matching, and several tests show that SIFT algorithm is very strict for requirements of feature points. The error rate of picture of the poor

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sampling is higher, sometimes artificial treatment is needed to achieve the desired results.

Figure 5. Results of image stitching.

5. Conclusion

The whole process of image stitching based on SIFT can be fully automated and the timeliness is high. Drawing out the key points which have the characteristic of scale invariant is the core content of SIFT algorithm, then the fitting of 3D quadratic function is used to lock the displacement of key points accurately, the low contrast feature points and the large floating on the edge responses points could be strictly eliminated. This idea can effectively overcome the displacement of traditional image stitching, angle of view and the light under the condition of large amplitude change constraints. Although the SIFT algorithm has the advantages of scale invariant features, but it is still flawed. In future applications, it is still necessary to improve the algorithm in order to obtain more accurate and stable high-resolution images.

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