TELKOMNIKA, Vol.12, No.4, December 2014, pp. 839~846
ISSN: 1693-6930, accredited A by DIKTI, Decree No: 58/DIKTI/Kep/2013
DOI: 10.12928/TELKOMNIKA.v12i4.303

Research on Image Splicing and Fusion Processing Algorithm in Large Visual Field

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Abstract

To obtain wide area and a large field of view image, splicing and fusion algorithm is presented. Single image is preprocessed by utilizing rough matching algorithm, which can narrow down the matching range to improve the speed and precision of image stitching and fusion, at the same time, Single image is preprocessed by filter processing algorithm, which will reduce interference noise, improve SNR and enhance the effective character information of image; the best matching position is found by using a combined splicing algorithm, which are ratio template matching algorithm and template matching algorithm, and the images are spliced at the best matching position; we take the neighborhood weighted average fusion algorithm to eliminate the distinct splicing trace. The captured images are processed by using correlation algorithm, a large field of view and high quality image is obtained. The experimental results verify the validity of the algorithm.

Keywords*: image splicing algorithm, image fusion algorithm, template matching, image processing*

1. Introduction

In the process of obtaining information, vision is a reflex which is most intuitive, most complete and most accurate about the surrounding [1]. The informations obtained by vision occupy most of the capturing information. However, in many cases, human beings cannot directly have the access to the information of the surroundings by themselves. As a kind of choice, it can be achieved by capturing image. The acquisition of image needs the help from optical system. In order to gain higher quality image and more actual surroundings, the capturing image need to be processed by some image processing. The image processing technology has been used in many fields, just as, we can test the leakage of pipeline and fix the position of leakage by image processing technology; and using image processing technology, the plate number of the running car on the road will be get by; and some tiny components can also be recognized, ect [2].

In order to get the optimal effect of vision, image acts as the transition media of vision, we need image which can reflect actual surroundings. Under a series of practical engineering background, one image which can reflect actual surroundings not only bases on the used optical system, but also the subsequent image processing technology for original image [3]. Acting as the transition media of vision, the image should have rich content and large field properties, only the iamge meets these demand, we can get more view, which will help us to obtain interesting things. But due to the single camera deficiency, single camera has limited field of view [4]-[5], we cannot see overall view from one camera. Panoramic image, just like our visual effect, cannot be obtained through one shoot. To overcome the shortage, multiple cameras are placed at different locations covering the entire field containing the effective information to obtain a large field of view image [6]. The all cameras can gain a group of images, and there is overlap among these images. Via image splicing, we can stitch the overlap among these images and finally fuse into a large field of view and complete new image, which contains all information from the group of images. Image fusion enhances the visual aspect of image which lay the foundation for human beings to access more effective information.

Received August 27, 2014; Revised October 14, 2014; Accepted October 29, 2014

2. Image preprocessing algorithm

2.1 Rough matching processing

In the image acquisition processing, there will be dislocation phenomenon in many images [7]-[8], so it is necessary to calibrate image. We should identify the location of the feature region of the two images and calculate the coordinate difference in the feature region between two images. According to coordinate difference, we adjust captured images and prepare for the following image splicing and fusion [9].

Because the optical parameters of the camera are constant, there are some correlation on the overlap proportion among the captured images and the similarity among the pixels [10]-[11]. Based on the correlation, we can estimate and locate roughly the location of the overlap among the series of images, which can narrow down the matching range to improve the speed and precision of image stitching and fusion. The schematic diagram of rough matching as shown in Figure 1.

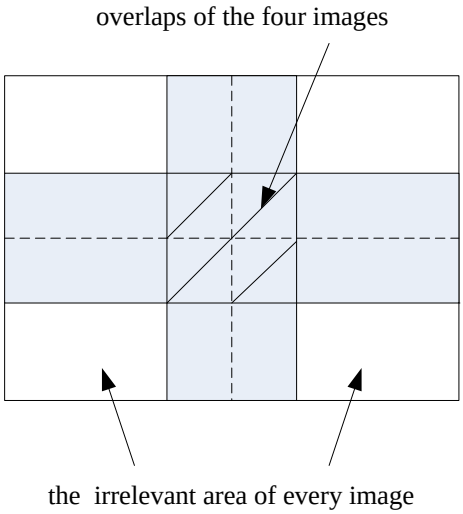

Figure 1. Schematic diagram of rough matching

2.2 Filter processing algorithm

In the image acquisition process, It is inevitable that there will be many different sorts of noise and distortion and also accompanying with reduction of contrast, which will lead to effective information in the image were reduced. The image quality will directly affect the algorithmic validity and accuracy of subsequent image stitching and fusion [13]. If we stitch and fuse the images which were directly collected by camera, we often cannot get the desired result. So we need to preprocess the collected images by reducing interference noise, improving SNR and enhancing the effective character information of image.

The median filtering is a nonlinear signal processing technology based on the order statistical theory, it can effectively suppress the noise, which is a typical nonlinear spatial filtering technology [14]. The median filter can protect well the signal details while removing noise. It also can remove singularities in gray image. When the isolated noise exists in images, which means the number of pixels occupied by the isolated noise is small and the number of pixels occupied by target is large. Under the circumstances, it is suitable to use the median filtering [15]. This paper uses the median filtering to suppress background and enhance the target, making the outline of the image clearer to improve the quality of the image. That will be conducive to further search for the matching location.

3. The Image Splicing Algorithm Results and Analysis

3.1 Ratio Template Matching Algorithm

In order to get a large field of view image, we need to establish visual correlation among the images which were acquired by cameras placed at different locations. Via matching principle, we should com-pare the level of similarity between the target area and the same size area from the different search area in images, then we need to identify the position, where is the highest level of similarity. The position viewed as the best splicing position [8]. Selecting two images from the images captured by cameras, then two sets of pixels were selected at intervals of a certain distance in horizontal direction, which is in the overlap of the first image. The gray ratio values of the two sets of pixels will be used as the reference template, and the best matching position from the overlap of the second image was searched. Because the gray values of some area in different images are close, if the reference template was selected improperly, it is easy to match wrongly. The key point to avoid wrong matching is how to select effective information, in the meantime, reduce the interference. The concrete implementation steps as shown in Figure 2.

As shown in Figure 2, *Imagea* and *Imaged* are the independent areas without overlap. Imageb and Imagec are the overlap between *ImageA* and *ImageB.*

Step 1, We select two sets of continuous four columns of pixels in the *Imageb*, and the interval value between the two sets of pixels is *D.* The gray ratio values of the two sets of pixels is a unit, we make the unit to be template *B*.

Step 2, Beginning the left side of the Imagec, similar to step 1, we select two sets of continuous four columns of pixels, the interval value between the two sets of pixels also is *D*. we make the new gray ratio values unit to be template *C1*.

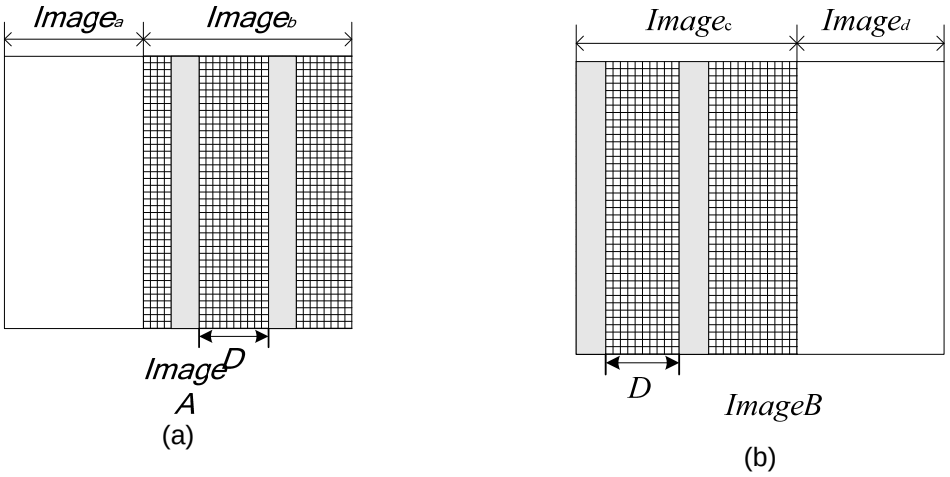

Figure 2. Schematic diagram of ratio template matching algorithm

Step 3, the absolute difference value about template *B* and template *C1* is calculated, which is viewed as template *M1*. We can obtain the column vector summation of the template *M1*. And then we can obtain the evaluation function *XS1* which is gray similarity between the templates *B* and *C1.*

Step 4, the two sets of the pixels from the step 2 were moved respectively, the movement is from left to right a column in horizontal direction. We obtain the new pixels, similar to step 2, a new template *C2* was obtained. We can calculate template *M2* and the evaluation function *XS2* which is gray similarity between the templates *B* and *C2*. In the same way, the pixels were kept moving from left to right in horizontal direction, then we obtain two sets of new templates and the evaluation function, which are *Ci*, *Mi* and *XSi*(i=3,4,...).

Step 5, If the gray similarity level of the two images is high, the value of the evaluation function is small. We need to find the minimum of the evaluation function *XSmin* and the

coordinates of the minimum (x,y). The coordinates position is the best position to splice *ImageA* and *ImageB*.

The advantage of the ratio template matching algorithm is simple and practicable. The speed of the algorithm is fast. But the algorithm will lose efficacy when the black pixels was found in the template. However, the template matching algorithm has wide usage. We can find the matching point exactly by this algorithm. In this paper, we combine the ratio template matching algorithm and the template matching algorithm to accomplish the image matching. We use the template matching algorithm when there are some black pixels in the image.

3.2 Template Matching Algorithm

In template matching algorithm, we need to select the designated requirement effective information in the first image, these information contain typical regional characteristics, it is just like shape, texture, color and so on. We get the mathematical description of these parameters, using the correlation theory to search and compare different areas in the second image. The pixels correlation of the two images is low, The lower the pixels correlation of the two images, the lower level of similarity of the two images. The schematic diagram of template matching algorithm as shown in Figure 3.

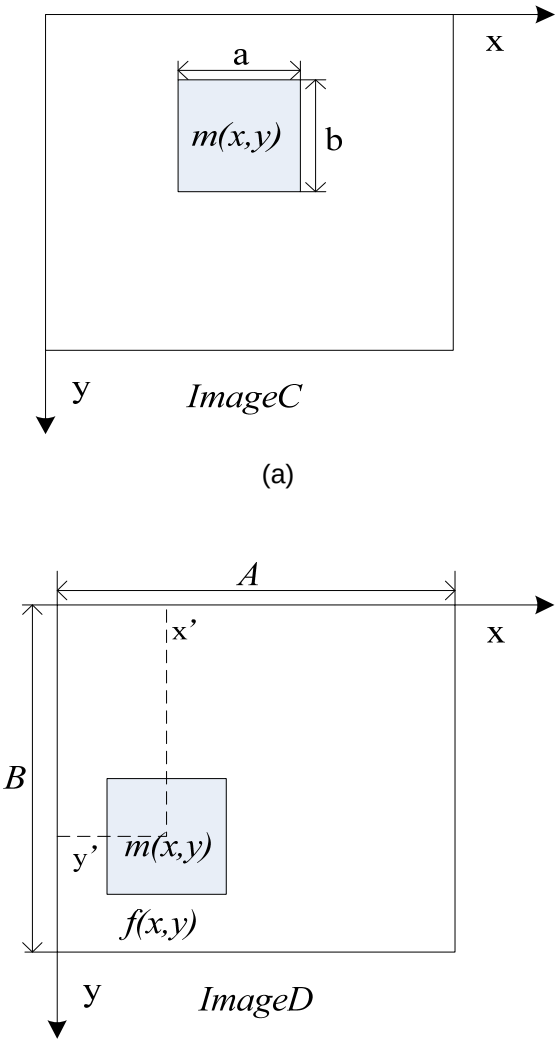

Figure 3. Schematic diagram of template matching algorithm

The concrete implementation steps described below:

First, the suitable template m(x,y) is selected in ImageC. The suitable reference template is conducive to reduce calculation of the template matching algorithm [16], which can improve the matching speed. The selected template must be validity and difference. We must ensure accuracy and the feature information from original image is presented reliably, in addition, the template feature must be distinct different from the other areas of the image [17], it is better that the correlation between the template and the rest part of the image is low.

Second, template parameter was set. We determine the size of the template m(x,y), which is a×b（unit：pixel）. And the first pixel coordinate of the template is (x,y).

At last, the process to search and match. The similarity is only part of the two images, so there are four directions to use the template to match the second image, the moving directions of matching template start at the top-left, top-right, bottom-left and bottom-right. The template approaches the second image by the four directions. Using these approaching directions is conducive to reduce the probability of wrong and omissive matches [18]-[19]. Take starting at bottom-left matching as an example, as shown in Figure 3, *imageD* is motionless and its size is A×B. The template approach to the *imageD* starting at the bottom-left and move to right in horizontal direction. We calculate the correlation of the different overlap, the function is shown:

$$H(x',y') = \sum_x \sum_y \left| f(x+x', y+y') - m(x,y) \right| \quad (1)$$

In formula (1), $x' = 1,2,...,A-a$, $y' = 1,2,...,B-b$. We can obtain the function $H(x',y')$ value by the formula (1) when any position in the image *D* is given. When the value of x' and y' have been changed, we can obtain the whole $H(x',y')$ value by the moving of the template *m(x,y)* on the *imageD.*

4. The Image fusion algorithm

In the image splicing processing, based on above splicing algorithm, we obtain the best matching position. If we only overlap two images at the best matching position, we will find distinct trail in two images across position. This will affect the image qaulity.

To eliminate this kind phenomenon, we use smoothing algorithm to dispose it. In reference [18], Shum.H Put forward that the central region of overlap is viewed as smooth transition region. Weight is viewed as the distance between the overlapping pixels and the boundary. Then the gray value is disposed smoothly by mathematical operation, which also can solve the pixels incoherence problem effectively. The pixel values in splicing position are distinct different from around pixel values. To protect most image details, this paper uses the neighborhood weighted average fusion method to dispose the distinct splicing trail.

We select one pixel *Q1(x,y)*, which is located in Image1 and is not located in the overlap between Image1 and Image2, just like Imagea in figure 2. Keeping the pixel value *Q1(x,y)*, we can get formula (2):

$$Q(x,y) = Q_1(x,y) \quad (2)$$

Likewise, another pixel is located in *Image2* and is not located in the overlap between *Image1* and *Image2*, just like Imaged in figure 2. Keeping the pixel value *Q2(x,y)*, we can get formula (3):

$$Q(x,y) = Q_2(x,y) \quad (3)$$

When the pixel is located in the overlap between *Image1* and *Image2*, the formula is shown as below:

$$Q(x,y) = \kappa \times Q_1(x,y) + (1-\kappa) Q_2(x,y) \quad (4)$$

In formula (4), κ is the gradient factor, in the overlap, according to the direction from Image1 and Image2, the κ value changes from 1 to 0. We can accomplish smooth processing of overlap between two images by using the above algorithm. To achieve ideal smooth processing effect, three conditions: (1). The intermediate gray state should keep drab smooth change in the gradual process. (2). The border curve of the intermediate gray state should try to maintain smooth. (3). Characteristics of target should be kept in the gradual process, no other extraneous features are found.

5. Image processing results and analysis

This paper uses Matlab software as the image processing platform. Firstly, the four captured images are disposed respectively As shown in Figure 4, due to the limited field of view of the camera, The whole scene cannot be obtained by only one image. We need to splice and fuse four images to get the whole scene. We use a pixel as a unit, the original image size are all 756×458.

Firstly, doing image preprocessing for four original images to reduce noise and improve SNR. We use median filtering to restrain background and enhance the effective information characteristics in the images, which can improve the quality of image and prepare for the following image splicing and fusion. In the image splicing processing, based on above splicing algorithm, we obtain the best matching position.

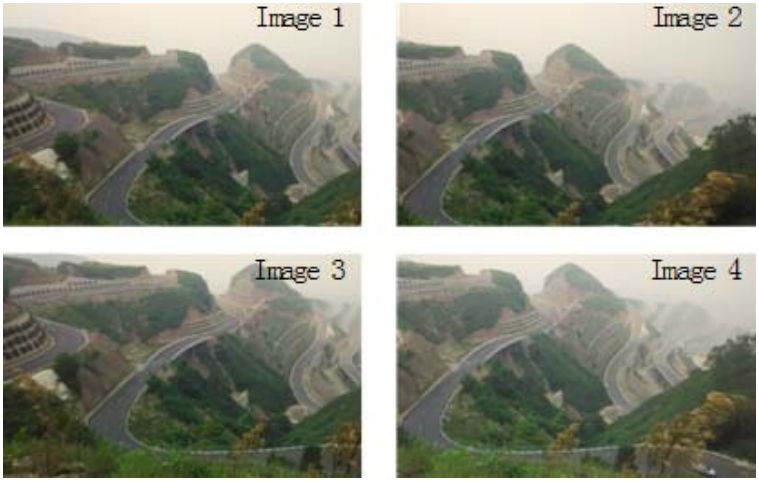

Figure 4. Four original images

As shown in Figure5, the *Image5* is spliced by processed *Image1* and *Image2*, the *Image6* is spliced by processed *Image3* and *Image4.* We can see the distinct trail in two images across position. In order to eliminate the distinct splicing trace, it is necessary to smooth the overlap of image. The image result using the splicing and fusion algorithm is shown as Image7 in Figure 6, the size of the Image7 is 925×522.

(a) (b)

Figure 5. Splicing images by processed original images

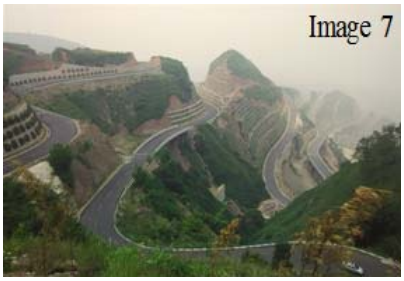

Figure 6. Panoramic image without splicing trail

In the Figure 5, we can see that anyone of two images contains more information than anyone from four original images, the splicing algorithm makes the image richer, but the splicing trail on the images is very distinct. To eliminate splicing trail, we use smoothing algorithm to dispose it in this paper. The result is shown as figure6. After a series of processing, the *Image7* has been enhanced in the visual. The more complete and rich content can be reflected in the Image7, which is conducive to extract the effective information in the large field of view image.

6 Conclusions

This paper uses splicing and fusion algorithm, which provides the theoretical basis and implementation method to obtain a large field of view image. In the splicing and fusing processing for many images, firstly, we estimate roughly the range of the overlap, which is based on the physical structure of acquisition system. The rough estimation can reduce the time for subsequent matching. We use a combined splicing algorithm of ratio template matching and template matching in this paper, which effectively avoids the failure of the algorithm. The amount of effective feature information of template is increased; we can get the best matching position by the introducing similarity evaluation function. Finally, we dispose the splicing trail by using the weighted average method of fusion algorithm, the image transition is nature, which is fused into a large field of view image, and the image contains all information from the four images. The experimental results show that the algorithm is reasonable and feasible. Image fusion enhances the visual aspect of image; the experiment has achieved good results.

Acknowledgements

This work was partially supported by Ph. D. Programs Foundation of Ministry of Education of China (20100201110031), National Natural Science Foundation of China (61105126 &60875043), and Special Foundation of President of Xi'an Technological University (XGYXJJ0524).

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