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Objective Quality Evaluation of Stitched Images Based on Information Entropy

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Abstract: In the process of image stitching, the image quality will decrease. In order to quantitatively analyze the stitching quality of stitched images, an objective quality evaluation algorithm based on information entropy is designed. Based on the structural similarity parameter analysis, this algorithm completes the parameter adjustment by comparing and analyzing the structural similarity between images. The experiment analyzes the image information entropy under different dislocation conditions. The results show that the algorithm can effectively suppress the information entropy after image stitching. In the objective evaluation, the gray mean and standard deviation are better than the traditional stitching algorithm, which verifies the superiority of the algorithm.

1. Introduction

Piecing together many related images with narrow viewing angles into a panorama without gaps and wide viewing angles is called image stitching [1]. Because the public's requirements for images with a wide field of view are increasing, the configuration equipment can only obtain a relatively small observation range. In order to make the field of view larger, a wide-angle equipment can be selected, but it has the disadvantage of reducing the resolution and losing part of the image content. The image connection operation is easy to understand, and the resolution is not small. It is widely used in some modern fields, such as VR, smart car driving, satellite remote sensing, hospital institutions, and health environments [2,3]. Matching images and fused images are roughly two components of stitched images. When the images are ready to be matched, there may be ghosting in the panorama image because the estimated homography matrix is not accurate [4]. The fusion image is mainly to solve the phenomenon that the brightness and exposure are different between the images during the connection process [5]. Panorama images sometimes produce "stitching seams" because of errors in the stitching of the images.

The degree of image stitching technology applied in computer vision is generally related to the quality of the stitching [6,7]. There are two main ways to judge image quality: subjective and objective. A mathematical model is constructed through the subjective sensory system of the human eye, and the quality of the image is measured and estimated by a real formula, which is an objective evaluation method. Using SSPA as a basis, HS Qireshi et al. proposed to use a similarity index to evaluate the spliced images, which is derived from the information of the original image and the concatenated image. Induction is not so sensitive, and the results obtained are sometimes different from subjective evaluation results, because the situation of distortion noise is more severe at this time [8]. Debabrata proposes to use several metrics to evaluate the quality of the stitched images [9]. The four common ways to measure the quality of stitched images are mutual information, mismatch percentage, average difference in pixel size, and highest point value. However, these four methods cannot accurately evaluate the quality of the image after splicing, nor can they quickly identify the two major influencing factors, which produce splicing errors.

Based on the evaluation of image quality, this paper proposes an information entropy connection image evaluation method (IEDG) [10,11] based on image difference, which can accurately judge the quality of the stitched image. Compared with SSPA, It can better and more sensitively identify ghosting and connection gaps.

2. Evaluation of Image Stitching Effect

In this paper, the Structural Similarity Parameter Analysis Algorithm (SSPA) is adopted, which imitates HVS in the part of punching structural errors, but its effect is not good because it is less sensitive to the surrounding information of a real image. Algorithm to achieve measures:

2.1. Excavate the Appearance Data of the Original Image

This is to compare the degree of deviation and the degree of light and shade between the original image and the connected image. It is necessary to perform grayscale processing on both and collect their foreign trade data.

There are three components R, G, B, and each component has 256 assignments. When the image displays color, each pixel is determined by R, G, and B, so there are more than 16 million color transformation forms. The depiction of a grayscale digital image is the same as that of a color image, which still shows the layout and characteristics of all and part of the color saturation and brightness of the whole image. The convenience of using grayscale processing is to reduce the amount of calculation for the next task. In this paper, the method of weighted arithmetic average is selected to implement grayscale processing, and its expression is:

$$f(i,j) = 0.5R(i,j) + 0.6G(i,j) + 0.2B(i,j) \tag{1}$$

In the formula, f(i, j) represents the grayscale value presented by the pixel whose coordinate is (i, j), R(i, j), G(i, j) and B(i, j) phase Corresponds to the value of the three components presented by the pixel point whose coordinates are (i, j).

In order to explore the surrounding data of the image, this paper selects the Sobel algorithm, which is easy to meet the requirements in space, the effect of noise on it is relatively small, and the detection of surrounding contour information also has good results, which can provide relatively accurate surrounding information.

2.2. Create a Difference Map

The difference map is to make the change of the image intuitive and obvious, and the corresponding pixels of the two images are made difference. It can excellently represent the difference between the original image and the spliced image, and can detect the difference in the degree of deviation and the degree of light and shade. In the operation, Gaussian smoothing is used to process the image, which is to reduce the influence of noise. Gaussian filtering is suitable for reducing Gaussian noise, which is linear and smooth, and is commonly used in image processing to reduce noise. In simple terms, this filtering is a process that performs weighted average processing on the whole image. After the weighted average is implemented, the pixel value can be obtained, which is each of the whole image and other points in its surrounding range. numerical value. After smoothing, the difference image can be obtained by performing absolute difference between the original image and the surrounding data of the spliced image.

2.3. Calculate the Information Entropy of the Difference Map

The difference map pixel data is judged. There is a relationship between the diversity of the data presented by the difference map and the quality of the mosaic. The diversity of the data presented by the difference map can be represented by the information entropy of the image. Information entropy represents the average amount of data about the image. It measures the amount of information in the image from the perspective of information theory. The high value of information entropy in the image represents the huge amount of information covered in the image, because the information entropy can be weighed by the direction of information theory. The number of data contained in the image. The information entropy of the difference graph can be expressed as

$$H = \sum_{i=0}^{255} p_i \log\left(p_i\right) \tag{2}$$

In the formula (2), the grayscale value of the pi representative image is the proportion held by the pixel of i, which can be expressed by the grayscale histogram.

The information entropy of the difference map and the difference between the degree of splicing deviation and the degree of light and dark are shown in Figure 1. With the increase of the degree of deviation and the degree of light and dark, the information entropy first begins to increase, and then gradually stabilizes. The peripheral contour data of the image is very important for the eyesight sense, especially the orientation information of the peripheral corners. The human eye can easily detect that the orientation of the peripheral corners has changed, and the human eye is not sensitive to the changes in the brightness and darkness. It can be seen from the figure that the degree of deviation is different from the degree of light and shade, and the information entropy changes rapidly with the growth of different levels, which is in line with the subjective judgment and evaluation of people, and can be used to evaluate the quality of the splicing.

3. Experimental Test and Analysis

The deviation degree error and the difference in light and shade are the two main factors that affect the quality of image stitching, which makes the stitched image more likely to have ghosts and stitching seams, which reduces the reliability of subjective vision. The simulation compares the different position deviations of the three algorithms, which are the IEDG algorithm, the traditional SSPA algorithm and the information entropy algorithm in this paper. It is proved that the method of IEDG objective discriminant assessment can deal with two situations, one is the degree of deviation, and the other is the difference of the degree of light and dark.

When testing the degree of deviation, the assembled picture will be exactly at the middle point, and the horizontal direction will be separated to two different SSPAs in the same direction, and the deviation will be from - 12 to 12. The simulation results of the three methods for evaluating the mosaic are shown in Figure 1.

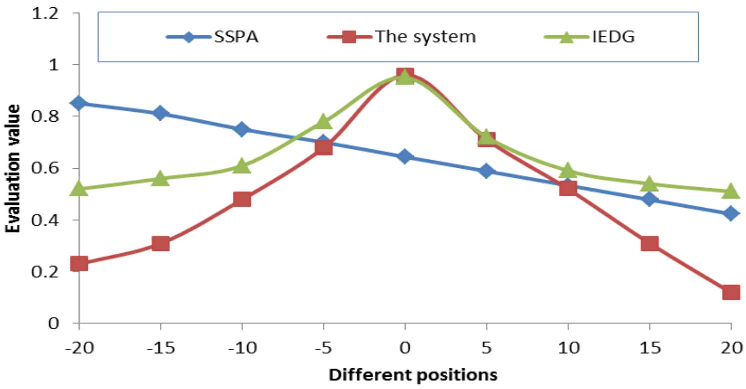

Figure 1: Evaluation results under different position deviations

Judging from human subjective experience, a small degree of splicing deviation error has little effect on the quality of splicing. When the deviation error reaches a certain level, the reliability of splicing will be reduced intuitively; When the deviation error is higher than a certain amount, it can be regarded as the reliability of splicing is extremely low, and when the degree of deviation becomes larger, the reliability of splicing cannot be affected. The corresponding objective discriminant results show stable changes.

It can be seen from Figure 1 that in the splicing images with different dislocation degrees, the difference in the discrimination results of the information entropy is small, which indicates that the information entropy evaluation method is not sensitive in the evaluation of the dislocation factor, and is not suitable for evaluating the spliced images. The evaluation results of SSPA show that in the case of deviation of 1-2 pixels, the stitching effect will be greatly reduced; With the increase of the degree of misalignment, the evaluation value of the SSPA method gradually slows down, and the score difference is not large, which cannot be accurate. When the dislocation is severe, the SSPA evaluation value is maintained at 0.5 or higher, which is moderate and inconsistent with the subjective sensory evaluation. According to the discrimination results of IEDG, when the error is less than 1 pixel, the evaluation effect is stable, and when the error is within 1-6 pixels, the evaluation effect is significantly reduced; When the error is greater than 6 pixels, the evaluation effect is The evaluation effect no longer decreases significantly, but gradually becomes stable. Comparing with the above two common Angfa, it can be seen that the information entropy algorithm used in this paper has better error redundancy.

4. Image Objective Evaluation and Analysis

(a) SSPA (b) IEDG (c) Information entropy

Figure 2: Images before and after optimization by information entropy classification algorithm

The dislocation in Fig. 2(a) is more different from the brightness; The brightness in Fig. 2(b) has an appropriate amount of difference, and there is a small part of inconsistency; There are some deviations in Fig. 2(c), and the brightness deviation is small. Due to the lack of a perfect benchmark image, the combination of point signal-to-noise ratio analysis and structural similarity cannot be used to evaluate the index, so the evaluation index without reference image quality is selected.

As can be seen from Figure 2 (a) - (c), the SSPA algorithm will generate standard deviations and gradients due to excessive enhancement when processing high-brightness images. The results show that the SSPA algorithm compares the three images, and obtains the actual measurement index after processing the three images and the average index change rate of the original image. The results show that the standard deviation of the three images obtained by the SSPA method is higher than the original result. It has increased by 108.51%, and the average gradient has increased by 156.36%, but the imaging quality is not very good, especially in the enhancement of the field map, the standard deviation has increased by 202.81%, the average gradient has increased by 592.85%, and the information entropy has increased by 57.42%; The standard deviation of the IEDG algorithm is relatively large due to "phagocytosis" and local oversaturation. Through calculation, the average standard deviation and average gradient of the three graphs obtained by the IEDG algorithm are increased by 113.34% and 156.38% respectively, and the information entropy is reduced to 2.97%. The standard deviation and mean gradient are growing too much. There is a build-up of pixels, a "swallow" of grayscales, and a localized darkening of the wheel. The standard deviation is used to measure the degree of dispersion between the gray level and the average gray level. A large standard deviation value can improve the imaging reliability of the image. However, some images with too sufficient gray levels and very concentrated gray levels also have higher standard deviation values, thereby affecting the details of the image. The main reason is that both IEDG and SSPA will be affected in the grayscale processing of equalized images, which is caused by their grayscale distribution characteristics. The comprehensive evaluation shows that the comprehensive image quality of the stitched image optimization algorithm based on information entropy is better than other methods, and it is consistent with the subjective evaluation results.

5. Conclusions

Aiming at the imaging quality evaluation of spliced images, this paper proposes an information entropy evaluation algorithm based on the difference graph structure. First, the gray edge features between the original image and the spliced image are analyzed, and then the difference image is calculated. Finally, the information entropy is used to complete the image analysis, objective evaluation. Simulation analysis and experiments show that this algorithm has better positional deviation redundancy effect than the common stitched image quality evaluation algorithms IEDG and SSPA.

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