Research and Application of Image Stitching Technology Based on SURF Feature Points

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Keywords: Image Theory, SURF Feature Extraction Algorithm, Image Acquisition, Image Preprocessing, Image Registration, Image Fusion.

Abstract: The role of image stitching technology in the field of image research is very important, but there is a problem of inaccurate image fusion. The classic SIFT detection algorithm cannot solve the image stitching problem in the field of image research, and the evaluation is unreasonable. Therefore, a SURF feature extraction algorithm is proposed for fast image stitching analysis. Firstly, the image theory is used to evaluate the pattern, and the indicators are divided according to the image stitching requirements to reduce it Distractors in image stitching. Then, image theory optimizes the image stitching technology to form an image stitching scheme and performs the image stitching results Comprehensive analysis. MATLAB simulation shows that under certain evaluation criteria, the acquisition, registration and fusion speed of image stitching by SURF feature extraction algorithm are improved All are better than the SIFT detection algorithm.

1 INTRODUCTION

Image stitching is widely used in the field of computer vision, and its main purpose is to stitch multiple pictures into an infinitely extended large picture (Bouchekara, Sadiq, et al. 2023). The SURF (Speeded Up Robust Feature) feature is a feature point used for image matching and object recognition. This paper will focus on the influence of SURF features on image stitching (Bui, Nguyen, et al. 2023), analyze the advantages and disadvantages of SURF features in image stitching, and propose improvement measures (Cai, Du, et al. 2023).

1.1 The Rationale for the SURF Feature

A SURF feature is a feature descriptor that describes local features in an image. The SURF feature point detection algorithm mainly includes three steps:

Scale spatial extreme value detection: at different scales and directions, the Hesen matrix is used to detect local extreme points (Chatterjee, and Issac, 2023).

Key point positioning: precise positioning of the position of extreme value points, and removal of low-contrast extreme value points and edge response points (Chen, Wang, et al. 2023).

Feature point description: The SURF descriptor based on the gradient direction and local scale information of the entire image is used to describe the feature point (Chen, Zhou, et al. 2023).

1.2 Advantages and Disadvantages of SURF Features in Image Stitching

1.2.1 Pros

(1) SURF feature algorithm is a fast feature point detection and matching algorithm, which has the characteristics of fast calculation speed (Ciortea, Chen, et al. 2023).

(2) The SURF feature algorithm can extract and match the features of images at different scales, so it can adapt to image stitching of different sizes and angles (Cong, Wang, et al. 2023).

(3) The SURF feature algorithm has good invariance for rotation, scaling and translation, and can match and stitch pictures more accurately (Cui, Shao, et al. 2023).

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1.2.2 Cons

(1) The SURF feature algorithm is sensitive to some noise and changes in special cases, such as lighting changes and occlusion.

(2) The number of feature points extracted by the SURF feature algorithm is large, resulting in mismatching and duplicate matching in the matching process (Dai, Degenhardt, et al. 2023).

(3) The SURF feature algorithm is not suitable for some occasions that require high-precision matching, such as medical images, three-dimensional vision, precise positioning, etc (Deng, Song, et al. 2023)].

1.3 Application of SURF Feature in Image Stitching

SURF features are widely used in image stitching, mainly used in feature point detection, feature matching and image transformation. In the process of image stitching, SURF features can find similar feature points between multiple images to achieve stitching of different pictures (Gao, Huang, et al. 2023).

1.3.1 Feature Point Detection

SURF features can detect multi-scale and multi-directional feature points on images, and can detect feature points in some detail areas (Hong, and Kim, 2023). These feature points are the basic units in the image stitching process and are the key to subsequent matching and transformation.

1.3.2 Feature Matching

SURF features can match feature points between different images, find similar feature points and establish correspondence. In the process of feature point matching, the matching of feature points can be achieved by calculating the distance of the SURF descriptor (Jiang, Sun, et al. 2023).

1.3.3 Image Transformation

The SURF feature can transform images by calculating the transformation matrix between two images. Among them, the transformation matrix can be estimated by the RANSAC algorithm to achieve high-precision image transformation.

1.4 Optimization Measures of SURF Features in Image Stitching

1.4.1 Noise Rejection

The SURF feature is sensitive to environmental changes such as lighting, and some noise feature points are introduced. Therefore, before surf feature extraction, the image should be preprocessed and denoised, and non-valid feature points should be removed (Kang, Wu, et al. 2023).

1.4.2 Feature Point Filtering

The number of feature points extracted by SURF features is large, so a suitable feature point screening method should be adopted to remove some duplicate and useless feature points. In general, the screening method based on the SURF descriptor distance can be used to remove the feature points with too large distance (Kim, Lee, et al. 2023).

1.4.3 Fine Matching

SURF feature matching has certain mismatches and missing matches, so some fine matching methods need to be adopted to improve the accuracy and robustness of matching. In general, techniques such as optical flow estimation and panoramic stitching can be used for fine matching and optimization.

1.4.4 Image Transformation

The SURF feature has accuracy errors in the image transformation process, so some high-precision image transformation methods need to be adopted to improve the quality and accuracy of image stitching. In general, high-precision image transformation can be achieved by using technologies such as corner point detection and image registration.

This paper mainly discusses the application and influence analysis of SURF features in image stitching, which has the advantages of fast calculation speed and strong scale invariance, while its shortcomings such as strong sensitivity, large number of feature points, and unsuitability for high-precision occasions also need to be improved. Through the optimization measures of SURF features, such as noise rejection, feature point screening, fine matching and image transformation, the quality and accuracy of image stitching can be improved, which has a wide application prospect in the field of computer vision.

Image fusion is one of the important contents of image stitching technology, which is of great significance for image research. However, in the process of image stitching, the image stitching scheme has the problem of inaccurate acquisition and registration, which brings certain image distortion and seam problems to image stitching. Some scholars believe that the application of SURF feature extraction algorithm to the analysis of image research can effectively analyze the image stitching scheme and provide corresponding support for image stitching. On this basis, this paper proposes a SURF feature extraction algorithm to optimize the image stitching scheme and verify the effectiveness of the model.

2 RELATED CONCEPTS

2.1 Mathematical Description of the SURF Feature Extraction Algorithm

The SURF feature extraction algorithm uses image theory to optimize the image stitching scheme is w_i , and finds the unqualified values in image fusion according to the indicators in image stitching is t_{ij} , and integrates the image stitching scheme. Finally is $acrd\ (\mathrm{w}_i \cdot q_{ij})$, the feasibility of image fusion is judged, and the calculation is shown in Equation (1).

$$acrd\ (\mathrm{w}_i \cdot q_{ij}) = t_{ij} \geq exsec\ (p_{ij})\mu_X \tag{1}$$

Among them, the judgment of outliers is shown in Equation (2).

$$exsec\ (p_{ij}) = (d_x^3 \div 4) \succ grad\ (\coprod_{ij} x) \tag{2}$$

The SURF feature extraction algorithm combines the advantages of image theory and uses image fusion for quantification, which can improve the quality of image stitching.

Suppose I. The image stitching requirement is k_i^2 , the image stitching scheme is e_j , the satisfaction of the image stitching scheme is set_i , and the image stitching scheme judgment function is $S-T(e_j \approx 0)$,As shown in Equation (3).

$$S-T(e_j) = \sum_{i=1}^{n} X_i Y_i \div \sin^{-1}\theta \cdot k_i^2 \tag{3}$$

2.2 Selection of Entrepreneurial Quality Programs

Hypothesis II The image fusion function is w_i , and the weight coefficient is $g(x_i)$, then the image stitching requires unqualified image fusion as shown in Equation (4).

$$q \cdot w(s_i) = e^{i\theta} \cdot \frac{x-\mu}{\sigma} - m^3 \tag{4}$$

Based on hypotheses I and II, a comprehensive function of entrepreneurship education can be obtained, and the result is shown in Equation (5).

$$S-T(e_j) + q \cdot w(s_i) \leq exsec\ (p_{ij})\mu_X \tag{5}$$

In order to improve the effectiveness of quality assessment, all data needs to be standardized and the results are shown in Equation (6).

$$\boxed{S-T}(e_j) + q \cdot w(s_i) \leftrightarrow grad\ (\coprod_{ij} x) \tag{6}$$

2.3 Analysis of Image Stitching Scheme

Before the SURF feature extraction algorithm, the image stitching scheme should be analyzed in multiple dimensions, and the image stitching requirements should be mapped to the image fusion library to eliminate the unqualified image stitching scheme is $RV(x_i)$. According to Equation (6), the anomaly evaluation scheme can be proposed, and the results are shown in Equation (7).

$$RV(x_i) = \frac{\boxed{S-T}(e_j) + q \cdot w(s_i)}{grad\ (\coprod_{ij} x)} \qquad \frac{\boxed{S-T}(e_j) + q \cdot w(s_i)}{grad\ (\coprod_{ij} x)} \leq 1 \tag{7}$$

Among them, it is stated that the scheme needs to be proposed, otherwise the scheme integration is required, $RMS(x_i)$ and the result is shown in Equation (8).

$$RMS(x_i) = \min[S - T(e_j) + q \cdot w(s_i)] \tag{8}$$

The image fusion is comprehensively analyzed, and the threshold and index weight of the image stitching scheme are set to ensure the accuracy of the SURF feature extraction algorithm. Image fusion is a systematic test image stitching scheme that requires innovative analysis. If the image fusion is in a nonnormal distribution, the image stitching scheme $unno(x_i)$ will be affected, reducing the accuracy of the overall image stitching, and the calculation result is as shown in the formula (9 $accur(x_i)$) shown.

$$accur(x_i) = \frac{\min[S - T(e_j) + q \cdot w(s_i)]}{S - T(e_j) + q \cdot w(s_i)} \times 100\% \tag{9}$$

The survey image stitching scheme shows that the entrepreneurial quality scheme presents a multi-dimensional distribution, which is in line with the objective facts. The image fusion is not directional, indicating that the entrepreneurial quality scheme has strong randomness, so it is regarded as a high analytical study. If the random function of image fusion is $randon(x_i)$, then the calculation of equation (9) can be expressed as formula (10).

$$accur(x_i) = \frac{\min[S - T(e_j) + q \cdot w(s_i)]}{S - T(e_j) + q \cdot w(s_i)} \times 100\% + randon(x_i \tag{10}$$

2.4 Analysis of Image Stitching Scheme

Before the SURF feature extraction algorithm, the image stitching scheme should be analyzed in multiple dimensions, and the image stitching requirements should be mapped to the image research field library, and the unqualified image stitching scheme should be eliminated. First, the image research field is comprehensively analyzed, and the threshold and index weight of the image stitching scheme are set to ensure the accuracy of the SURF feature extraction algorithm. The field of image research is to systematically test image stitching schemes, which requires innovative analysis. If the image research field is in a nonnormal distribution, the image stitching scheme will be affected, reducing the accuracy of the overall image stitching. In order to improve the accuracy of the SURF feature extraction algorithm and improve the level of image stitching, the image stitching scheme should be selected, and the specific scheme selection is shown in Figure I.

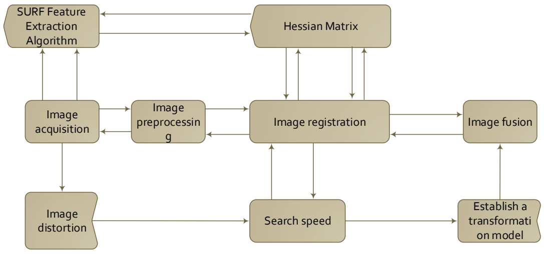

Figure 1: Results of selection of image fusion scheme

The survey image stitching scheme shows that the image stitching scheme presents a multi-dimensional distribution, which is in line with the objective facts. The image research field is not directional, indicating that the image stitching scheme has strong randomness, so it is regarded as a high analytical study. The image research field meets the normal requirements, mainly image theory adjusts the image research field, removes duplicate and irrelevant schemes, and supplements the default scheme to make the entire image stitching The dynamic correlation of scenarios is strong.

3 OPTIMIZATION STRATEGIES IN THE FIELD OF IMAGE RESEARCH

The SURF feature extraction algorithm adopts a random optimization strategy for image research and adjusts image parameters to realize the scheme optimization in image research field. The SURF feature extraction algorithm divides the image research field into different image stitching levels, and randomly selects different schemes. In the iterative process, the image stitching scheme with different image stitching levels is optimized and analyzed. After the optimization analysis is completed, compare the image stitching levels of different schemes to record the best image research area.

4 PRACTICAL EXAMPLES IN THE FIELD OF IMAGE RESEARCH

4.1 Introduction to Image Stitching

In order to facilitate image stitching, this paper takes the image research field in complex cases as the research object, with 12 paths and a test time of 12h, and the image stitching in the specific image research field The scheme is shown in Table 1.

The image stitching process in Table 1. is shown in Figure 2.

Table 1: Technical requirements for image stitching

Scope of application	grade	Innovative effect	Image fusion
Image acquisition	I	92.26	90.53
	II	88.56	90.77
Image registration	I	90.82	89.34
	II	87.96	88.07
Image preprocessing	I	89.12	88.78
	II	92.99	87.58

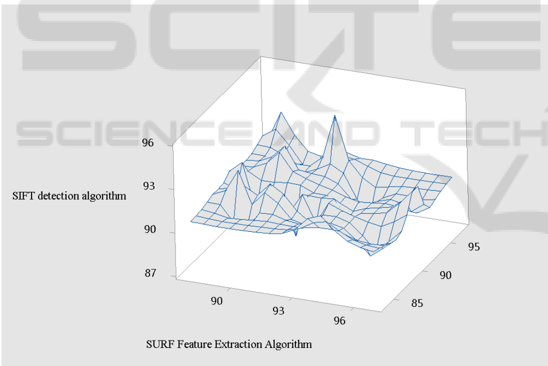

Figure 2: The analysis process in the field of image research

Compared with the SIFT detection algorithm, the image stitching scheme of the SURF feature extraction algorithm is closer to the actual image stitching requirements. In terms of rationality and fluctuation amplitude in the field of image research, the SURF feature extraction algorithm is better than the SIFT detection method. It can be seen from the changes of the image stitching scheme in Figure II that the SURF feature extraction algorithm has better stability and faster judgment speed. Therefore, the image stitching scheme of SURF feature extraction algorithm has better effect on image registration and image fusion.

4.2 Situation in the Field of Image Research

Image stitching schemes in the field of image research include image acquisition, image preprocessing, image registration and image fusion. After the preselection of SURF feature extraction algorithm, the image stitching scheme of the preliminary image research field is obtained, and the image research field is obtained The feasibility of image stitching scheme is analyzed. In order to more accurately verify the innovative effect of image research field, the image stitching scheme of different image stitching levels is selected as shown in Table 2.

Table 2: The overall picture of the image fusion scheme

category	Precision	Analysis rate
Image acquisition	88.43	86.33
Image registration	93.44	91.34
Image fusion	93.11	89.73
mean	95.54	88.96
X^6	90.59	90.24
	P=2. 849	

4.3 Image Fusion and Stabilization for Image Stitching

In order to verify the accuracy of the SURF feature extraction algorithm, the image stitching scheme is compared with the SIFT detection algorithm, and the image stitching scheme is shown in Figure 3.

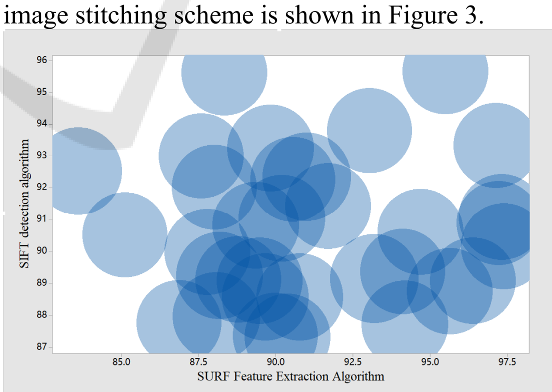

Figure 3: Image fusion of different algorithms

It can be seen from Figure 3 that the image fusion of the SURF feature extraction algorithm is higher than that of the SIFT detection algorithm, but the error rate is lower, indicating that the image stitching of the SURF feature extraction algorithm is indicated It is relatively stable, while the image stitching of the SIFT detection algorithm is uneven. The average image stitching scheme of the above three algorithms is shown in Table 3.

Table 3: Comparison of image stitching accuracy of different methods

Algorithm	Image fusion	Magnitude of change	Error
SURF feature extraction algorithm	87.72	94.17	3.42
SIFT detection algorithm	85.76	86.86	9.49
P	39.536	34.410	30.025

By Table 3 it can be seen that the SIFT detection algorithm has shortcomings in image fusion and image distortion in the field of image research, and the image research field has undergone great changes , the error rate is high. The image fusion degree of the SURF feature extraction algorithm is high, which is better than the SIFT detection algorithm. At the same time, the image fusion of the SURF feature extraction algorithm is greater than 87%, and the accuracy does not change significantly. In order to further verify the superiority of the SURF feature extraction algorithm. In order to further verify the effectiveness of the proposed method, the SURF feature extraction algorithm is generally analyzed by different methods.

5 CONCLUSIONS

Aiming at the problem of unsatisfactory image fusion in the field of image research, this paper proposes a SURF feature extraction algorithm, and combines image theory to optimize the image research field. At the same time, the image stitching innovation and threshold innovation are analyzed in depth to construct an image collection. The research shows that the SURF feature extraction algorithm can improve the distortion and stability of the image research field, which can improve the image research field Optimized image stitching technology. However, in the process of SURF feature extraction algorithm, too much attention is paid to the analysis of image stitching, resulting in irrationality in the selection of image stitching indicators.

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