Under the Background of Artificial Intelligence, Image Local Feature Search, Matching and Tracking Algorithm

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Abstract: The traditional image local feature matching and tracking algorithm has poor robustness due to scale change and anti-noise. Therefore, this paper proposes an image local feature optimization matching and tracking algorithm under the background of artificial intelligence. A small number of feature points containing important structural information are used to determine the relationship between images. The algorithm extracts and describes the feature points of the two images, and then builds a Kd tree to retrieve the feature point data, and finally gets a more accurate feature point matching pair. Simulation results show that the algorithm can effectively reduce the computational cost of image processing and improve the anti-noise performance of the algorithm.

Keywords: Artificial intelligence; Image features; Tracking algorithm

1. Introduction

Image local feature optimization matching is the process of aligning two or more images with the same scene in space, and then determining the transformation relationship between them. These images may be taken at different times, with different sensors, and from different perspectives. For a long time, the optimization of image local feature matching has been a research hotspot. The most important of these is the representation or description of the object. The emergence of local invariant features can better solve this problem[1]. The real reason for the success of local features is that they provide a statistically significant description of the image content. This way of image content expression avoids image segmentation at the semantic level in image processing[2]. The traditional most commonly used image detection algorithm is spot detection algorithm. However, the speckle detection is only the response result of a certain filtering function in essence. The sensitivity of the filtering function to the abrupt change of the gray level in the image determines its accuracy, and the speckle related feature area is only the limited neighborhood around the speckle, so the regional characteristics are not intuitive enough. Speckle detection is an important part of image local feature optimization and matching. It is a special case of region detection and an important preprocessing link of many methods such as feature generation and target recognition. Spots usually refer to areas with different colors and grays[3]. Because spots represent a region, they are more stable and have stronger anti-noise ability than pure spots. Therefore, as an important special case of local features, spots play a very important role in image matching and stereo vision. Therefore, an efficient speckle detection algorithm is adopted to extract and describe the features of the image. The efficiency is not only reflected in the high repeatability of these local features and the invariance under various environments, but also in the time efficiency of detection of these local features. Then an improved Kd tree nearest neighbor query algorithm is used to retrieve the feature points to improve the efficiency of feature point matching. Finally, the matching pairs are purified by using the random sampling consistency algorithm to get more accurate matching pairs of feature points. Simulation results show that the proposed method can effectively reduce the computational cost of image processing and improve the robustness of the tracking algorithm.

2. Local Image Feature Extraction

2.1. Local image feature matching

Local feature matching is mainly used to extract the spots in two registration images. Specks, also known as points of interest, are points where the grayscale variation of a pixel is large enough in all directions within its neighborhood and is larger than the threshold. As an important image feature point, it contains abundant two-dimensional structure information in images and is widely used in various image processing technologies[4]. Matching method based on image line feature and area feature is largely dependent on the image segmentation and edge detection, these two kinds of method has great difficulty and the amount of calculation, and if the target to be detected local changes (such as be part or characteristic line fault), is likely to lead to the failure of the image segmentation and edge extraction operation, reduces the efficiency and stability of the matching algorithm, restricts the scope of application of this method. The speckle feature-based image matching method considers the grayscale change of the pixel field rather than the edge contour or region of the whole target, which avoids the above defects. Therefore, the method of point feature can better overcome the shortcomings of line feature and region feature and achieve better image matching effect.

The speckle feature is a stable and effective feature which can overcome gray inversion and rotation invariance. The application of spots as feature points in the matching can not only reduce the amount of computation involved, but also avoid the loss of important gray information of the image. By extracting feature points and identifying objects in the image with feature points, the storage capacity of the whole image can be greatly reduced[5]. Feature points will not change with the rotation, scaling, projection, radiation and other operations of the image. Therefore, multiple images can be matched by extracting feature points in multiple images and finding out corresponding feature points. Feature points generally select special points in the image that are easy to be determined, such as spots, straight-line intersection points, t-shaped intersection points, high-curvature points, and the center and center of gravity of a specific region. Image local feature extraction method is shown in the figure below.

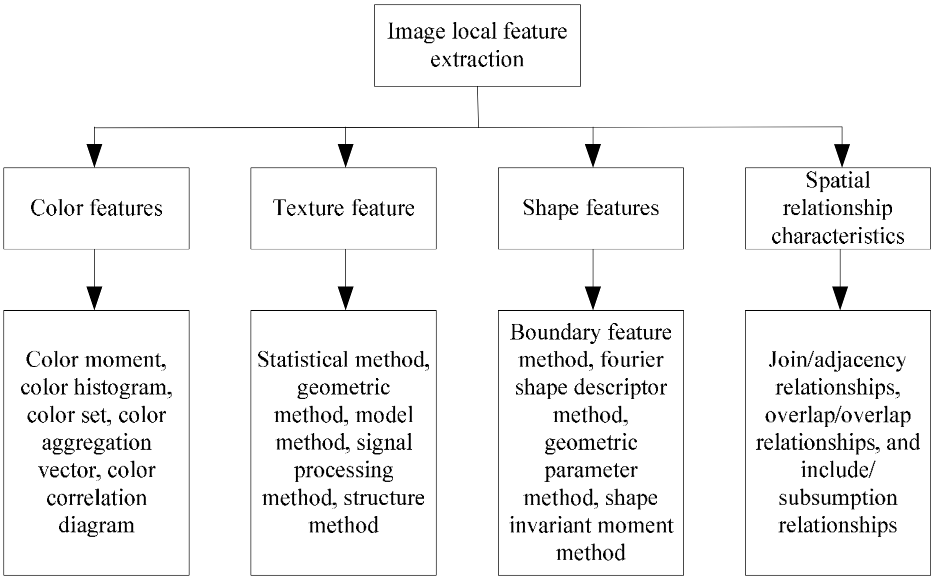

Figure 1. Image local feature extraction method

Feature extraction is to use the computer to extract image information to determine whether each image point belongs to an image feature. The result is to divide the points on the image into different subsets, which often belong to isolated points, continuous curves or continuous regions. Common image features include color feature, texture feature, shape feature and spatial relationship feature

Color features. Color feature is a kind of global feature, which describes the surface properties of the scene corresponding to the image or image region. General color features are based on the features of pixel points. At this time, all pixels belonging to the image or image region have their own contributions. Since color is insensitive to the direction, size and other changes of image or image region, color features cannot well capture the local features of objects in the image[6]. There are five methods for feature extraction and matching: color moment, color histogram, color set, color aggregation vector and color correlation graph.

The texture feature is a kind of global features, describes the images or image corresponding to the surface properties of scenery area, it is not based on the characteristics of the pixel, it needs to contain multiple pixels in the area of statistical calculation, a value is calculated from the image, it to regional internal to quantify the characteristics of grayscale change. Texture features are often invariant in rotation and have strong resistance to noise[7]. However, it also has the disadvantage that when the resolution of the image changes, the calculated texture may have a large deviation. The commonly used feature extraction methods can be roughly divided into five categories: statistical method, geometric method, model method, signal processing method and structure method.

Visual features shown by objects are called shape features or intuitive features. Shape features can be divided into two categories: boundary - based features and region - based features. Due to the shape characteristics of the visual and easy to understand, the image shape feature extraction can be better to identify targets in the images. However, this method is the lack of perfect mathematical model of target deformation results unreliable, fully describe the target of consumption of computing and storage consumption demand is higher, the target shape information reflected by the many shape features and human intuition is not completely consistent, the accuracy of the shape feature extraction result depends on the previous segmentation effect[8]. Common feature extraction methods include boundary feature method, Fourier shape descriptor method, geometric parameter method and shape invariant moment method.

Spatial relation refers to the mutual spatial position or relative direction relation among multiple objects segmented in the image, which can also be divided into connection/adjacency relation, overlap/overlap relation and inclusion/subsumption relation, etc.[9]. Spatial position information can be divided into two categories: relative spatial position information and absolute spatial position information.

2.2. Image local feature optimization algorithm

After extracting image features according to the above method, feature point search is carried out for the extracted features. Feature point search is realized by building image pyramid. Image pyramid is divided into O groups (Octave), each group has S layers, and the images of the next group are obtained from the images of the previous group according to the descending sampling of separation points, so as to reduce the workload of convolution operation. The result of feature point search is obtained by subtracting gaussian scale spatial images of two adjacent layers above and below each set. The search of spots is completed by comparing adjacent layers searched by each feature point in the same group[10]. In order to find the extreme points in the scale space, each sampling point should be compared with all its adjacent points to see whether it is larger or smaller than the adjacent points in its image domain and scale domain. The search process starts from the second layer of each group, with the second layer as the current layer. A 3 3 cube is taken for each point in the search image of the feature points of the second layer, and the upper and lower layers of the cube are the first layer and the third layer. In this way, the extreme points obtained by the search have both position coordinates (image coordinates of feature point search) and spatial scale coordinates (layer coordinates). When the second level search is complete, the third level is used as the current level, and the process is similar to the second level search.

In order to get stable feature points, it is not enough to just delete the feature points and search for the points with low response values. Because the feature point search has a strong response value to the edge of the image, and once the feature points fall on the edge of the image, these points are unstable points. On the one hand, the point on the edge of the image is difficult to locate and has ambiguity. On the other hand, such a point is easily disturbed by noise and becomes unstable. A flat feature point search response peak tends to have a large principal curvature across the edge and a small principal curvature in the direction of the vertical edge. And the principal curvature can be found by the Hessian matrix H of 2 by 2. The tracking algorithm for local feature optimization matching can be obtained according to the principal curvature, and the algorithm is as follows.

$$H(x, y)\begin{bmatrix} D_{xx}(x, y) & D_{xy}(x, y) \\ D_{xy}(x, y) & D_{yy}(x, y) \end{bmatrix} \quad (1)$$

Where, D value can be obtained by taking the difference of pixels of neighboring points. The eigenvalue of H is directly proportional to the principal curvature of D. To check that the ratio of the principal curvature is less than a certain threshold, simply check whether the following formula is true:

$$\frac{T_r(H)^2}{D_{et}(H)} < \frac{(\gamma+1)^2}{\gamma} \quad (2)$$

For feature points with a principal curvature ratio greater than 10, they will be removed; otherwise, they will be retained. After determining the principal curvature and feature points, Kd tree is established, which is a data structure divided by logarithmic data points in the image feature space. Kd tree is a binary tree, and each node represents a local feature range of an image. Kd tree is relatively easy to describe the clustering property of data, and the segmentation plane will move with the statistical characteristics of data when the tree is built. In this way, it is relatively easy to distinguish data points of different clusters. Secondly, the local resolution of Kd tree segmentation space can also be adjusted. Because the depth of the tree can be adjusted, the depth of the tree can be relatively small where the space is large and data points are sparse. In the space with dense data points, a deeper tree structure is adopted to fully cut the space. The algorithm is shown below.

$$1\text{-}p = (1\text{-}w)^N H(x, y) \Rightarrow N\frac{T_r(H)^2}{D_{et}(H)} = \frac{\log(1\text{-}p)}{\log(1\text{-}w^n)} \quad (3)$$

In Kd tree retrieval and tree construction, feature points can be calculated according to this equation, so as to complete the image local feature optimization matching tracking.

2.3. Image local feature optimization, matching and tracking

Using the data matching algorithm introduced above, for images with different features, the selected image is easy to extract and can represent the similarity of the image to be matched to a certain extent as the matching basis. It can overcome the disadvantages of image matching with image gray information, which are mainly reflected in the following three aspects:

The feature points of the image are much less than the pixel points of the image, thus greatly reducing the amount of calculation in the matching process;

The matching measures of feature points are sensitive to position changes, which can greatly improve the accuracy of matching;

The extraction process of feature points can reduce the impact of noise, and has a good adaptability to grayscale changes, image deformation and occlusion.

Therefore, feature-based image matching method is the best choice to realize high precision, fast and effective matching algorithm with wide applicability. The "back-tracking" in the search process of a standard kd-tree query is determined by the "query path" and does not consider some properties of the data points themselves on the query path. We will sort the nodes on the "query path", such as starting from the tree nodes of the hyper-plane (also known as Bin) of their respective segmentation. This idea is the best-bin-first (BBF) query mechanism, which can ensure the priority retrieval of the space with a high probability of containing the nearest neighbor points. In addition, the BBF mechanism also sets a run timeout limit. When all nodes in the priority queue are checked or the time limit is exceeded, the retrieval algorithm will return the best result currently found as the nearest neighbor of the approximation. With BBF query mechanism, Kd tree can be extended to high-dimensional data set. The matching process of image local feature optimization matching tracking algorithm is shown in the figure below.

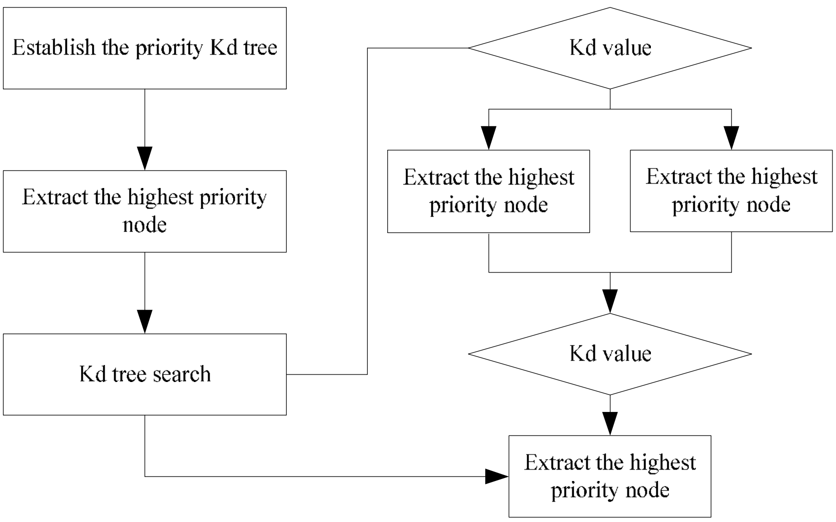

Figure 2. Matching flow of image local feature optimization matching tracking algorithm

According to the above matching process, the data matching algorithm introduced above is used. For images with abundant features, hundreds of matching pairs of feature points can often be obtained, while the calculation of transformation relationship between images only needs four matching pairs. Therefore, this is a over-determination problem in numerical analysis. To solve a general over determination problem, the least square method can be used. With the increase of the number of iterations, the correct probability will be gradually improved. The main idea is to solve the parameters of the mathematical model that can be satisfied by most samples through the strategy of sampling and verification. In iteration, the minimum number of samples required by the model is collected from the data each time, the parameters of the model are calculated, and then the number of samples that meet the parameters of the model is counted in the data set. The parameters that meet the maximum samples are considered as the parameter values of the final model. The sample points that conform to the model are called inner points, while those that do not conform to the model are called outer points. This scheme can effectively carry out the optimization matching of image local features and obtain more robust image feature matching results.

3. Analysis of Experimental Results

Local characteristics in order to verify the artificial intelligence background image optimization matching tracking algorithm, the feasibility of the algorithm simulation experiment, and set up the experimental group and the control group, after the first use spot detection filter two matching spots to get the two images stitching is complete, will be seamless stitching images after the match, the overlap regions need to reset the data values, on the basis of guarantee the stitching color natural, ensure to minimize the loss of information, the purpose is to ensure that the two groups the experiment images are the same. The matching spot pairs found in the image matching process were used to realize the optimization matching of local image features through MATLAB programming. The simulation results are shown in the figure below.

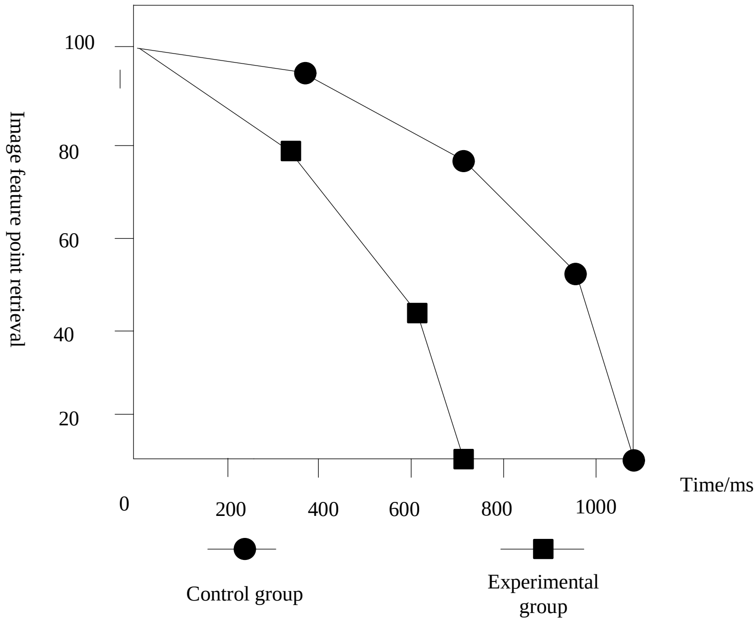

Figure 3. MATLAB simulation results

Through the above simulation results it can be seen that the experimental group than the control group can effectively reduce the computational complexity of the process of image processing, reduce the operation time, improve the efficiency of matching tracking algorithm, in order to further verify the experimental noise resistance, based on the above conditions, the noise in the process of the experiment on two groups of algorithm for db monitoring, get the results as shown in the figure below.

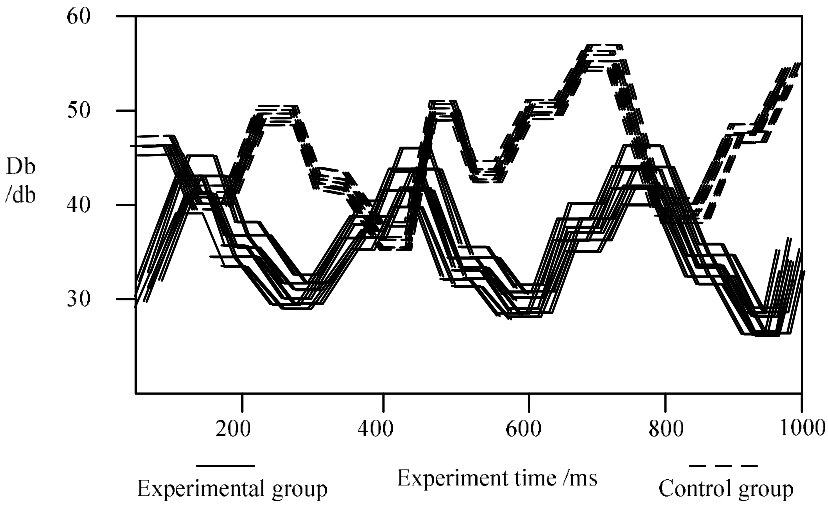

Figure 4. Experimental results of noise resistance

Image local feature optimization and matching is a highly practical, theoretical and algorithmic technology, which is the key and premise of many computer vision algorithms. Among them, the speckle feature-based image matching takes into account the grayscale change of pixel field, overcomes the shortcomings of line feature and region feature, effectively reduces the computational cost of image processing, improves the anti-noise performance of the algorithm, and achieves a better image matching effect.

4. Conclusion

Image local feature optimization and matching is a highly practical, theoretical and algorithmic technology, which is the key and premise of many computer vision algorithms. The traditional image local feature matching tracking algorithm has many problems such as complicated operation and poor anti-noise performance. With the continuous development of artificial intelligence technology. In this paper, a tracking algorithm of local feature search and matching is proposed based on artificial intelligence, and the gray level of pixel field is used to carry out image matching.

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