Improved SIFT Feature Extraction of Image Registration Algorithm Research

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Abstract. This paper uses Isoapm's dimensions to improve sift matching algorithm and reduce the computation. The characteristics of the SIFT are determined by using association rules support to further correct match points. The experimental results show that the algorithm is effective, which improves the speed and reduces the registration error.

Introduction

Image registration is the space alignment between images of the same object in different time or different angles . It is used in medicine, remote sensing image, image retrieval, image fusion and other image field. It is the application of computer vision, such as the cornerstone of depth recovery, motion analysis and 3D reconstruction problems. The general process of image registration technique is as follows: firstly, two picture processing, feature extracted feature points; through the similarity measure to find the matching feature points; through the parameter space coordinates of the feature points are matched; finally, the use of space coordinate transformation parameters of image registration.Sift algorithm is a local feature extraction algorithm,which Looks for extreme value point and extracts the position, scale and rotation invariant in scale space.It is invariant to rotation, scale zoom, brightness change.At the same time, angle changes, affine transformations, and noise is to maintain a certain degree of stability. The three important process of Sift are: 1, extract the key points; 2, additional detailed information on key points (local character); 3, through the characteristic points of two or more parties, two group matches, finding matching pairs of characteristic points, establishing the correspondence between the objects in the image.

According to the characteristics of the SIFT feature extraction method, this article Improved SIFT algorithm, improved the computational speed, and reduce the registration error.

The formation of SIFT feature vector and image feature matching

Sift is based on the theory of scale space[1, 2]. Sift is generated by using the different scales of gaussian difference nuclear and image convolution in order to simulate multi-scale feature of image data. And then build the image pyramid. Subtract between the adjacent layers in each group. Thus the equivalent images produced by DOG filter are gotten. After that look for the extreme value point in this space.

Each sampling point is compared to the all neighboring points, to see whether it’s bigger or smaller than the other adjacent points in image domain and scale domainl. Thenthe extremepoint is found to be the key point, then remove low contrast and unstable edge response points, to enhance the stability and improve the ability of anti noise.

For each of the key points to specify the direction of the gradient direction parameters using key points neighborhood pixel distribution characteristics, which makes the operator with rotation invariance. The key point is the center of the neighborhood window sampling, using gradient direction histogram statistics of the neighboring pixels. The coordinate axis is the key point to ensure the direction, rotation invariance.

8 x 8 window centered on the key points, As shown in Fig. 1, every little grid represents a pixel neighborhood of feature points in scale space, the arrows represent the gradient direction of the pixel. The length of the arrow is the gradient value , and the nearer the pixel gradient direction of the feature points, the greater contribution to the information.

Then cut the 8 x 8 window into 2 x 2 window or 4 Windows, each window has a seed point, which is obtained by the original cumulative 4 x 4 bits after computing the gradient direction histogram. Thus each point is 4 * 8 namely 32 dimensions.

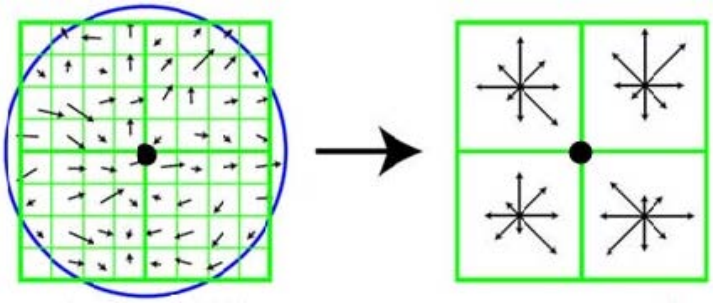


Fig. 1 Field gradient direction and key point feature vector

In practical application, in order to enhance the robustness of matching, using 4x4 or16 seeds to describe each key point, thus the key point can produce 128 SIFT data, 128 dimensional feature vector is formed.

The improvement of SIFT

Isomap method of reduction of dimensions.

Isomapis a global approach and trying to keep the geometric characteristics of the data[3, 4], mapping the neighbor points on a manifold to low dimensional nearest neighbor point, mapping the far point on the manifold to the far lower-dimensional space. Because the feature is a 128-dimensional feature vectors after sift extraction, matching with heavy computation, by Isomap dimension reduction methods here.

Here assuming any two points using sift features extracted are i（N_1,N_2,N_3.....N_{128}) and j（M_1,M_2,M_3.....M_{128}).

First. Manifold M based on the distance between a pair of points i,j in Input space x made sure that Adjacent points. Minimum Euclidean distance to determine neighbor here.

$$d_{ijj} = sqrt(\sum (M_{Z1} - N_{Z2})^2) < \varepsilon \quad \text{Z=1,2,…,128} \tag{1}$$

These points with neighbor relationships can be expressed as a weighted graph G.

Second, the adjacent shortest paths dG (i,j)in a graph G by Isomap calculation to calculate the geodetic distance between dM (i,j) of all the points in a manifold M,and a simple algorithm for solving shortest path:

If I and j are connected, expressed asd_X(i,j).

When I and j not connected, At first： $d_G(i,j)=\infty$.

Then, for each value of K, using min{d_G(i,j), d_G (i,k) + d_G (k,j)} instead. The matrix of D_G ={d_G (i,j)} contains all the shortest distance between two points in the nearest neighbor graph G.

Third, we construct d dimensional embedding, and the CMDS method was applied to map distance matrix D_G = {d_G(i,j) }.

In the space Y in d-dimensional space keep the essence of manifold geometry to the greatest extent, building an embedded data. Select points from the coordinate vector y_i of Y to make the error function is minimized, obtain a global minimum by setting a d-dimensional unit vector y_i of the coordinates of the τ (D_G) .

$$E = \| \tau(D_G) - \tau(D_Y) \| \tag{2}$$

Association rules based on support degree.

Here is support decision rules based on the association rule as the basis between the feature points matching:Calculating description vector N_j (A)of feature point A are mapped into a low dimensional

space after dimension reduction and descriptor vector N_j (B) of a B feature point in the target image. The Euclidean distance between them is d(N_j(A), N_j(B)). If d (N_j (A), N_j (B)) is the smallest in all the feature points, called the matching succeed between the description of the j-th child vector of the target image feature points B and the original image feature points A. If the quantity of descriptor vectors of the original image feature points a and b image feature point matching successfully and the total quantity ratios of μ is greater than a certain threshold. Then consider these two points a and b are strongly related, denoted by A, B. Sup (A,B) is called support of Association rule A and B, min_sup for the minimum support thresholds.

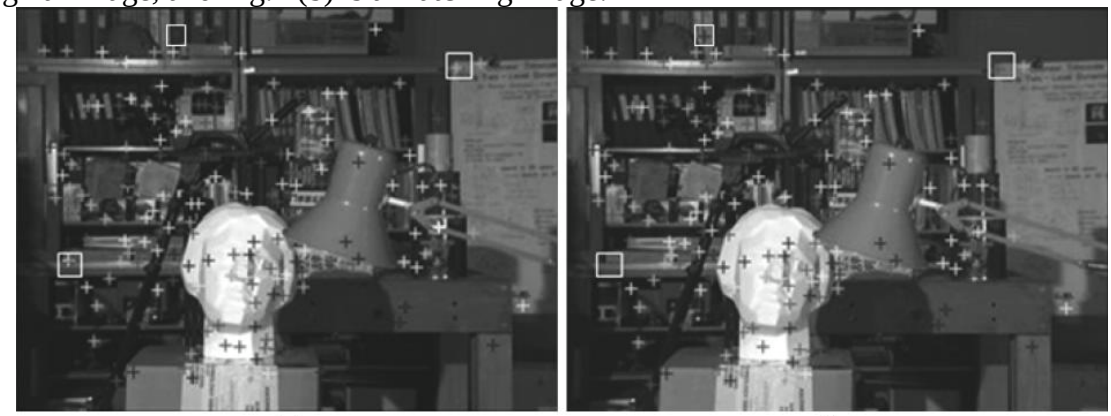
Then remember the set of all the features of the original image and the target image-point after dimension reduction for P=p_1,p_2,...,p_m and Q=q_1,q_2,...,qn. Calculating all feature descriptor vectors of N_i (P_K) and N_i (Q_L), i,j=1,2,...,8 in the formula, k=1,2,...,m, and l=1,2,...,n. in the original and destination images.

Feature point matching, given its original image feature points p_k* looking for strongly correlated with maximum support and is marked q_l* ,the image feature points, then from the original feature set p and target image feature points in set Q removed p_k* and q_l*, respectively, up until the feature set is the empty set.

In order to get better judgment, here using two-way matching [5], then reverse match, If the vector quantity of feature points to be registered in the image matching and the total quantity ratio is greater than a certain threshold, we accept the registration results, if it is less than this threshold, then give up.

The experimental results

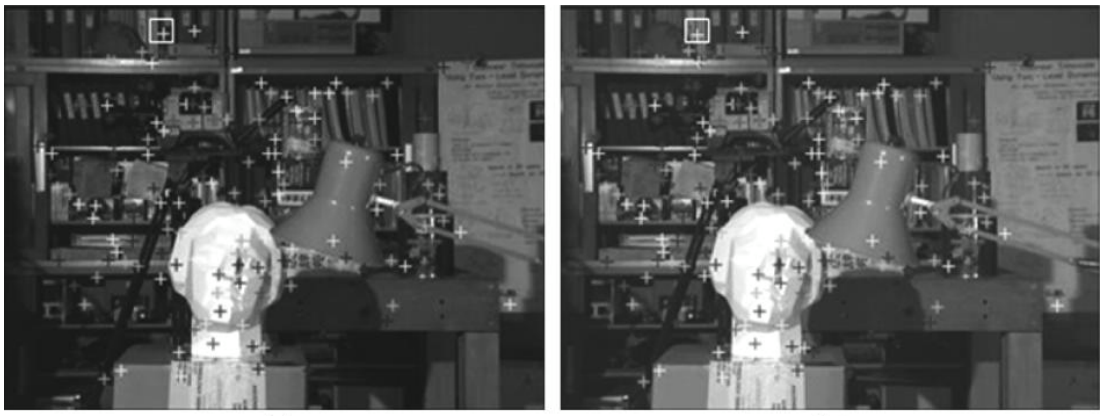
Test images are provided by the University of Tsukuba. The image pixel is 384 * 288. The operating environment is matlab7.1.Fig. 2 is the result of using sift directly after matching. Fig. 2(a) is the original image, and Fig. 2(b) is a matching image.



(a) (b)

Fig. 2 SIFT

Fig. 3 is the registration of the methods in this paper. Because here Isomap dimensionality reduction methods is affected by the parameters of k,here is a selection of k=6, which obtained 6 neighbor points. Dimension after dimension reduction reduced from 128 dimensions of the original to 35 dimensions. Matching by Support criterion of Association rules.



(a) (b)

Fig. 3 Isomap dimensionality reduction SIFT

The results are as Table 1.

Table 1 Performance summary of the proposed algorithm

Method	The logarithm of the distribution	Logarithm of a pair	Accuracy rate	Time
SIFT	213	193	90.61%	0.116
Improved SIF in this paper	180	178	98.89%	0.114

The improved registration algorithm significantly improves the accuracy, and time is reduced slightly.

Conclusion

In order to realize a key step that is feature extraction in image registration, This article uses a SIFT feature extraction algorithm with Strong matching ability. The basis of SIFT algorithm theoretical builds a Gaussian pyramid through scale space. Using hierarchical structure to find the feature points, and the formation of the Feature point descriptorat various levels. But dimension is too high,Isomap dimension reduction methods was used in this article. But due to dimensionality reduction method required the uniformity of the data so it can take advantage of improved cn-isomap method to dimensionality reduction. But it reduces its registration accuracy,this article matching by using Support judging rules of Improvement of association rules,Corrected by two-way matching, significantly improved the accuracy of registration.

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