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Research on image recognition algorithm based on improved SIFT

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ABSTRACT

Due to the problems of SIFT algorithm in image recognition, the recognition accuracy is not high and the matching speed is slow. In this paper, a fast method for obtaining and matching feature points is proposed. Firstly, based on the feature point acquisition method of image edge, the image edge is extended, and the feature points are judged only in the extended region. Then, the normalized gray difference values of 16 subregions around the feature points are added to the feature point descriptor to enhance the feature point description ability. The dimension of descriptors is reduced by KPCA method, and the cosine similarity is used to preprocess noise feature points to speed up the matching speed. The experimental results show that compared with SIFT algorithm, the image recognition rate is improved by about 8%, and the recognition speed is improved by about 50%.

KEYWORDS

Target detection; SIFT algorithm; Feature descriptor; KPCA dimension reduction

1 Introduction

Image recognition is to obtain the feature matrix of the image through the feature extraction algorithm. According to the similarity judgment method, the corresponding image is found from the existing database, so that the image is intelligently classified and processed. At present, the more mainstream image feature extraction algorithms mainly include LBP algorithm, HOG algorithm, Harris algorithm and SIFT algorithm[1]. SIFT algorithm[2] is insensitive to image noise and has scaling, rotation and affine invariance, which can effectively resist image affine transformation, rotation transformation, scaling transformation and other deformation, and has a certain ability to suppress the influence of noise, and the algorithm has good robustness. Jiang B, Yang L Y, et al.[3-4] proposed the use of PCA algorithm to reduce dimension of feature descriptors generated by SIFT algorithm. ROWEISS, et al. [5] proposed a nonlinear dimensionality reduction method to reduce the computational load during algorithm matching.

In view of the shortcomings of SIFT algorithm, three improvements are proposed in this paper. (1) A feature point detection method based on image contours is proposed, which mainly searches feature points near image contours, effectively removes feature points with not obvious features, and reduces the number of feature points. (2) Based on the SIFT descriptor, 16-dimensional gray difference value information of sub-regions is added to enhance the description ability of feature points. (3) In this algorithm, KPCA nonlinear dimensionality reduction algorithm is used to reduce the dimensionality of data.

2 SIFT Algorithm

2.1 Construction of scale space

SIFT algorithm uses image difference pyramid to represent the change of image in different scale space, so as to realize the simulation of multi-scale space. For the original image, more than 2 times of sampling and grouping are performed to obtain images processed by different Gaussian filters. It forms the Gauss Pyramid. Then, by calculating the difference of pixel values between adjacent layers, the Gaussian difference pyramid is generated.

2.2 Feature point detection

When traversing the pixels of the non-first and non-last layers in the differential Gaussian pyramid, the extreme value points are selected compared with the 26 pixels of the surrounding 8 directions and adjacent layers. Then the three-order curve fitting is carried out to obtain the exact sub-pixel coordinates. Finally, the unstable points are eliminated by Hessian matrix.

After the feature points are determined, the gradient amplitude and gradient direction of each pixel in the neighborhood where the feature points are located are calculated, and the direction of the feature points is determined using histogram statistics to ensure the invariance of image rotation. Formula (1) and formula (2) are the gradient amplitude and direction of the feature points (x, y) respectively.

$$m(x,y) = \sqrt{(L(x+1,y) - L(x-1,y))^2 + (L(x,y+1) - L(x,y-1))^2} \quad (1)$$

$$\theta(x,y) = tan^{-1}((L(x,y+1) - L(x,y-1))/(L(x+1,y) - L(x-1,y))) \quad (2)$$

2.3 Description of feature points

The SIFT algorithm divides the region around feature points into 16 sub-regions, each with 16 pixels. With the main direction of feature points as the axis direction, the gradient values and gradient directions of all pixels in the subregion are calculated, and the accumulation is carried out on the 8 gradient directions. Eventually each feature point can produce a 128-dimensional SIFT feature point descriptor. They have illumination invariance, multi-scale space invariance and rotation invariance.

2.4 Feature point matching

In the matching of feature points, for the feature points in one image, the two feature points with the shortest Euclidean distance are found in another image. The ratio of the nearest distance to the next proximity is calculated. If the ratio is lower than the preset threshold, the two feature points are considered to be successfully matched. You can improve the matching stability by adjusting the threshold.

3 Improved Algorithm

3.1 Feature point detection

According to the SIFT algorithm to obtain feature points, feature points are generally located at image edges, corner points, locally dense enough areas and image texture areas, which have the characteristics of gray value and gray value of adjacent pixel points change greatly. The method of edge extension and filtering is used to improve the speed of feature point recognition and effectively suppress the less significant feature points. The algorithm flow is as follows.

(1) Using the Log operator to compute edge sets for images processed with Gaussian pyramid.

(2) The coordinates in the image edge set are extended by 4 pixels in 8 directions around them to enhance their edge features and prevent the omission of feature points.

(3) The pixel in the image edge set is used as the feature point search target, and the SIFT algorithm is used to obtain the feature point descriptor set.

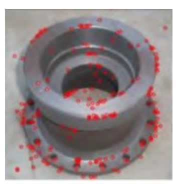

Figure 1 SIFT algorithm

Figure 2 Improved algorithm

3.2 information enhancement

3.2.1 The pixel gray difference as the feature point

After the feature points are determined by the SIFT algorithm, 16 surrounding sub-regions are taken as the center of these feature points, and then the gradient direction and value in 8 directions are calculated in these sub-regions respectively. Each feature point eventually generates a descriptor containing 128 dimensions of data. In order to better describe the feature points and suppress the influence of noise, this paper takes the gray difference values of 16 sub-regions around the feature points as the feature description content of the feature points, and describes the local features of the image more accurately.

3.2.2 KPCA algorithm

KPCA algorithm is the extension of kernel function based principal component analysis (PCA), the main idea is to map the features in the original data to a new high-dimensional feature space, and then carry out principal component analysis in this new feature space, so as to obtain more meaningful features. The advantage of KPCA is that the characteristics of the data with nonlinear structure can be obtained, and the original data can be reduced to a lower dimension, so that it is easier to fit and understand.

3.2.3 Cosine similarity method

Cosine similarity method represents the degree of similarity in direction between two vectors, which has the advantages of independent vector size, small computation and accurate judgment of direction consistency. When the cosine similarity is smaller, the Angle between the two vectors is smaller, and the degree of similarity in direction is higher. The cosine similarity method is used to remove the noise feature points of the recognized image. The cosine similarity between the feature points of the recognized image and the feature points in the image library is comprehensively calculated. If the calculated cosine similarity is greater than the specified threshold, the two feature points will not be similar.

4 Experimental results and analysis

4.1 Comparison of algorithm recognition accuracy rate

Table 1 shows the comparison results of image recognition accuracy rate between the proposed algorithm, SIFT algorithm and PCA-SIFT algorithm after dimensionality reduction.

Table 1 Comparison of correct rate of algorithm recognition

Image transformation		SIFT Algorithm	PCA-SIFT Algorithm	Improved Algorithm
zoom lever	1.2	83.3%	81.8%	90.4%
	1.5	81.6%	80.2%	89.5%
	2	78.4%	77.1%	86.3%
rotation Angle	15	81.4%	79.6%	87.5%
	30	79.2%	77.1%	84.3%
	45	75.8%	72.3%	80.6%
gaussian noise	10	76.4%	76.4%	83.4%
	20	71.5%	71.5%	81.5%
	30	62.3%	57.2%	74.6

As can be seen from Table 1, the method proposed after dimensionality reduction can effectively improve the correct recognition rate of images, with an average increase of 8% compared with the other two algorithms.

4.2 Comparison of algorithm identification time

As shown in Table 2, the algorithm in this paper improves the recognition speed significantly, with an average increase of about 50%.

Table 2 Algorithm recognition time comparison (ms/sheet)

Image transformation	SIFT Algorithm	PCA-SIFT Algorithm	Improved Algorithm
zoom	2846	2086	1015
rotation	2938	2122	1127
noise	2945	2152	1243

5 Conclusion

In order to solve the problem of large computation and long time consuming of SIFT algorithm in image recognition, an improved method is proposed based on feature point acquisition near the image contour, increasing the first-order difference value information of feature points, adopting KPCA dimension reduction and quadratic matching. The experimental results show that in the process of workpiece image recognition, the proposed algorithm not only retains the high matching accuracy of SIFT, but also improves the image matching speed, which has great practical value.

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