An Image Retrieval Algorithm Based on SURF For Embedded System

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Abstract- *To study the problem of real-time and accuracy of the image retrieval algorithm of embedded system with scale, rotation and illumination. Improved SURF algorithm, which is applied to the binary image feature extraction, improve the real-time performance of the image, the use of LSH algorithm to establish the index of the image feature database, to avoid duplicate feature extraction, the use of LSH algorithm to approximate the search image features, and the similarity into line sort, select the best matching image. When the image has scale, rotation, illumination, this algorithm has a higher retrieval accuracy than the SURF algorithm and ORB algorithm, and has a better robustness than the SURF algorithm. The experiments show that the algorithm has scale, rotation and illumination conditions of the embedded system of image retrieval, has good real-time performance and achieved good application effect.*

Keywords- SURF algorithm; Embedded system image; LSH algorithm; image retrieval algorithm

I. INTRODUCTION

In recent years, with the rapid development of multimedia, Internet and other technologies, the popularity of Smart Handheld, mobile terminals, robots and other embedded systems, the number of images has increased rapidly. How to retrieve the required images from a large number of images has become a hot issue in the field of computer vision.

Content-based image retrieval algorithm (CBIR) [1-4] has been developing rapidly in recent years. The algorithm is based on the image of various features to retrieve similar images, the key lies in the image feature extraction and feature matching, more text-based image retrieval algorithm (TBIR) more objectivity.

The content-based image retrieval process is divided into two key points: (1) extract the characteristics of the query image and image database image (2) using a search algorithm to compare the image database with the query image characteristics, according to the approximate display results. In the image feature extraction phase, David G. (SIFT algorithm [5]), which has the characteristics of translation, rotation and scale invariance, but the SIFT algorithm uses the multidimensional feature descriptor to compute the complexities of the multi-dimensional descriptor, Low construction efficiency, can't meet the real-time requirements. Bay H in 2008 proposed the SURF algorithm (Speeded Up Robust Features) [6], using Hessian matrix to ensure that the two image feature point matching accuracy, in the traditional PC has a good real-time, but for embedded systems It is difficult to meet the requirements of real-time. In order to improve the real-time performance of the algorithm, an algorithm based on binary descriptor, such as ORB algorithm [7-11], is proposed to improve the efficiency, but it does not have scale invariance.

In this paper, a method is proposed to map the 64-dimensional descriptor constructed by the SURF feature descriptor as a binary descriptor, to keep the scalar invariance of the SURF algorithm and improve real-time. And the LSH algorithm [12-14] is used to establish the feature index of the image in the database, and the approximate neighbourhood of the query image is searched by LSH. The experimental algorithm has better robustness in the embedded system image retrieval Sexual and real-time.

II. MPROVED SURFALGORITHM

The SURF algorithm is mainly based on the detection of the scale space, using Hessian to extract the feature points, and use the integral image to complete the image convolution operation, as defined by:

$$«L\ x_{xx}(\ ,w)\#L\ x_{xy}(\ ,w)\ » \quad (1)$$

$$H(\ ,\ )x\ w\ «\qquad »$$

$$«\neg L\ x_{x}(\ ,w)\#L\ x_{yy}(\ ,w)»¼$$

Where $L\ x_{xx}(\ ,w)$, $L\ x_{yx}(\ ,w)$, $L\ xxy(\ ,w)$, $L\ xyy(\ ,w_{)}$ is the Gaussian second order differential image convolution of the point x on the scale. The approximation of the two matrix determinants is calculated by using follow:

$$\mathrm{Det}(Happrox)D\ Dxx\qquad yy(0.9Dxy)2 \quad (2)$$

The extreme point is detected by Det(Happrox). This point is a local extremum, when the value is positive. In the extreme point 3-dimensional cube area with non-maximum suppression, select the 26 field values in the maximum value is the characteristic point, through the interpolation operation to determine the feature points in the image and scale space, the exact location and scale. The empirical thresholds will be tested in the actual operation.

The SURF feature is a 64-dimensional vector with the main direction as the longest vector direction. Based on the wavelet transform, the coordinate axes are rotated to the main direction, and the length is 20 w square blocks with the feature points as the center. The sub-regions are divided into 16 sub-regions of 4 × 4 with the square box as the center. Each sub-region consists of a four-dimensional vector, according to following:

16 sub-regions. Where $^{d}_{x}$ and d_y are wavelet responses in the x and y directions in the sub-regions calculated using the same interval w .

In this paper, propose a 64-dimensional feature descriptor constructed by SURF feature descriptor to the Hamming space, to generate the corresponding binary descriptor. The binary descriptor can directly calculate the Euclidean distance to improve the computational efficiency. Suppose a 64-dimensional feature vector $p(^{x}_{1}, ^{x}_{2}, ..., ^{x}_{d})$,where dę[1-64]. Mapping p to

Hamming space, generating the corresponding binary descriptor using follow:

$$p\ u\ x\ u\ x\mathrm{c}_{c}(\ _{1}),\ _{c}(\ _{2})...,u\ x_{c}(\ _{d}) \qquad (4)$$

Where $u\ x_{c}(\ )_{i}$ represents a binary string consisting 1 of x_i followed by 0 of c- x_i, c is the maximum of x_i in p, i is the value between 1 and d.

III. IMPROVED EMBEDDED IMAGERETRIEVAL ALGORITHM

Firstly, the feature extraction algorithm is used to extract the feature of the image in the image database, and it is transformed into a binary descriptor. Then, the LSH algorithm is used to establish the image feature index, and the query image is indexed. Finally, the LSH algorithm is used to approximate the neighbourhood search Establish image feature library index as follow:

1) Generate the corresponding binary descriptor using the SURF algorithm.
2) Hash function family $g_{j}(\ )(p\ j\ \ (0,\ ],l\ l\ \ N))$,it is a random selection of k (k (0,c du))bits in pc , and each of the hash functions $g\ p_1(\ )!g\ p_2(\ )!\ldots!g\ p_j(\ )$has a hash table.
3) Mapping pc to its corresponding hash table according to $g_{j}(\ )(p\ j\ \ (0,\ ],l\ l\ \ N))$.

The LSH algorithm search step as follow:

1) Establish an index for the query image: for the q_1! q_2!q_k feature vector of the image to be queried, press index to create process 3.1 to index the image feature to be queried.
2) Generate candidate neighbor features : all the hash entries of $g\ q_i(\ _{j})(i\ \ (0,\ ],l\ j\ \ (0,k])$ are compared with the feature vector of the image to be queried, and the entry whose distance is less than the threshold is retained. The corresponding feature is the candidate neighbor.
3) Display the search results: the candidate neighbor feature is sorted by the degree of Hamming distance between the candidate feature and the feature of the image to be queried. In this paper, the first 10 images are selected, that is, 10 images are displayed at a time.

IV. ANALYSIS OF EXPERIMENTAL RESULT

In order to verify the retrieval effect of this algorithm, the experimental environment adopts Intel (R) Pentium (R) CPU 3.0GHz, Windows 7 operating system. The system software is developed by using VC ++ language programming and related functions in OpenCV. In the experiment process, the algorithm, SURF algorithm and ORB algorithm were used in the Oxford image set and Corel image set respectively.

A set of images with scale, illumination and rotation were selected from the Oxford image set. The algorithm, SURF algorithm and ORB algorithm were used to test the selected images. The correct rate is shown in Figure 1 to 3, the retrieval time is 708.324ms, 321.452ms, 435.815ms, indicating that the algorithm in the same rotation, light, scale conditions, the correct rate of retrieval than the SURF algorithm and ORB algorithm, and the retrieval.

time Significantly lower than the SURF, slightly lower than the ORB algorithm. It shows that the algorithm has good robustness under the condition of scale, rotation and illumination, and can obviously reduce the retrieval time and real - time.

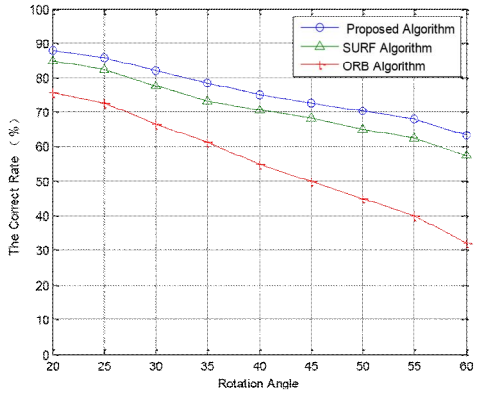

Figure 1. Retrieves the correct rate when the image rotates change

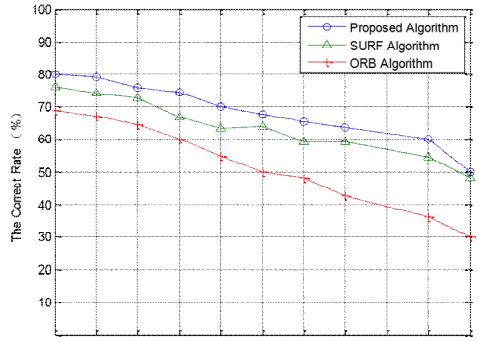

Figure 2. Retrieves the correct rate when the image scale change

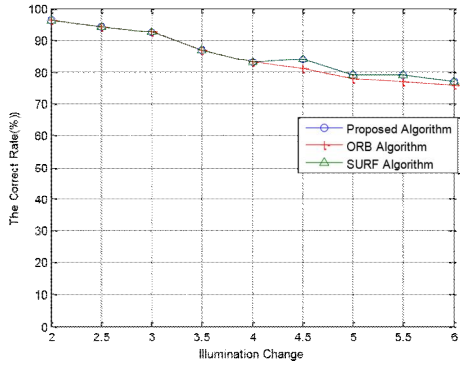

Figure 3. Retrieves the correct rate when the image illumination changes

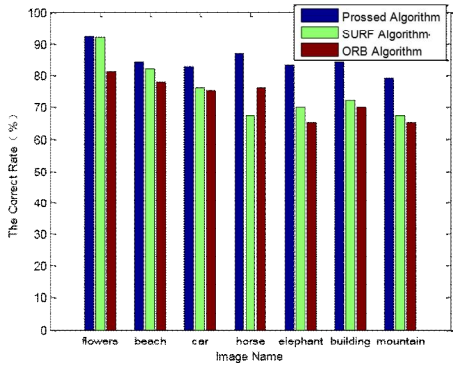

Figure 4. Comparison chart of average image accuracy

Flowers, cars, beach elephants and other images from Corel images set are tested the correct rate of retrieval. As shown in Figure 4, the accuracy of the algorithm is higher than that of SURF and ORB. The Figure 5 for the Corel image set of a car search results, where the first pair of images to be queried, return 10
Images.

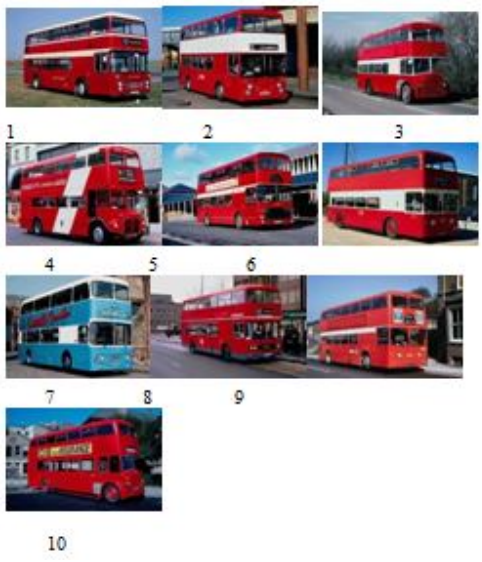

Figure 5. Retrieval results of car image

V. CONCLUSIONS

In this paper, the SURF algorithm is used to map the feature points to the Hamming space to generate the binary descriptor. The retrieval process is improved. Firstly, the improved SURF algorithm is used to construct the image library feature index. Then, the LSH algorithm is used to approximate the near-neighbor search of the query image feature, and the distance of the multi - dimensional space distance is transformed into Hamming distance, which improves the retrieval efficiency. In conclusion, the algorithm proposed in this paper can improve the speed and accuracy of

the previous SURF algorithm and can be applied to the embedded system.

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