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CBIR을 위한 코너패치 기반 재배열 DCT특징 분석

Rearranged DCT Feature Analysis Based on Corner Patches for CBIR (contents based image retrieval)

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(Jimin Lee · Jongan Park · Youngeun An · Sangeon Oh)

Abstract - In modern society, creation and distribution of multimedia contents is being actively conducted. These multimedia information have come out the enormous amount daily, the amount of data is also large enough it can't be compared with past text information. Since it has been increased for a need of the method to efficiently store multimedia information and to easily search the information, various methods associated therewith have been actively studied. In particular, image search methods for finding what you want from the video database or multiple sequential images, have attracted attention as a new field of image processing. Image retrieval method to be implemented in this paper, utilizes the attribute of corner patches based on the corner points of the object, for providing a new method of efficient and robust image search. After detecting the edge of the object within the image, the straight lines using a Hough transformation is extracted. A corner patches is formed by defining the extracted intersection of the straight line as a corner point. After configuring the feature vectors with patches rearranged, the similarity between images in the database is measured. Finally, for an accurate comparison between the proposed algorithm and existing algorithms, the recall precision rate, which has been widely used in content-based image retrieval was used to measure the performance evaluation. For the image used in the experiment, it was confirmed that the image is detected more accurately in the proposed method than the conventional image retrieval methods

Key Words : Corner Patch, DCT, CBIR, Rearrangement.

1. Introduction

These days, our society has developed into a knowledge-based society from an industrial society due to the development of information technology, and research based on visual systems in diverse areas has been actively done along with the development of computer based businesses. As visual systems have been combined with areas of intelligence in moving robots [1, 2], intelligent traffic system [3-5], and medicine [6, 7], the importance of visual systems has been raised as a central technology which will contribute to human welfare and business directly.

The fundamental work of a visual based system is to detect lines, corners, and curves as geometric traits in images. It has been proposed a technique that uses feature parameters such as chain code[8], Zernike moment[9-10], invariant moment[7], Fourier descriptors[7] as the search technology using the shape information. Among them, a corner detection that is an important feature of the image processing and computer vision, has been studied by using method to detect corner position using the mask of circular in the image of the gray level, to analyze the distribution of the brightness, and to be crossed by using direction of the straight lines in the contour lines, etc.[12]

Zuniga and Haralick proposed a method of extracting a corner, taking into account change of the successive pixels and directional change rate of the inclination within each point and peripheral a certain area[13]. Kichen and Rosenfeld proposed method to extract the corner using the degree of curvature of the contour line by the local inclination width as the variation degree of constant inclination value.[14]

Moravec has proposed a method of detecting a point with the greatest change width as the corner through analyzing the contrast value in all directions of each pixel.[15] Harris and Stephens, by using the contour information of the image, proposed a method for detecting the corner through

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the cross-correlation method.[16] Trajkovic and Hedley extracted the corner by analyzing the contrast changes of the image in all directions from each pixel.[17]

In addition to these corner extraction process, a number of methods have been studied [18]; as method etc. for detecting the corner by locally splitting the contour map of the image, by analyzing the curvature information if the distribution of the contrast has the form of curvature[18-21], by using a symmetric analysis.[22-23], and by using a video image registration algorithm based on corner point detection and feature point integration.[24]

Therefore, Image retrieval method to be implemented in this paper, utilizes the attribute of corner patches based on the corner points of the object, for providing advanced methods of efficient and robust image search.

This study is composed of the following: Chapter 2 describes a corner detector and Chapter 3 describe the proposed image search algorithm. Chapter 4 demonstrated the validity of the algorithm proposed through a simulation.

2. Corner Detector

In the video signal processing and computer vision field, the Corner information is one of important information along with the image of the contour. In particular, in the system of object recognition and the image matching, the position of the corners, can be displayed together on the contour image. In the computer vision to detect the position of an object, it is an important element to simplify the feature points of the object and extract a significant feature point, along with reducing the amount of computation and improving of the processing speed of the image data.

Of these feature points, because it can reduce of a feature point of the image data and be representative of the feature of the image, a method of using such a corner point that the intensity distribution is changed sharply in the image, can be more quickly and easily recognize the object in the input image than using method detecting the entire contour of the image.

2.1 Harris Corner Detector

Harris corner detection algorithm was proposed by Harris. C and Stephens. M in 1988. [21] The operator, based on Local Auto-correlation function of video signal with a combination of Moravec's corner detection and contour extraction operator, analyzes the spatial variations of contrast due to the movement of the window and then, it is arranged to detect the corner.

2.1.1 A characteristic of Harris Corner : How to apply the Harris corner detection operator is as follows.

Firstly, calculate the spatial variation of contrast.

$$B(u,v)=\sum_{x,y} w(x,y)[I(x+u,y+v)-I(x,y)]^2=[u,v]M\begin{bmatrix}u\\v\end{bmatrix}$$

$$M=\sum_{x,y} w(x,y)\begin{bmatrix}I_x^2 & I_{xy}\\ I_{xy} & I_y^2\end{bmatrix} \quad (1)$$

Here, $I(x, y)$ represents the brightness value of the image, $B(u,v)$ shows the mean of the contrast value of the image. And $w(x, y)$, is a strong Prewitt windows of vertical and horizontal components of the image.

If the λ_1 and λ_2 is the eigenvalues of a matrix obtained, it determines the corner to changes in the values of the decision variables.

$$R=\det(M)-k(Trace(M))^2 \quad (2)$$

Here, $\det(M)$ is meant the product of the eigenvalues λ_1 and λ_2, $Trace(M)$ means the total of the two eigenvalues λ_1 and λ_2. By applying a threshold to obtained the decision variables R, detect a corner in the local maximum value. The R value of the decision variable that depends on a value between the eigenvalues L and M, the image as can be seen in Figure 1, can be expressed by the following three areas.

If the small values both the eigenvalues L and M, which is that the change in the contrast of the image is small, it means that decision variable R has a substantially constant value, which means a flat state. if any of the eigenvalues of the eigenvalues L and M is much greater than the other eigenvalues, this means that the closer the contour of the video. As shown in Figure 1, if very large both eigenvalues L and M, this means that the decision variable R is increased in all directions, which means that closer to the corner.

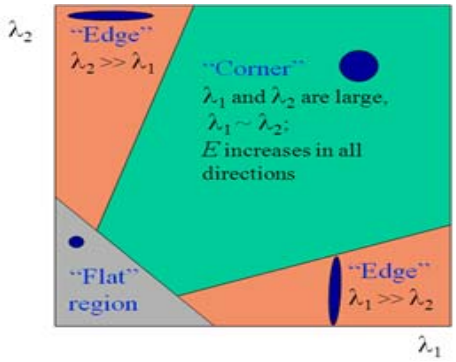


Fig. 1 Feature point division according to the distribution of eigenvalues

2.1.2 Harris Corner problems : However, Harris corner detection, has the following problems.

Because it use the Moravec corner detector and self-correlation function, take more computation time. If there are many parts that have an isolated point, such as Salt & Pepper noise in the video, it is difficult to detect the correct corner. That is, Harris corner detection has a problem which is sensitive to noise. Because it use the Prewitt window, Harris corner detector is strong to vertical and horizontal components, but weak on the diagonal components as Moravec operator.

2.2 SUSAN corner detection algorithm

SUSAN corner detection algorithm is proposed by Smith and Brady in 1997. This algorithm uses a circular mask form based on the values of adjacent pixels in the mask, to detect the corners. It determines the number of pixels having the luminance value close to the brightness of the central pixel in the mask. The basic idea of this algorithm is that "it is a corner point that size of the USAN (Univalue Segment Assimilating Nucleus) is the geographically smallest pixel".

2.2.1 A characteristic of SUSAN corner detector: As the method of evaluating the corners, there is determined whether a pixel is USAN, applying comparison of the brightness values. Figure 2 is the USAN, that is a set of pixels similar to the brightness value between the central pixel of the circular mask and the other pixels within the mask.

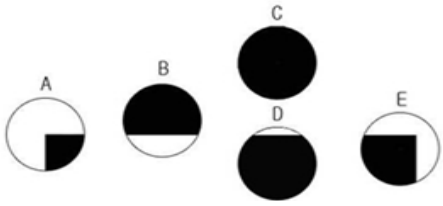


Fig. 2 USAN area

C and D in Figure 2, it means that the number of pixels similar to the central value in the mask is many. In this cases, it means the many likelihood that the edges or corners does not exist. For B, the mask is made to exist on a straight line contour, the number of surrounding pixels, such as an intermediate value for having an intermediate degree of the maximum value, it will be detected by the contour line. For A, is to have the least number of pixels is supposed to be the center value of the mask is present in the corner points of the image, in this case, is detected in the corner.

2.2.2 SUSAN Corner Problems: SUSAN corner detection is to use a circular mask of certain size, if discontinuity is frequently occur in the size and a certain threshold value and the image, the number of corner detection is frequently occur.

3. ,Rearrangement DCT Feature analysis according to Corner patch size

After extracting a corner point of the image, and rearranging the histogram of the DCT coefficients by calculating the DCT coefficients of the corner patch, it is desired to propose a method for configuring the feature vectors. Figure 3 shows the order diagram for realization of such an algorithm.

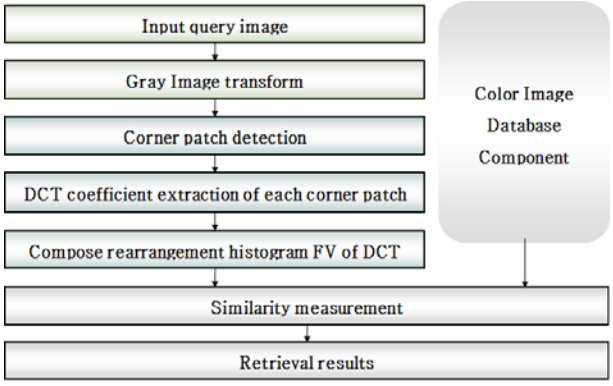


Fig. 3 Design of the corner patch DCT rearrangement algorithm

Order of the operations of the proposed algorithm is as follows:

First, converts the query image to gray scale.

Second, after converting to the edge image using the edge detection Canny, to detect line images using the Hough transform. Using the image that is complemented by the Hough transform to extract the corner points of the edge and the edge intersect. Make up a 3 * 3 corner patch table with all corner points within the query image.

By calculating the DCT from the corner patch to extract DCT coefficients. Finally, to obtain a histogram by selecting a portion of the extracted DCT coefficient sequence, construct a feature vector by rearrangement.

The order of operations as described above, first, converts the image to gray scale, as shown in Figure 4 (a), is

converted to the edge image using the Canny edge detection. After edge detection, and the land converted into lines constituting the edges of meaningful using the Hough transform, as shown in Figure 4 (b), the edge and the edges intersect with the complementary edge image as shown in Figure 4(c), extract the corner points.

(a) (b) (c)

Fig. 4 Result of the Hough transform (a) Canny edge image, (b) Image after Hough transform, (c) corner points Image

Then, after extracting a part of the corner patch DCT coefficients as shown in Figure 5, and calculate histogram.

Finally, by rearranging the histogram as shown in Figure 6, constitute a feature vector.

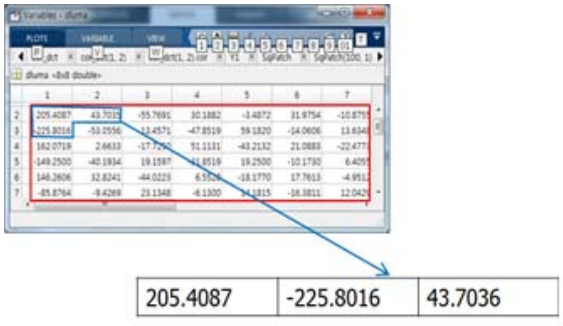


Fig. 5 The corner patch DCT coefficients

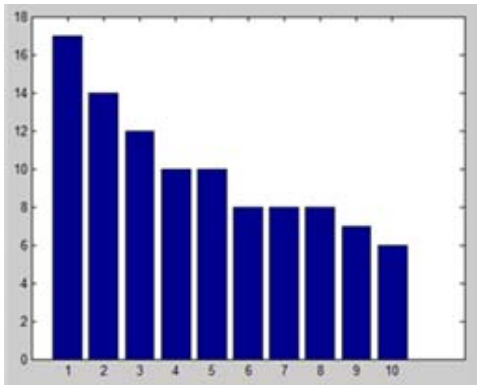


Fig. 6 The Rearrangement histogram of corner patch DCT coefficients

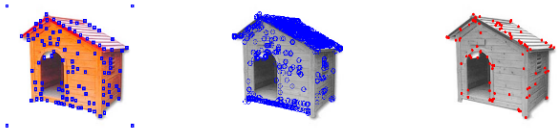
4. Simulation and Analysis

Algorithm proposed in this paper was performed by using the MATLAB7.8 software with various video images.

For this test, query images were analyzed under the same conditions. First of all, the query images used for each algorithm were the same. To explain the image retrieval method: a database of 3000 images was collected and of those 20 was chosen for to be query images for comparison. Then similar images to the 20 query images were decided on according to the algorithms. For the simulation of the algorithms, common corner detector method targeting diverse images and feature points of the proposed algorithm were saved as data in advance. For the data that was saved, when new query images were entered, only newly entered query images had to have their feature points calculated, and measurements of similarity were compared with the use of feature points in the data and the resulting similar images extracted.

4.1 Comparison of Corner detector

To compare the Harris corner detection and SUSAN corner detection and corner detection using line intersection used in the proposed paper were experimented with the house image.



(a) (b) (c)

Fig. 7 Comparison according to the corner detection (a) Harris Corner, (b) SUSAN Corner, (c) Corner using line intersection

As can be seen in Figure 7(a), the Harris corner detection can be differentiated depending on changes in the respective predetermined threshold value, it extract a corner feature points in the case of the isolated points form. In the case of the isolated corner, that its intensity variation is large, is sometimes recognized as a corner because its calculation result of the curvature value is substantially similar to the curvature value of the corner point. Method using the SUSAN algorithm extracts a corner feature points by using intensity distribution in the circular mask. Since using the change value in the mask, it generates a number of errors than the actual corner.

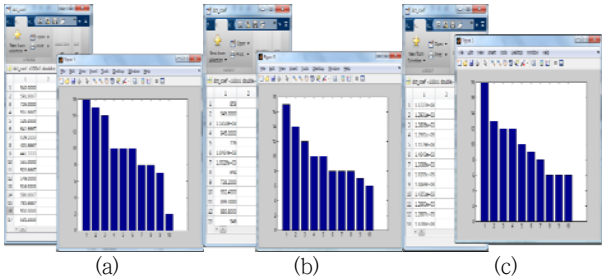
If the corner does not contain the edge points around the detected corner, the corner detector using a line intersection removes the corner to recognize the dummy

candidate, so as well as to find the optimal corner, the detection rate is faster than the Harris corner detection and SUSAN detector.

4.2 Feature Comparison according to corner patch size

The following Figure 8 compares the search performance depending on the number of the DCT coefficients of the selected corner patch and according to each corner patch size in the corner of the corner patch algorithm using DCT.

Figure 9 is a representative query image used in the simulation and Figure 10, 11, 12 and 13 are results of the simulation for the query image in Figure 9.



(a) (b) (c)

Fig. 8 Comparison acco(c) corner points Imagerding to the corner patch size (a) 3*3 corner patch DCT, (b) 5*5 corner patch DCT, (c) 7*7 corner patch DCT

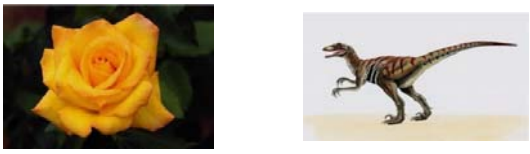


Fig. 9 Query image Q1, Q2 (a) Q1 (b) Q2

Fig. 10 The results of the retrieval for the Q1 image using the corner patch histogram

Figure 10, 12 shows the results of the retrieval for the image in Figure 9 using the corner patch histogram algorithm. Figure 11, 13 shows the results for the image in Figure 9 using an image retrieval system which uses rearrangement DCT of corner patch coefficients proposed in this study.

Corner patch DCT-based algorithm, the image is rotated than the algorithm of the existing corner points, while issuing common to find and enlarged and reduced images, it was confirmed that it is not put out by well search. However, in the case of Recall and Precision, than the corner patch histogram algorithm Recall is 0.09, Precision since high 0.04, it was confirmed that the retrieval performance better.

Fig. 11 The results of the retrieval for the Q1 image using the rearrangement DCT of corner patch coefficients

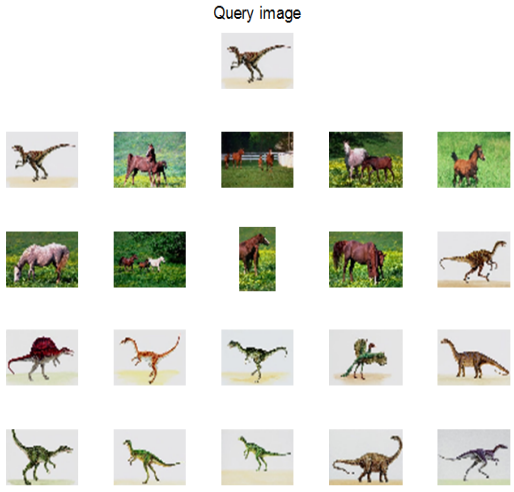


Fig. 12 The results of the retrieval for the Q2 image using the corner patch histogram

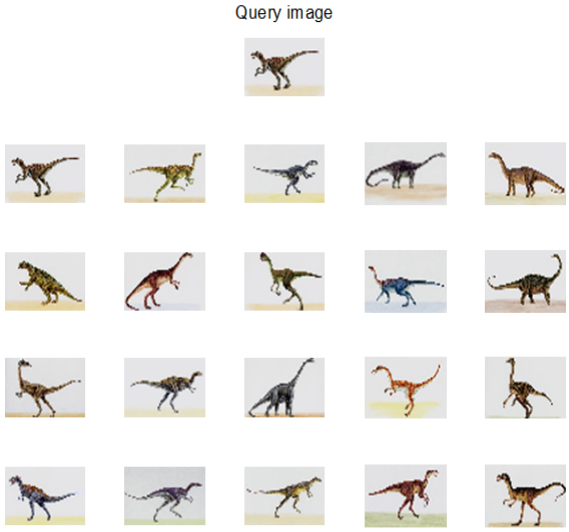


Fig. 13 The results of the retrieval for the Q2 image using the rearrangement DCT of corner patch coefficients

To analyze the efficiency of the content based image retrieval, measurements of the two functions Recall and Precision were used [26]. Recall is the ratio of retrieved images to the query images in an image database, and Precision is the ratio of query images to the retrieved images. That is, consider A as a set of relevant images in an image database and B as a set of retrieved images. In that case, Recall and Precision can be defined as a conditional probability.

In a real test, the following equation is used:

$$R_e = \frac{R_r}{T}, P_r = \frac{R_r}{T_r} \tag{3}$$

Table 1 shows the results the corner patch histogram algorithm and the retrieval system using the rearrangement DCT of corner patch proposed in this study.

Table 1 Performance measurement result

		The corner patch histogram algorithm	The rearrangement DCT of corner patch algorithm
House	Recall	0.66	0.85
	Precision	0.39	0.44
Bus	Recall	0.75	0.90
	Precision	0.47	0.50
Dinosaur	Recall	0.75	0.85
	Precision	0.57	0.40

5. Conclusion

In this paper, it is proposed that the rearrangement corner points based search algorithm for the information search of new forms to enhance the noise invariance in conventional corner points are utilized in recognition of form. After extracting a corner point in the image, this study proposed a method for configuring a feature vector by applying the DCT.

To verify the proposed algorithm is composed of a variety of images other sizes, through simulation using the 3,000 database, it was confirmed the following facts.

Corner patch DCT-based algorithm, the image is rotated than the algorithm of the existing corner points, while issuing common to find and enlarged and reduced images, it was confirmed that it is not put out by well search. However, in the case of Recall and Precision, than the corner patch histogram algorithm Recall is 0.09, Precision since high 0.04, it was confirmed that the retrieval performance better.

The proposed system in this way, by extracting the information of the various forms of data of the multimedia, to configure the optimum database, will be able to utilize a system that can be searched. In the future, the development of optimized algorithms expressed characteristics information of the video, optimized search engine should research on the construction of continuous video database is continued.

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References

[1] G. Capi, “A Vision-based Approach for Intelligent Robot Navigation”, Intelligent Systems Technologies and Applications, vol. 3, no. 2, (2010)

[2] A. Chatterjee, O. Ray, A. Chatterjee, and A. Rakshit, “Development of a Real-life EKF based SLAM System for Mobile Robots employing Vision Sensing”, Expert Systems with Applications, vol. 38, no. 7, (2011), pp. 8266-8274.

[3] B. Fishbain, M. Mehrubeoglu, “Guest Editorial of the Special Issue on Real-time Vision-based Motion Analysis and Intelligent Transportation Systems”, Real-

Time Image Processing, (2010)
[4] Y. Fang, “Fusion-layer-based Machine Vision for Intelligent Transportation Systems”, MIT Thesis, (2010)
[5] Kim. J, Kim. I, Kwon. N, Park. H, and Chae. J, “A Hybrid Algorithm for Online Location Update using Feature Point Detection for Portable Devices“. KSII Transactions on Internet and Information Systems, 9, 2, (2015), pp. 600-619
[6] R. G. Brown, C. E. Hann, and J. G. Chase, “Vision-based 3D Surface Motion Capture for the DIET Breast Cancer Screening System”, Computer Applications in Technology 39, (2010), pp. 72-78.
[7] M. Patel, S. Lal, D. Kavanagh, and P. Rossiter, “Fatigue Detection Using Computer Vision”, Electronics and Telecommunications, vol.56,no. 4, (2010)
[8] A.K. Jain, “Fundamental of Digital Image Processing”, Prentice Hall International, (1989)
[9] A. Khotanzad and Y.H. Hong, "Invariants Image Recognition by Zernike Moments", IEEE Trans. on Pattern Analysis and Machine Intelligence, vol. 12, no. 5, (1990), pp. 489-497.
[10] H.K. Kim, J.D. Kim, D.G. Sim, and D.I. Oh, "A modified Zernike moment shape descriptor invariant to translation, rotation and scale for similarity-based image retrieval", Multimedia and Expo, 2000, ICME 2000. 2000 IEEE International Conference on, vol. 1, pp. 307-310, (2000)
[11] Y.S. Kim and W.Y. Kim, "Content-based trademark retrieval system using a visually salient feature", Image & Vision computing, vol. 16, no. 12-13, (1998), pp. 931-939.
[12] F. Mokhtaian and R. Suomela, "Robust Image Corner Detection Through Curvature Scale Space", IEEE Trans. On PAMI, vol. 20, no. 12, (1998), pp. 1376-1381.
[13] O.A. Zuniga and R.M. Haralick, "Corner Detection using Facet Model", Proc. Conf on Pattern Recognition and Image Processing, (1983), pp. 30-37.
[14] L. Kitchen and A. Rosenfeld, "Gray level corner detection", Pattern Recognition Letters, vol. 1, (1989), pp. 95-102.
[15] H.P. Moravec, "Towards automatic visual obstacle avoidance", Proceedings of the 5th IJCAI, MIT, Cambridge, Mass., (1977), pp. 584.
[16] C. Harris and M. Stephens, "A combined corner and edge detector", Proc. 4th Alvely Vision Conference, (1988), pp. 189-192.
[17] M. Trajkovic and M. Hedley, "Fast corner detector", Image and Vision Computing, vol. 16, no. 2, (1998), pp. 75-87.
[18] S.M. Smith and M. Brady, "SUSAN-a new approach to low level image processing", International Journal of Computer Vision, 23, no. 1, (1997), pp. 45-78.
[19] C. Achard, E. Bigorgne, and Devars, "A sub-pixel and multispectral corner detector", Pattern Recognition, Proceedings. 15th International Conference on. vol. 3, (2000), pp. 959-962.
[20] P.I. Rockett, "Performance assessment of feature detection algorithms : a methodology and case study on corner detectors", Image Processing, IEEE Transactions on. vol. 12, no.12, (2003) Dec., pp. 1668-1676,
[21] X.C. He and N.H.C Yung, "Curvature scale space corner detector with adaptive threshold and dynamic region of support", Pattern Recognition, ICPR, Proceedings of the 17th International Conference on. vol. 2, (2004)Aug, pp. 23-26.
[22] Zheng, Zhiqiang, Han Wang, and Eam Khwang Teoh, "Analysis of Gray Level Corner Detection", Pattern Recognition Letters 20, (1999), pp. 149-162.
[23] J. Bigun, "Recognition of local symmetries in gray value images by harmonic functions", Proc. 9th Int'1 Conf. on Pattern Recognition,(1998), pp. 345-347
[24] Jing, Dong, Chen Dong, and Jiang Shuwen. "Video Seamless Splicing Method Based on SURF Algorithm and Harris Corner Points Detection." International Journal of Multimedia and Ubiquitous Engineering 11.4 (2016) pp. 197-206.
[25] J. K. Lee, "Design of the Pattern Recognition System using Corner Detector and Local Block Matching Algorithm", Ulsan UNIV. Thesis, (2007)
[26] Y. Kim, W. H. Kwon, B. H. Koo, K. S. Youn, “Object boundary tracking using modified chain code algorithm”, Journal of CICS, vol. 10, (2007)

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