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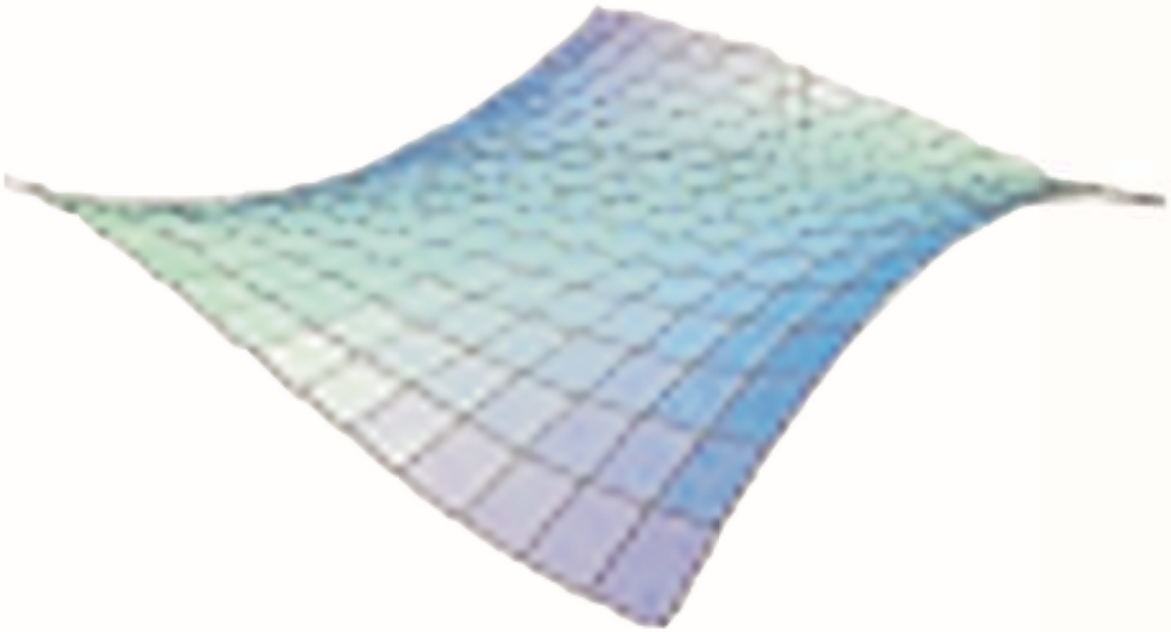

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[2] D.O. Hebb, Organization of Behaviour, Wiley, New York, 1949.

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A New Technique Based on PIFS Code for Image Retrieval System

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Abstract

This paper proposes a new feature extraction method for image retrieval system based on local self-similarity PIFS code. The feature of image is represented by using distance and angle of a pair of range and domain block position from fractal code. This paper also uses variant contrast and spatial dimensions fractal feature for comparison. The testing of system's performance is using 1000 images which have been stored in a database with 10 different categories with different number of image for each category. Images are classified as Homogeneous and Heterogeneous Image based on the complexity of the background image. The results show the proposed method gives a good performance.

Keywords: Image Retrieval, Fractal Code, PIFS code

1 Introduction

Information Technology's growth has change the way of people life in searching, storing and using information, one of which is the forming of images. Retrieving information in images form (image retrieval) becomes an active area of research in information technology because of some constraints in its settlement especially which is related to the relevance of the information that has been processed [6].

There are two methods of image retrieval. Those methods are; taking a text based image retrieval called metadata and content-based image retrieval. Base metadata using alphanumeric attributes is used to describe the context or the contents of an image [2]. To overcome the limitations of text-based image retrieval, there is a more effective way that is image capturing based on the content, including color, texture, shape, and special relationship object [3,14,16]. The Image Capturing which is based on the content known as Content-Based Image Retrieval (CBIR). CBIR is an approach in image retrieval which is based on the information which has contained in the image by using low-level image content [1,11,13]. The most challenging aspect of CBIR is to bridge the gap between low-level layout features and high-level semantic concepts [4]. The approach which is based on color and texture feature extraction is still being enhanced continuously [10, 17].

Various methods could be used in image retrieval system based on content. Fractal is also used for image compression and image analysis. Analysis of the image which is referred is the use of fractal coding to separate features of an image [8, 9]. Image retrieval system using fractal coding previously has been used by several researchers but using different methods in extraction feature [5,11,14]. This paper introduces a new feature extraction method based on local self-similarity fractal by using distance and angle from a pair of range and domain block position from PIFS code. This paper also uses variant contrast and spatial dimensions fractal feature for comparison.

This paper is organized as. Part 2 describes about related works. Part 3 portrait schemes stages of fractal-based image retrieval. Part 4 describes the results of testing. Part 5 contains a summary of the image retrieval system based on fractal.

2 Related Works

The image retrieval's developments have been done by several researchers so far. There are several researches about image retrieval which are using fractal code that has been done. Ben A.M. Schouten and Paul M. de Zeeuw [12] described the extraction of the feature that could be obtained by the fractal code which could be used as well to do image retrieval processing. They defined the features for the textures are symmetry, contrast, coarseness and feature for spatial

similarity which are; uniformity, direction and dimension. The other related researches about this case are using PIFS codes to do similarity-based image retrieval [15]. They did the region(R) range extract and domain (D) range correspondence in vector mapping and did the clustering in order to get the representative vector from each image and then searched the similarity between them. Several other researches that have been done were utilizing the fractal coding to enhance their research results [7]. In our previous research, had been utilized the fractal coding to do palmprint biometric recognition [9]. Here, this research utilizing the extraction process features from our previous research for image retrieval system.

3 Proposed Scheme

This section is an overview of the whole process of image retrieval system that has several modules such as preprocessing, fractal coding, feature extraction and similarity measure. **Figure 1** shows the proposed scheme

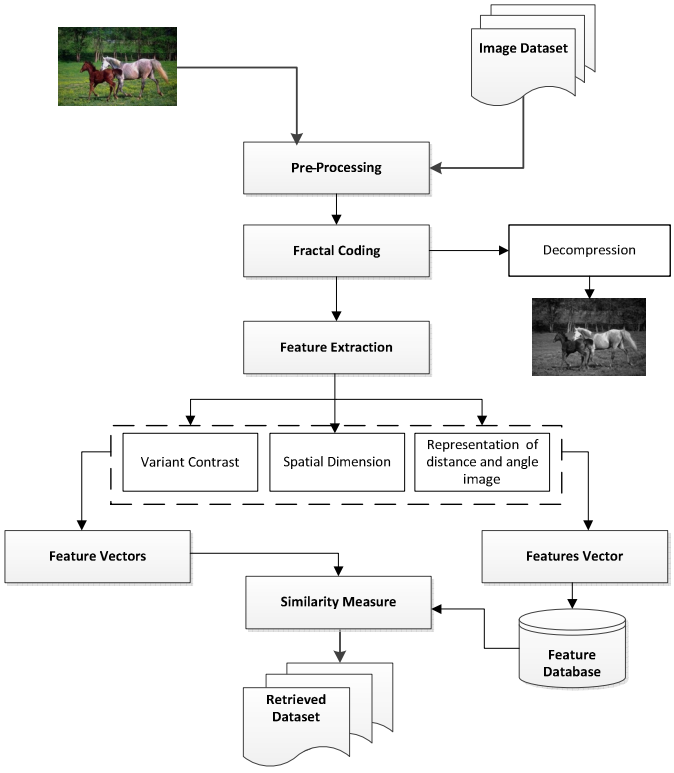


Figure 1. Image Retrieval diagram using fractal coding method

3.1 Preprocessing

The preprocessing stage converts image into gray level and scales the image size to 256 x 256 pixels.

3.2 PIFS Code

Fractal code of an image is a compression code which is generated by the self-similarity characteristic of fractal. Fractal codes of image is obtained by using the partitioned iterated function system (PIFS) method that works based on local self-similarity of image. Quad tree technique parts each image into range and domain blocks. The domain blocks have larger size than the range blocks [9]. The relation between a pair of range block (R_i) and domain block (D_i) is noted as

$$R_i = w_i(D_i) \qquad (1)$$

where w_i is contractive transformation that represent the similarity relation between R_i and D_i, and is usually defined as:

$$w_i\begin{bmatrix} x_i \\ y_i \\ z_i \end{bmatrix} = \begin{bmatrix} a_i & b_i & 0 \\ c_i & d_i & 0 \\ 0 & 0 & s_i \end{bmatrix}\begin{bmatrix} x_i \\ y_i \\ z_i \end{bmatrix} + \begin{bmatrix} e_i \\ f_i \\ o_i \end{bmatrix} \qquad (2)$$

where x_i and y_i declare top-left coordinate of the R_i, and z_i is the brightness value of its block. a_i, b_i, c_i, and d_i are the coefficients which represent rotation, scaling and luminance offset respectively. Vector elements e_i and f_i are offset value of space. s_i and o_i represent contrast scaling and luminance offset respectively. The actual fractal code f_i is usually used in practice [9,15].

$$f_i = \left((x_{D_i}, y_{D_i}), (x_{R_i}, y_{R_i}), size_i, \theta_i, s_i, o_i\right) \qquad (3)$$

where (x_{R_i}, y_{R_i}) and (x_{D_i}, y_{D_i}) declare top-left coordinate position of the range and domain block, respectively, the size of range block is represented by *size*, and θ_i declare the spation rotation index of the domain region. The index value can been seen in [8, 9]. The PIFS code of an image is denoted as follow:

$$F = \bigcup_{i=1}^{N} f_i \qquad (4)$$

where N represents the number of the fractal code. The formula (5) is used to determine weather a pair of range and domain block is similar or not.

$$d(R,D) \le \varepsilon, \quad (5)$$

where *d(R,D)* and ϵ represents RMSE and tolerance value. The pair of range and domain block is similar if *d(R,D)* is less or equal than ϵ. Otherwise, the block is denoted as not similar[9]. This paper used tolerance value ϵ = 1.

3.3 Feature Extraction

The feature of image is represented by using distance and angle of a pair of range and domain block positions from fractal code. For comparison this paper also uses variant contrast and spatial dimensions fractal feature.

3.3.1 Proposed Feature Extraction Method

Distance feature C_1 and angle feature C_2 are formed by the following rules.

$$C_1(m,n) = dist_i,\ m = 1,2,\dots,M_1,\ n = 1,2,\dots,M_2 \qquad (6)$$

where $dist_i = \sqrt{\left(x_{R_i} - x_{D_i}\right)^2 + \left(y_{R_i} - y_{D_i}\right)^2}, i = 1,2,\dots N$ (7)

for $m = x_{R_i}$ and $n = y_{R_i}$, and otherwise $dist_i = 0$.

$$C_2(m,n) = \alpha_i,\ m = 1,2,\dots,M_1,\ n = 1,2,\dots,M_2 \qquad (8)$$

where $\alpha_i = arctan\left|\frac{y_D - y_R}{x_D - x_R}\right|, i = 1,2,\dots,N$ (9)

for $m = x_{R_i}$ and $n = y_{R_i}$, and $\alpha_i = 0$ for the other condition.
Requirements below are added to the calculation for the value of α_i.

If $x_D > x_R$ and $y_D \geq y_R$ then $\alpha_i = 360 - \alpha_i$.
If $x_D < x_R$ and $y_D \leq y_R$ then $\alpha_i = 180 - \alpha_i$
If $x_D < x_R$ and $y_D \geq y_R$ then $\alpha_i = 180 + \alpha_i$
If $x_D > x_R$ and $y_D \leq y_R$ then $\alpha_i = \alpha_i$
If $x_D == x_R$ and $y_D \geq y_R$ then $\alpha_i = 270$
If $x_D == x_R$ and $y_D \leq y_R$ then $\alpha_i = 90$

C_1 is called distance feature because contains $dist_i$ that represent the distance between range blocks and domain block, and C_2 is called angle feature since C_2 contains α_i that represent the angle between range blocks and domain the block. The next step is divides C_1 and C_2 to be M x M blocks and then for each block was calculated the average value μ to obtain the feature vector v_1 that related to C_1 and v_2 that related to C_2 feature, as follows [9]:

$$v_1 = (\mu_1, \mu_2, \dots, \mu_{M^2}) \qquad (9)$$

$$v_2 = (\mu_1, \mu_2, \dots, \mu_{M^2}) \qquad (10)$$

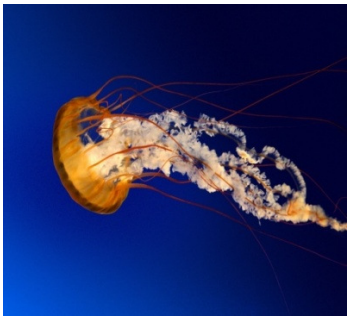
This paper selected M = 16 so the length of each feature vector v_1 and v_2 is 256.

3.3.2 Variant Contrast

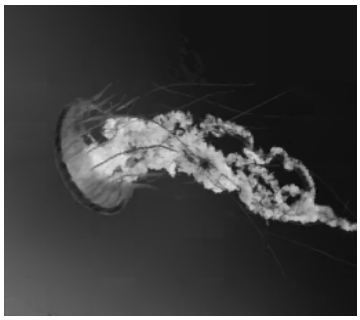
Variant contrast feature can be calculated by the equation:

$$\mu = \frac{1}{N}\sum_{i=1}^{N} s_i \qquad (10)$$

$$\sigma = \frac{1}{N}\sum_{i=1}^{N}(s_i - \mu)^2 \qquad (11)$$



(a)



(b)

0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	3	3	3	4	3	3	4	3	1	3	0	0	0
0	0	4	6	5	4	2	3	3	4	5	6	1	0	0	0
0	0	5	4	7	4	4	3	3	3	3	2	0	0	0	0
0	0	6	5	5	4	5	3	3	2	2	3	4	1	0	0
0	0	4	3	5	6	5	3	2	4	3	3	3	4	2	0
0	0	1	5	5	4	3	0	3	3	3	3	4	4	2	0
0	0	0	3	5	4	0	0	0	0	3	4	3	5	5	7
0	0	0	0	0	0	0	0	0	0	0	3	2	3	4	7
0	0	0	0	0	0	0	0	0	0	0	0	2	0	4	1
0	0	0	0	0	0	0	0	0	0	0	0	2	1	0	2
0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

(c)

0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	10	16	10	10	10	16	16	10	0	10	0	0	0
0	0	10	20	20	20	10	16	16	16	16	20	0	0	0	0
0	0	20	20	20	20	20	20	20	20	20	10	0	0	0	0
0	0	20	20	20	20	20	20	20	20	16	20	20	0	0	0
0	0	10	20	20	20	20	20	20	20	20	20	16	20	0	0
0	0	0	20	20	20	10	0	10	20	20	20	20	20	10	0
0	0	0	10	20	16	0	0	0	0	10	20	20	20	20	20
0	0	0	0	0	0	0	0	0	0	0	10	10	10	10	20
0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

(d)

0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	6.5	5.2	7.1	3.2	4.6	7.1	9.4	7	3.9	5	0	0	0
0	0	5.5	4.1	6	6.6	9.7	9.9	9.3	8.7	8.3	7.5	6.5	0	0	0
0	0	7.8	6.1	9.5	4.9	7.6	12	12	12	8.4	9.6	0	0	0	0
0	0	6.7	6.2	6.1	9.2	8.6	8.2	11	9	9.6	10	13	6.5	0	0
0	0	7.1	4.6	7.8	7.2	4.2	9.2	8.3	7.9	11	12	9.6	11	4.4	0
0	0	7.3	6.9	4.4	7.5	6.4	0	9.6	9.5	8.4	9.3	11	12	8.9	0
0	0	0	5.8	4.7	7.4	0	0	0	0	9.2	9.8	10	7.2	8.3	4.3
0	0	0	0	0	0	0	0	0	0	0	6.1	6.9	9.6	6.2	9
0	0	0	0	0	0	0	0	0	0	0	0	5.7	3.6	4.8	0
0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	5.9
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

(e)

1.08	0	0.75	0	0.98	0	1.15	0	0.35	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1.06	0	1.08	0	0.52	0	0.44	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.35	0	1.21	8.26	14.3	11.7	11.2	10.9	11.9	12	6.98	2.66	8.95	0.44	0.86	0
0	0	11.1	19.9	18.6	15.7	9.55	15	13.3	13.5	10.5	11.8	5.21	0.71	0	0
1.29	0	14.1	17.2	20	18.6	16.7	15.3	16.7	15	14.5	8.25	0.45	0.36	0.61	0
0	0	14.5	15	16.2	14.8	17.5	15	12.7	11.5	11.8	14.1	12.8	4.44	0	0
1.25	0	7.34	10.6	6.64	14.3	13.9	13.8	10.8	12.6	12.6	12.7	9.88	10.7	4.79	0.67
0	0	5.82	8.55	4	7.95	3.37	0.51	7.53	8.18	7.77	8.15	9.47	12.6	7.26	0.53
1.05	0	1.27	4.39	6.88	9.43	0.76	0	0.51	0	6.38	8.28	8.13	9.83	9.23	10.3
0	0	0.91	0.41	1.39	0.45	0	0	0	0	0.59	4.52	7.15	4.59	5.7	9.48
0.35	0	0.46	0	0.61	0	0.61	0	0.49	0	0.66	0	4.8	1.52	5.13	0.56
0	0	0	0	0	0	0	0	0	0	0	0	1.95	0.51	0.66	1.81
0.32	0.41	0.45	0	0.22	0	0.62	0	0.53	0	0.61	0	0.51	0	0.65	0
1.32	0.23	0	0	0	0	0	0	0	0	0	0	0	0	0	0

(f)

Figure 2. Image Sample (a), Decompressing gray scale image (b), representation of distance feature (c), representation of angle feature (d), variant contrast (e), spatial dimension (f)

Where μ represent the average of contrast scaling s_i from fractal code, σ represent variant contract feature, and N denotes the number of contrast scaling factor used [8].

3.3.3 Spatial Dimension

Spatial dimensions feature could be obtained by counting the number of couples which are not similar when determining the fractal code. Fractal code only contains similar pair. It does not contain the pairs which are not similar [8,12]. Spatial dimension feature is computed as follows:

$$d_i = \log\left(\frac{(f_{i+1})}{(f_i)}\right) \qquad (12)$$

Figure 2 shows the representation of distance, angle, variant contrast and spatial dimension vector feature with size 16 x 16 blocks. Figure 2(b) shows the gray level version of decompression image of original image. The proposed method and also variant contrast can be formed directly from compression code.

4 Experiment Result

4.1 Sample Image

The performance testing is using 1000 images which has stored in database with 10 different categories with different number of image for each category. The testing is done to 5 query images for each category, and then the image is divided into 2 types, which are homogenous image and heterogeneous image are based on its background complexity. The 5 categories of homogeneous images are the image of dinosaurs, dolls, design, motors, and buildings. As for the 5 categories of heterogeneous are the image of horses, roses, cars, elephants, buses which are taken from http://wang.ise.pso.edu.

4.2 System Testing

The system performance is measured by precision parameter in first 20 images which are returned by system. It's defined by:

$$Precision = \frac{No.relevant\ document\ retrieved}{Total\ no.document\ retrieved} \qquad (13)$$

The similarities degree between query and reference image is used Euclidean's distance, which is simple and suitable in most cases, and especially when dealing with large numbers of images.

Table 1 and **Table 2** compare the odds between 3 different features as for homogeneous and heterogeneous.

Table 1. The results of the average accuracy of each category for homogeneous image

No.	Category	Variant Contrast (%)	Spatial Dimension (%)	Proposed Method (%)
1	Dinosaurs	94.05	96.67	99.05
2	Doll	94.52	92.14	92.34
3	Design	93.57	87.62	98.81
4	Motor	78.33	77.38	82.52
5	Building	100	100	100
Average Accuracy (%)		92.09	90.76	94.54

Table 2. The results of the average accuracy of each category for heterogeneous image

No.	Category	Variant Contrast (%)	Spatial Dimension (%)	Proposed Method (%)
1	Horse	85.95	87.86	73.80
2	Flower	64.28	87.62	95.24
3	Bus	64.52	83.33	74.71
4	Elephant	78.57	84.28	78.84
5	Car	66.9	65.48	68.79
Average Accuracy (%)		72.04	81.71	78.28

The average value of the accuracy for all categories which is tested by using variant contrast, spatial dimensions, and combination of distances and angles features from type of homogeneous images respectively is 92.10%, 90.76% and 94.56%, while from type of the heterogeneous image respectively is 72.04%, 81.71% and 78.28%.

Figure 3 shows the results of testing the system to find the accuracy for homogeneous image type.

(a) (b)

Figure 3. (a) The first 20 retrieving homogeneous images using variant contrast, (b) The first 20 retrieving heterogeneous images using combination of distance and angle feature

4.3 Feature's Endurance Testing

The endurance testing has been done on several testing processes such as; rotation testing, brightness, zoom, and also blur testing. The testing has been done by doing editing process on testing image. The testing is done in every feature by doing similarity testing process on edited image. With the same original image which has been stored in database, endurance testing would have a valid value if

the similar image appears on the first 10 picture. Every image category is represented by 10 pictures which later will be done the editing process based on its test. The editing process shows that combination distance and angle feature, variant contrast feature have a better endurance in some testing criteria while spatial dimension has a lower endurance.

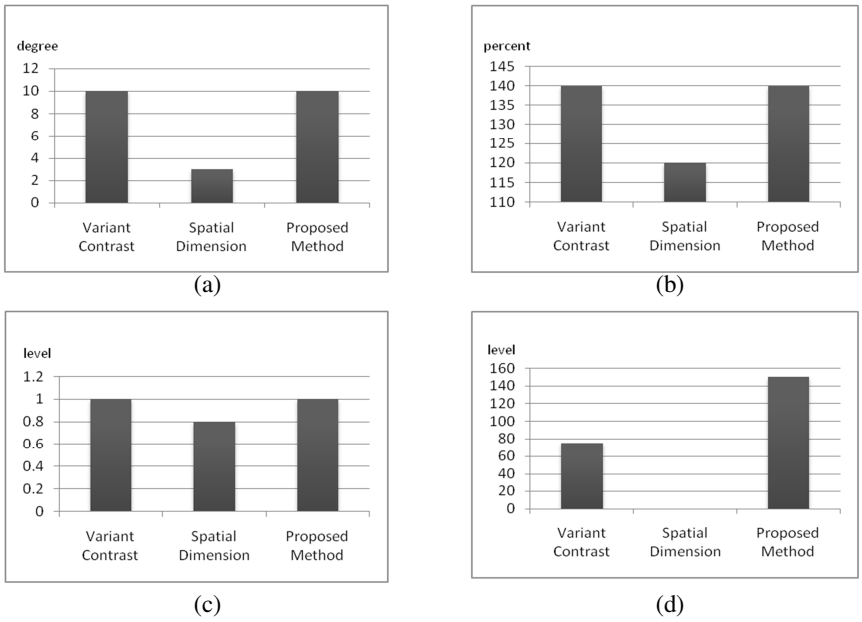


Figure 7. Feature's endurance testing, (a) rotation testing, (b) zooming testing, (c) blurring testing, (d) brightness testing

5 Conclusions

The experiment results show that the proposed feature extraction method in this paper, distance and angle features, could handle image retrieval system with good performance and also can be formed directly from fractal compression code. System accuracy by using homogeneous image type gives better accuracy than heterogeneous image type. Our method is also successful in endurance testing by using query images which are rotated, scaled, blurred, and changed its brightness. Going forward, the proposed method will be improved its performance especially for heterogeneous image.

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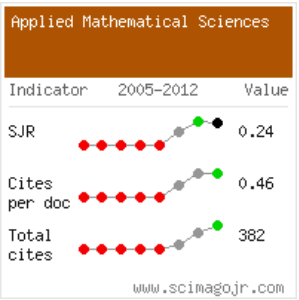

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Indicators	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
SJR	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,136	0,270	0,235
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Cites / Doc. (4years)	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,21	0,44	0,42
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