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IMAGE RETRIEVAL OF MOTIFS IN MALAY VERNACULAR ARCHITECTURE

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Abstract

In this paper, we propose a simple yet effective technique of indexing and retrieval of motifs from the carvings found in the Malay vernacular architecture. The algorithm will further classify the motifs into two main codes, i.e, Bunga' code and 'Daun' code. The 'Bunga' code will be sub-categorized into eight types and the 'Daun' code will also be sub-categorized into eight types. Hence, given an input motif image, it is expected that it will output the correct motif classification. The proposed algorithm will not only retrieve the motifs automatically but it will also create a database of digitized motifs.

Keywords: Malay Vernacular Architecture; motif; image retrieval.

1. Introduction

The art of Malay vernacular architecture in carvings, in particular, has its own style and originality which will eventually become extinct over time if they are not being preserved properly. Old houses maybe deteriorated along with their historical and originality background. Mohd (2007) has explored the work on motifs which was done by Smith (1996) and Nasir (1987) in the east coast of peninsular Malaysia. He has observed that similar features in the motifs were found in the Malay vernacular architecture. Interestingly, Mohd (2007) has translated the motifs into two major categories namely, "bunga" and "daun". Eight codes were further categorized from "bunga" based on the number of petals of the flowers and another eight codes from the category of "daun" which was based on its shapes. Unfortunately as mentioned in Christine (2009), this usable information has never being digitized and it is only observed manually. Based on the concept of image processing, the motifs obtained can be classified automatically by using the codes as categorized by Smith (1996) . It can also be done by using neural network or Support Vector Machine which was done by Vapnik (1995) or any other classifier tool that will produce a high accuracy result. General image features that have been used by many researchers include colour, texture and shape features. It has been observed that, many imaging applications such as image indexing and retrievals is based on good image classification as been mentioned by Fredembach et. al (2004), Giacinto et. al (2000), Pun et. al (1996) and Chang S.F. (1997). The rest of the paper is organized in two sections. Section 2 mainly describes the retrieval algorithm design, and Section 3 reports the initial experiments to evaluate the proposed algorithm.

2. Retrieval Algorithm Design

To extract indexing keys out of the Joint Photographic Experts Group (JPEG) bit streams, a thorough examination of how JPEG bit stream is produced is necessary. After the block-based Discrete Cosine Transform (DCT) coefficients are quantized and ordered in zig-zag scanning, the JPEG compression scheme uses the runlength coding to specify the number of zeroed alternate current (AC) coefficients preceding each non-zero valued AC coefficient. For direct current (DC) coefficient, only the difference between its previous DC and itself is encoded. Both AC and DC coefficients are grouped into a number of categories according to their magnitude values as illustrated in Table-1. A fixed Huffman coding table is then designed to specify the category and the length of its codeword. The base code table for DC is illustrated in Table-2, and part of the base code table for AC coefficient is illustrated in Table-3, which is incomplete but illustrated to explain how the run-length AC is entropy encoded in JPEG.

Table 1: JPEG Coefficient Coding Categories

Range	DC Difference Category	AC Category
0	0	N/A
-1, 1	1	1
-3,-2,2,3	2	2
-7,...,-4,4...,7	3	3
-15,...,-8,8,...,15	4	4
-31,...,-16,16,...,31	5	5
-63,…,-32,32,…,63	6	6
-127,…,-64,64,…,127	7	7
-255,…,-128,128,…,255	8	8
-511,…,-256,256,…,511	9	9
-1023,…,-512,512,…,1023	A	A
-2047,…,-1024,1024,…,2047	B	B
-4095,…,-2048,2048,…,4095	C	C
-8191,…,-4096,4096,…,8191	D	D
-16383,…,-8192,8192,…,16383	E	E
-32767,…,-16834,16384,…,32767	F	N/A

Table-2 JPEG default DC code (luminance)

C	BC	L	C	BC	L
0	010	3	6	1110	10
1	011	4	7	11110	12
2	100	5	8	111110	14
3	00	5	9	1111110	16
4	101	7	A	11111110	18
5	110	8	B	111111110	20

Where C = Category; BC = base code; L = length

Table-3 JPEG default AC code (luminance)

R/C	BC	L	R/C	BC	L
0/0	1010	4	2/1	11011	6
0/1	00	3	2/2	11111000	10
0/2	100	4	2/3	1111110111	13
…			…		
1/1	1100	5	3/1	111010	7
1/2	111001	8	3/2	111110111	11
…			…		

Where R/C=run/category; BC=base code; L=length.

As an example, if the differential value of a DC coefficient is within the category 2, its magnitude value will be one of four possible values ranging from -3 to 3 as specified in Table-1. Therefore, it will be encoded by a base code of 100 followed by 2 bits to specify its exact magnitude value within that category. For an AC coefficient, assuming its magnitude value falls into the category 3, and two preceding zeros are counted by run-length coding. This would give us R/C = 2/3. From Table-3, this AC coefficient will be encoded by a base code of 1111110111 followed by 3 bits to specify its exact magnitude value out of the possible 8 values given in Table-1. From the above analysis, it can be seen that JPEG entropy coding scheme is essentially built upon two major factors. One is the number of zeros recorded by run-length coding along the zig-zag scanning order, and the other is the magnitude value of each DCT coefficient. In principle, the magnitude values of the DCT coefficients represent the signal energy within that particular block, which also reflect the texture feature of those pixel values inside that block. As a matter of fact, MPEG-4 refers the DCT-based entropy coding as texture coding to differentiate from its shape coding. To this end, we could construct an indexing key by considering those category numbers to characterize the texture feature of each individual pixel block. Hence, the total number of 64 coefficients inside each block will enable us to produce 64 texture elements, which correspond to their category numbers specified in Table-1 to 3. For those zero valued AC coefficients, their texture elements are simply regarded as zeros. As a result, a vector of 64 elements is constructed to represent the texture feature of the pixel block. To characterize the texture feature of an entire image, such a vector can be used as a building block towards formulation of the indexing key. Therefore, given N blocks of DCT coefficients inside an image, the indexing key can be constructed as follows:

Indexing-key = {c1, c2, c3, …c64} (1)

Where $ci = \frac{\sum_{k=1}^{N} category_k}{N}$ stands for the ith category

(number among the 64 DCT coefficients)

The advantage of this design lies in the fact that the indexing key can be directly built up by those entropy codes, and thus no decoding is ever needed. Specifically, to build the texture key for each image file, all we need is to read those bits of base codes from the compressed file, which are used to encode the category number of the DCT coefficients for each individual block, and all other bits are simply ignored. From a JPEG compressed image bit stream, the EOB (end-of-block) codes will enable us to count the total number of blocks inside each image. For the retrieval process, the query image in question will be subjected to the same operation to read those base code bits and category numbers are used to calculate its indexing key as given by Smith (1996). The keys computed for the query image will then be compared with keys stored for those images inside the database via the Mean Square Error (MSE) method.

3. Experimental Results

To test the proposed algorithm, we constructed a test database of around 1716 JPEG images, which are broadly classified into two main themes "Bunga" and "Daun". The two main groups are further classified into sub-categories as given in Table 4.

Table 4:Breakdown of Test images

BUNGA	No. of images	DAUN	No. of images	
Bbt	91	Dbh	11	
Bbp	43	Dbl	132	
B3k	104	Dbt	235	
B4k	106	Djk	27	
B5k	51	Djl	176	
B6k	29	Djr	240	
B7k	21	Dt	164	
B8k	56	Dhg	230	
	501		1215	1716

We then selected 10 different query images to carry out the image retrieval, in which a total of 9 target images are retrieved for every query image. According to the values of their matched distances, the retrieved images are arranged in an ascending order, where the first image corresponds to the minimum distance derived between the retrieved image and the query image. Hence, an ascending order of 9 ranks is formulated. The total experimental results are summarized in Table-5. The results show that the algorithm is able to extract rank 1 images 100% of the time, rank 2 images 70% of the time and up to rank 3 images at least 60% of the time.

Table 5. Retrieval results

un #	1	2	3	4	5	6	7	8	9	10	Total
Rank 1	1	1	1	1	1	1	1	1	1	1	10
Rank 2	1	1	1	1	1	1	1	0	0	0	7
Rank 3	0	0	1	1	0	1	1	1	1	0	6
Rank 4	1	1	0	1	1	1	1	1	0	0	7
Rank 5	1	1	1	0	1	1	1	1	0	1	8
Rank 6	1	1	1	0	0	1	1	0	1	1	7
Rank 7	1	1	1	0	1	0	0	1	1	0	6
Rank 7	1	1	1	1	1	1	1	0	1	1	9
Rank 8	1	0	0	1	1	1	1	1	1	1	8
Rank 9	0	1	1	1	1	1	1	1	0	1	8

where 1 stands for relevant and 0 is not relevant

It also appears that for ranks 4 – 9 most of the images are retrieved in the range of 60% to 90% of the time which is encouraging.

To strengthen our initial experiments design, we illustrate two query examples in Figure-1 for the convenience of visual inspection, which will contribute to the visual examination of relevancy between the query image and the retrieved images. As shown in Figure-1, sample query 1with query image DBH10_D_11.JPG was used to compare with the images in the database. The images below the query image shown in Figure-1 are the images retrieved automatically by using the algorithm proposed and were ranked based on its similarity. It should be noted however that the system has yet to be fully tested against a considerably larger size image database, which is currently under consideration. Nonetheless, the initial experimental results do present encouraging signs for our proposed algorithm.

Conclusion

In this paper, we have carried out image retrieval on digitized Malay motifs by using the algorithm proposed. Moving forward, we also hope to accomplish two things. First and foremost, we hope to build a collection of digitized images of motifs in Malay vernacular architecture. It is expected that more images will be added to the current repository. Apart from helping to preserve an important cultural heritage, we would also be making it publicly available for others who want to do their research in Malay motifs. Secondly we would like to develop a GUI – based system that will categorize automatically for a given image into their sub-categories. This is more of a learning tool for students who are interested in this area.

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Figure 1:

a. Sample query 1

Query image : DBH10_D_11.JPG

DJR4_D_253 DHG10_D_12. DJL10_D_26 DHG4_D_192 DBT10_D_174 DT10_D_141

BBT10_B_18 DBL9_D_25 DJR8_D_230 DBT4_D_294

b. Sample query 2

Query image :B3KSS4_B_75.JPG

B6K4_B_94 B4K4_B_77 B4K4_B_72 B6K4-B_14 DT4_D_339 DT4_D_155

DJR4_D_312 BBPL4_B_17 B8K4_B_17 B5K4_B_74