Content Based Image Retrieval Using Advanced Color and Texture Features

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ABSTRACT
The paper presents an efficient Content Based Image Retrieval (CBIR) system using color and texture. In proposed system, two different feature extraction techniques are employed. A universal content based image retrieval system uses color, texture and shape based feature extraction techniques for better matched images from the database. In proposed CBIR system, color and texture features are used. The texture features were extracted from the query image by applying block wise Discrete Cosine Transforms (DCT) on the entire image and from the retrieved images the color features were extracted by using moments of colors (Mean, Deviation and Skewness) theory. The proposed system has used Corel database of 1000 images. The feature vectors of the query image will then be compared with feature vectors of the database to obtain similar images. Individual and combined vectors using color and texture features were computed and the combined feature vector results were comparatively better. The proposed system provides an efficiency of 60%.

Keywords
Content Based Image Retrieval, Color Models, DCT, Color Moments.

1. INTRODUCTION
As processors become increasingly powerful, and memories become increasingly cheaper, the deployment of large image databases for a variety of applications have now become realizable. Databases of art works, satellite and medical imagery have been attracting more and more users in various professional fields for example, geography, medicine, architecture, advertising, design, fashion, and publishing [1]. Effectively accessing desired images from large and varied image databases is now a necessity. In typical CBIR system the visual content of the images in the database are extracted and descried by multidimensional future factors. Colors are widely used for image retrieval in an Image Retrieval System. "Content-based" means that the search will analyze the actual contents of the image rather than the metadata such as keywords, tags, or descriptions associated with the image. Here the 'content' refers to colors and textures information that can be derived from the image itself. CBIR is desirable because most web based image search engines rely purely on metadata and this produces a lot of false detection in the results [2], [3]. Also having humans manually enter keywords for images in a large database can be inefficient, expensive and may not capture every keyword that describes the image. Therefore, in this paper we proposed efficient content based image retrieval method using color and texture feature to improve above mentioned problems.

2. LITERATURE SURVEY
Content Based Image Retrieval is the retrieval of images based on visual features such as color, texture and shape. Reasons for its development are that in many large image databases, traditional methods of image indexing have proven to be insufficient, laborious, and extremely time consuming. These old methods of image indexing, ranging from storing an image in the database and associating it with a keyword or number, to associating it with a categorized description, have become obsolete. In CBIR, each image that is stored in the database has its features extracted and compared to the features of the query image. Several CBIR systems currently exist, and are being constantly developed.

The Color Selection exploited CBIR system [6], facilitates query-by-color. It is based on 11 color categories, used by all people, while thinking of and perceiving color. Then the low frequency DCT coefficients that are transformed from YUV color space as feature vectors are used for retrieval of images [7]. This system allows users to select its dominant feature of query images so as to improve the retrieval performance. But the technique is sufficient for performing effective retrieval by introducing users' opinions on the query images.

In Region of Interest Image Indexing System [4], user can select the region of interest (ROI) and the system will search all the images in the database to find the all related regions among the database. A Universal Model for Content-Based Image Retrieval combine three feature extraction methods namely color, feature and edge histogram descriptor [5]. The image properties analyzed in this work are by using computer vision and image processing algorithms. For color the histogram of images are computed, for texture co-occurrence matrix based entropy, energy, etc., are calculated and for edge density it is Edge Histogram Descriptor (EHD) that is found. For retrieval of images, a novel idea is developed based on greedy strategy to reduce the computational complexity. Such existing approaches required large storage space and lot of computation time to calculate the matrix of features.

Therefore, in this paper, the efficient content based image retrieval using advanced color and texture feature extraction is deployed. The color features are extracted using three color moments and texture features are extracted directly from block based DCT coefficients which are in transform domain. Hence it does not need any complex computation for texture feature extraction. The proposed method can be directly applied to image in the compressed domain, this solve the storage space problem.

3. GENERAL IMAGE RETRIEVAL SYSTEM

Basic idea behind CBIR is that, when building an image database, feature vectors from images (the features can be color, texture, shape, region or spatial features, etc.) are to be extracted and then store the vectors in another database for future use.

General image retrieval system is shown by Figure 1, is consists of three main modules, input module, query module, retrieval module.

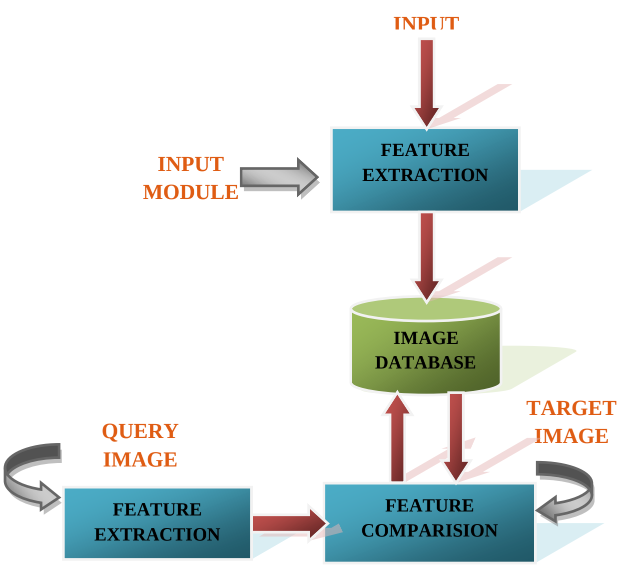

Fig1. Block diagram of General Image Retrieval System

In input module, the feature vector is extracted from each input image and stored into the image database with its input image. When query image is entered into the query module, the feature vector of the query image is extracted. In retrieval module, the extracted feature vector of query image is compared with the images stored in the database. Similar images are retrieved according to their similarity with the query image. Finally the target image will be obtained from the retrieved images.

4. IMAGE RETRIVAL USING COLOR AND TEXTURE FEATURE

Most large image database systems require efficient feature comparison as well as feature extraction to provide a reasonable response to an image query. The exhaustive search of every image in a large image database can be very expensive. Therefore in our system, by applying hierarchical retrieval using color and texture, it is possible to reduce the search space in a large image database.

Here at the first, the global retrieval is done, using color category code. After global retrieval, the images which have the same color category code as that of the query image are selected. Then the local retrieval within the selected images is done, using a texture feature vector. Finally, a target image can be obtained from the images with the same color category code, instead of from all the images in database.

5. COLOR FEATURE EXTRACTION

Color, apart from being one of the most widely used visual features in content-based image retrieval, is relatively robust and simple to represent. Various studies of color perception and color spaces have been proposed, in order to find color-based techniques that are more closely aligned with the way that humans perceive color.

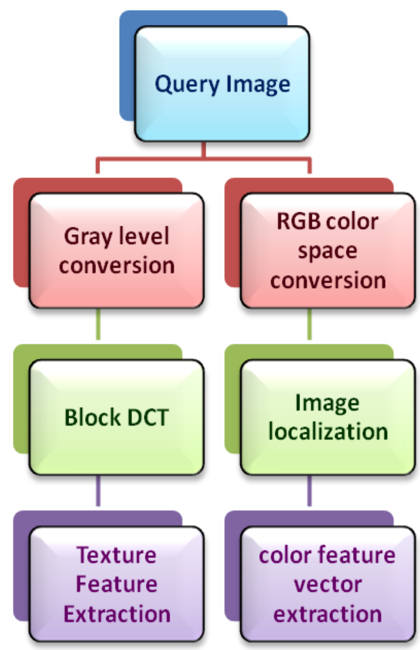

Fig: 2 Block diagram of feature Extraction

This section describes the entire indexing and retrieval process using the Discrete Cosine Transform. The block diagram of feature extraction is shown by figure 2. Here, we first extract the RGB components of the image. The RGB components separately are then divided into block sizes of 8x8 each and three moments are retrieved using equation 1, 2, and 3. This process is repeated for all 1000 images in the database.

During retrieval, the query image feature vector is matched with the 1000 database image feature vectors and the difference between the query and each resultant is calculated. This difference is then sorted to create new vector of the top 150 similar images. Color category code will be used for global search in hierarchical retrieval.

5.1 Color Feature Vector Extraction

Stricker proposed a color extraction method using the three moments of each color channel of an image: average, standard deviation and skewness [1]. For feature vector extraction, its color features are computed by the following equations:

$$E_i = \frac{1}{m.n}\sum_{j=1}^{m.n} P_{ij} \qquad \text{... (1)}$$

$$\sigma_i = \left[\frac{1}{m.n}\sum_{j=1}^{m.n}(P_{ij}-E_i)^2\right]^{1/2} \qquad \text{... (2)}$$

$$\alpha_i = \left[\frac{1}{m.n}\sum_{j=1}^{m.n}(P_{ij}-E_i)^3\right]^{1/3} \qquad \text{... (3)}$$

Where Ei is an average of each color channel (i= R, G, B), σi is a standard deviation, αi is a skewness. Pij is a value of each color channel at jth image pixel. m.n are the total number of pixels per image.

6. TEXTURE FEATURE EXTRACTION

Most existing approaches to texture feature extraction use statistical methods. For the analysis of a texture image, it requires large storage space and a lot of computation time to calculate the matrix of features [5]. In spite of large size of each matrix, a set of their scalar features calculated from the matrix is not efficient to represent the characteristics of image contents. Therefore; we propose texture feature extraction method based on Discrete Cosine Transform (DCT) [3]. The block diagram is shown by Fig. 4.

When a query image is provided, its RGB version is converted into a gray level version for DCT transform. The image is then divided into block sizes of 8x8 and DCT is applied on each of these blocks individually. The texture feature vector is obtained from some DCT coefficients. Since we use the DCT coefficients directly from the transform domain, it does not need additional complex computation. It will then overcome some problems of existing methods such as computational complexity and storage space. Using a texture feature vectors, we can retrieve similar images from an image database with texture feature only.

For hierarchical retrieval, with the help of a texture feature vector, we can retrieve candidate image from only the image group with the same color category code generated by a color feature vector. The hierarchical method can reduce the search space in a large image database.

6.1 The Block Based DCT Transform

For DCT transform first we convert RGB image into gray level image. We then used block based DCT transformation. The equation used for the DCT calculation for each pixel is given as follows:

$$F(u,v) = \frac{C_u C_v}{4}\sum_{i=0}^{7}\sum_{i=0}^{7} f(i,j)\cos\frac{(2i+1)u\Pi}{16}\cos\frac{(2i+1)v\Pi}{16} \qquad \text{... (4)}$$

Where f (i, j) is the pixel value at the (x, y) coordinate position in the image, F (u, v) is DCT domain representation of f (i, j), where u and v represent vertical and horizontal frequencies, respectively. The DCT coefficients have an excellent energy preservation property, i.e.

$$E = \sum_{i=0}^{k-1}\sum_{j=0}^{k-1}(f(i,j))^2 = \sum_{u=0}^{k-1}\sum_{v=0}^{k-1}(F(u,v))^2 \qquad \text{... (5)}$$

Where E is the signal Energy. The coefficients with small u and v correspond to low frequency components; on the other hand, the ones with large u or v correspond to high frequency components. For most images, much of the signal energy lies at low frequencies; the high frequency coefficients are often small enough to be neglected with little visible distortion. Therefore, DCT has superior energy compacting property. DCT techniques can be applied to extract texture feature from the images.

6.2 Texture feature Vector Extraction

For efficient texture feature extraction, our method uses some DCT coefficients.

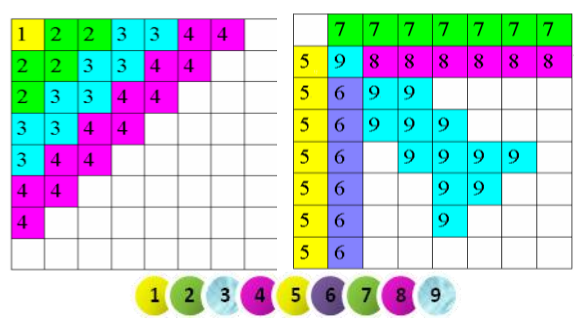

Fig: 4 DCT 9-Features Vector

For each sub block containing one DC coefficient and other AC coefficients, we extract a feature set of 9 vector components by averaging specific regions of coefficients as shown by figure 4, considering following characteristics:

1) The DC coefficient of each sub block represents the average energy of an image (vector component 1).
2) All remaining coefficients within a sub block contain frequency information which represents a different pattern of image variation (vector components 2 to 4).

3) The coefficients of some regions within a sub block also represent some directional information (vector components 5 to 9).

For example, the coefficients of the most upper region in a DCT transform domain represent some vertical and horizontal edge information, respectively.

7. EXPERIMENT RESULTS

The experiment was conducted on a set of 1000 images. The dataset was obtained from internet. The database consists of 100 images of every class. The images are taken from different viewpoints but under approximately constant illumination conditions. The image resolution is resized to 256 x 256 pixels irrespective of its prior resolution.

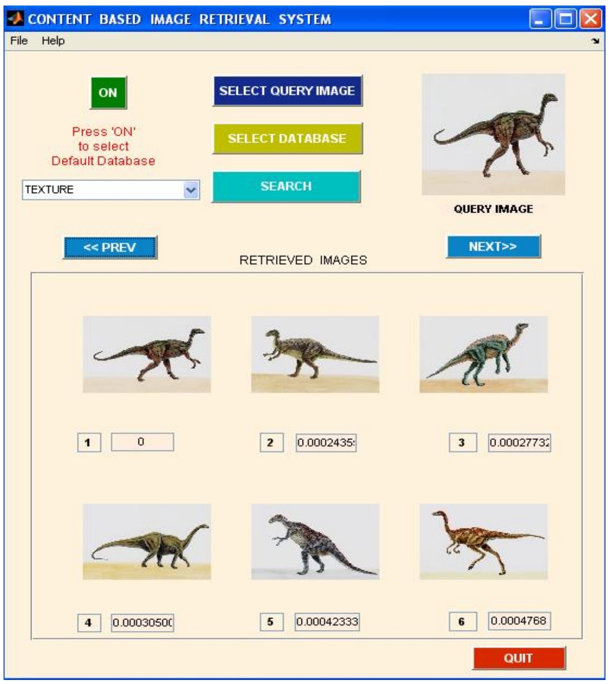

Fig: 5 Sample Image retrieval with texture

A query image is provided by the user. Then similar images from database are selected and displayed. Examples of corresponding query and database images are shown by figure 5. We have used three different techniques for retrieval of images.

They are as follows:

1) Using Color (HSV and YCbCr) And Texture
2) Using only Color (HSV and YCbCr)
3) Using only Texture

Amongst all three techniques the first one 'Using Color (YCbCr) And Texture' is giving very efficient results than any other technique as shown by the table I, II, and III. It retrieved 60% of total available images in the database which are similar to given query image. As shown by table I, it can be concluded that YCbCr gives good result than HSV.

In DCT, as most of the information about the image is covered by low frequency components i.e. DC coefficients of DCT 'only DC' gives best result than that of 'only AC'. By using both efficiency increases but not as that of Color and Texture shown by table I and II. By comparing only color moments we get lesser efficiency than any other method as shown by table III. But YCbCr still gives good result shown by table I.

The proposed system employing color and texture feature extraction methods yields better performance as compared to other CBIR feature extraction methods, shown by the Table IV.

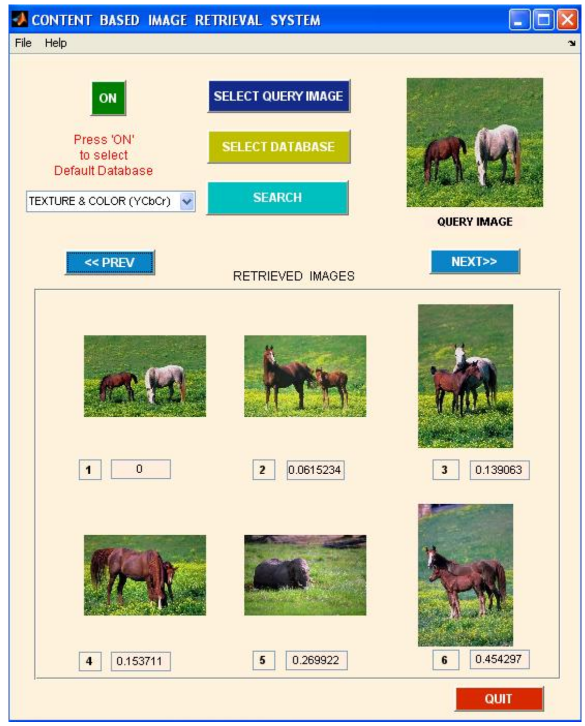

Fig: 6 Sample Image retrieval with texture and color

Table I: Efficiency of the system using both Color & Texture Features

Category	Texture & Color (YCbCr) (%)	Texture & Color (HSV) (%)	Only Color (YCbCr) (%)
Tribal people	55	25	40
Beaches	50	25	45
Landmarks	25	25	40
Buses	50	40	40
Dinosaurs	80	60	80
Elephants	60	35	60
Roses	88	60	92
Horses	80	70	85
Mountains	40	40	30
Food	40	40	80
Average	**60**	**42**	**60**

Table II: Efficiency of the system using different DCT Coefficients

Using Texture(Top 24)			
Category	**Only dc (%)**	**Only AC (%)**	**AC+DC Coefficients (%)**
Tribal people	25	23	25
Beaches	25	24	30
Landmarks	24	50	40
Buses	25	24	25
Dinosaurs	100	30	100
Elephants	34	23	40
Roses	26	25	80
Horses	24	23	25
Mountains	17	22	40
Food	25	24	25
Average	**33**	**27**	**43**

Table III: Efficiency of System using different Color Moments

Categories	**Using Color (Top 24)**				
	Hue (%)			**Saturation (%)**	**All Combined (%)**
	Mean	**Dev**	**Skew**	**Mean**	
Tribal people	23	25	34	27	28
Beaches	31	36	45	32	36
Landmarks	29	27	23	20	25
Buses	27	35	38	35	34
Dinosaurs	54	53	65	58	57
Elephants	38	34	31	37	35
Roses	41	39	30	28	34
Horses	23	33	33	36	32
Mountains	28	32	30	28	30
Food	21	26	28	33	27
Average	**32**	**34**	**36**	**34**	**34**

Table IV: Comparison of Efficiencies of different CBIR Methods

CBIR Methods	**Swain's Method**	**Stricker's Method**	**Funt's Method**	**Proposed System (DCT & Color Moments)**
Average Efficiency	30%	38%	36%	60%

8. CONCLUSION

In this paper, an image retrieval system based on color and texture feature extraction methods was presented. In proposed system the texture feature extraction provides an efficiency of 43%. Color feature extraction in HSV color space provides an efficiency of 33%. Color feature extraction in YCbCr color space provides an efficiency of 60%. The Texture & Color feature extraction (wherein HSV color space is used) provides an efficiency of 42%.

The Texture and Color feature extraction (wherein YCbCr color space is used) provides an efficiency of 60%. Thus the proposed system employing color and texture feature extraction methods provides better results as compared to other CBIR feature extraction methods like Swain's Method, Funt's Method, Stricker's Method and Tamura's Method which has an efficiency of 48%.

9. REFERENCES

[1] Sang-Mi Lee, Hee-Jung Bae and Sung-Hwan Jung, "Efficient Content based Image Retrieval Methods using Color & Texture," ETRI Journal, Vol. 20, No. 3, pp.272-283, 1998.

[2] Remco C. Veltkamp and Mirela Tanase, "Content Based Image Retrieval Systems: A Survey," International Journal of Engineering Science and Technology, Vol. 20, No. 5, pp. 1-62, 2002.

[3] Dr. H.B.Kekre, Sudeep D. Thepade and Akshay Maloo, "Image Retrieval using Fractional Coefficients of Transformed Image using DCT and Walsh Transform," International Journal of Engineering Science and Technology. Vol. 2, No. 4, pp. 362-371, 2010.

[4] Greg Pazz, Ramin Zabih and Justin Miller, "Region of Image Indexing System by DCT and Entropy," International Journal of Engineering Science and Technology, Vol. 8, No. 2, pp. 93-101, 2002.

[5] S. Nandagopalan, Dr. B. S. Adiga, and N. Deepak, "A Universal Model for content Based Image Retrieval," International Journal of Computer Science, Vol. 4, No. 4, pp. 531-538, 2009.

[6] E.L. van den Broek, L.G. Vuurpijl, P. Kisters and J.C.M. von Schmid Nijmegen, "Content Based Image Retrieval: Color Selection exploited," International Journal of Engineering Science and Technology, Vol. 30, No. 3, pp. 456-462, 1997.

[7] Tienwei Tsai, Taiwan, Yo Ping Huang and Te-Wei Chiang, "Fast Image Retrieval Using Low Frequency DCT Coefficients," International Journal of Engineering Science and Technology, Vol. 6, No. 3, pp. 106-120, 2003.