

Content based Intelligent Image Retrieval Based on Super Pixel with Wavelet Transform

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ABSTRACT: In this paper we propose Intelligent Content-Based Image Retrieval (ICBIR) based on super pixel with multi-resolution image. Super pixel plays an important role in image retrieval since instead of single pixels a group of pixels in an image is called a super pixel. Super pixel has computationally efficient, representationally effective and near-complete future and is completely meaningful. The super pixel is formed in a multi-resolution environment. Based on super pixel color and texture features are extracted and the feature vector is formed. We constructed an image database based on the feature vector. Cosine distance method is incorporated to find the distance between query image and target image in the image database. The proposed method is very efficient since we proposed the super pixel concept which provides fast and memory efficient because features are extracted in a multi-resolution environment. The proposed method is implemented in Vistex and Corel database images. The precision and recall performance methods are incorporated to measure the accuracy of proposed methods. The proposed method obtains better results when compared to that of the existing techniques.

KEYWORDS: Super pixel, CBIR, multi-resolution, Cosine distance, distance method

I. INTRODUCTION

For the past two decades, Content based Image retrieval (CBIR) has attracted researchers in the multimedia domain [3]-[11]. Remarkable works have been proposed both theoretically and practically. In 1992, Kato [12] proposed a system which is automatically to retrieve image from image database is known as CBIR. This system uses visual contents, such as color, texture for indexing images. Even though numerous sophisticated algorithms have been proposed in the domain, still systems lack in terms of time complexity, and space complexity and also wide gap between semantic and low-level features [13]. Generally, features extracted from an image as a form of pixels which is most important in factor of time and space complexity. In order to improve the retrieval accuracy to reduce number of features. Thus, it is important to select dominant features that results in good retrieval accuracy. In this scenario we used super pixel in order to reduce time and space complexity. Color plays an important role since it is invariant to image size and orientation [14]. Recently color correlogram [15], color histogram [16] and MPEG-7 color descriptor [17] methods have been adopted in the CBIR system. Another feature of CBIR is system texture plays an important role in retrieval systems [18] [19], which is considered based on the second order statistical techniques such as covariance, energy, homogeneity, correlation, etc. Recently Elif Albuz et al [12], proposed a method which is based on vector wavelet, and efficient feature space. The feature space is indexed using color and texture features for images in the database. The author mentioned feature key of an image not only considers content itself but also to how much the image is deviated from other images. The authors mentioned retrieval time linearly depends on number of images that is similar to query image not an entire database. Subsequently, Kokare et al [20] have developed a system which based image decomposition in which M-band wavelets methods used yields improved retrieval results. Because M-band wavelet decomposition scheme considers number of sub-band for feature extraction to reduce feature vector. But this technique failed accuracy and demands more computational complexity. Sequentially, Minh et al [21] have developed

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a method based techniques: Feature Extraction (FE) and Similarity Measurement(SM). The first, FE step becomes a Maximum Likelihood (ML) estimator for the model parameters of image data and SM step amounts for computing the Kullback–Leibler distances between model parameters. But this system suffers due to the number of parameters [22]. Recently, Kokare et al. [23] developed a method which is based on Dual-Tree Rotated Complex Wavelet Filter (DT-RCWF) and Dual-Tree Complex Wavelet Transform (DT-RCWF) which used improves retrieval accuracy and reduces time. Same author [2] have developed a technique , which considers both 2-D Rotational Wavelet Filter(RWF) and Discrete Wavelet Transform to improve the performance of previous method. The new method improves characterization of diagonally oriented texture. Recently, Young, and Nam [1] proposed a CBIR methods, which consider color autocorrelograms in HSV color space and BDIP(Block Difference of Inverse Probabilities)-BVL(Coefficient Variation of Local Correlation coefficients) moments extracted for Value(V) in multiresolution domain.

Most of the literature proposed methods to improve retrieval accuracy and time complexity, but still gap between semantic features and low-level features and also suffer accuracy of time and space complexity. To cover come above said problems we proposed a technique which based super pixel in multiresolution environment [34]. The proposed method extracts color and texture features in super pixel based multiresolution domain The proposed novel technique consider dominant features as color distribution and texture characteristics at low-level of the images.

The rest of the paper is organized as follows: Section –II, describes multiresolution based decomposition and Feature Extraction (FE) methods. The distance method is discussed in section III. Experimental results are discussed in section-IV and section-V concludes with conclusion.

II. PROPOSED IMAGE RETRIEVAL METHODS

The proposed method extract color and texture based on super pixel in multiresolution domain which is conceptual simple since wavelet transform play an important role, it is tools to decompose an image into various forms sub image. The proposed methods extracts color and texture features in and HSV color space since H and V component represent color dominants and texture characteristics contain in V component. Based on both color and texture features, feature vector is formed and stored as a database, which is called as feature database.

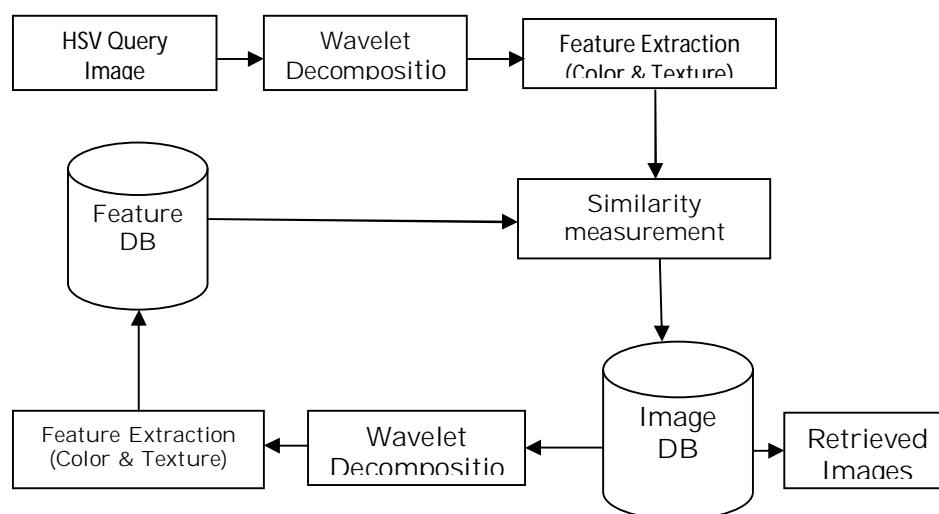


Fig.1. Block diagram of retrieval method.

The Cosine Measure is employed to measure the distance between the feature vectors of the query and target images. Furthermore cosine distance is used to measure divergence of feature vectors. The overall concept of the proposed work is illustrated in Figure-1.

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III. MULTIREOLUTION BASED IMAGE FEATURE EXTRACTION

Wavelet is a mathematical tool which is used to decompose the images into various multiresolution levels is called sub bands [24]-[26], is multi-scale oriented. For convenience of computation, input image size with $N \times N$ is converted to a sequence $X(n)$ where $n = N \times N$. Here Deba-4 wavelet transform is incorporated to decompose the input image into approximations and details components, results are the low-pass and high-pass filters as shown in Fig.2. The proposed method decompose the images until obtain optimum level. The optimum level not losing the dominant color and texture characteristics in the image. The concepts of the decomposition process are depicted in fig.3.

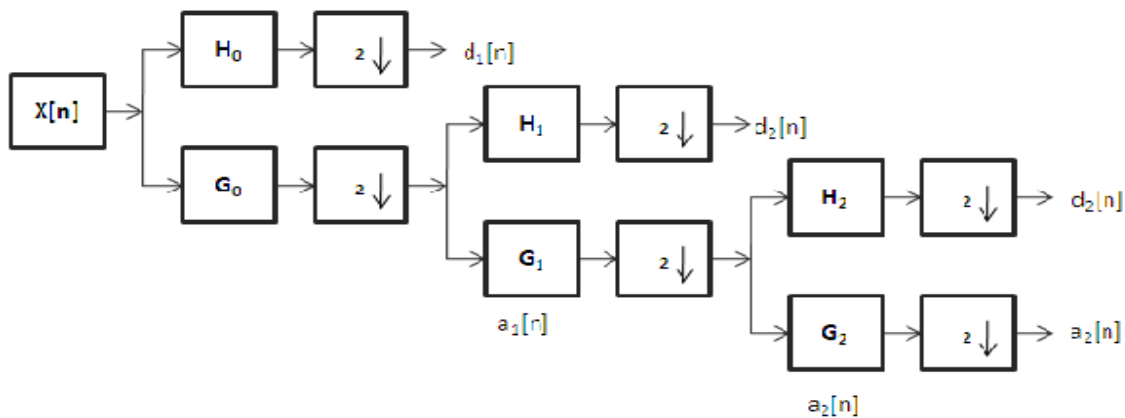


Fig. 2. Decomposition structure at three levels

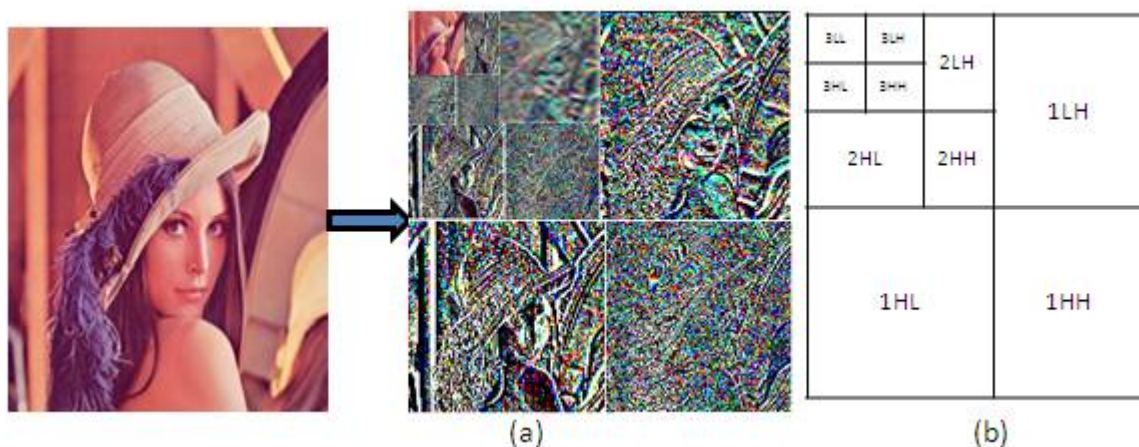


Fig. 3 Decomposition structure (a). Deabu-4 Wavelet transform of an image – pyramid at three level decomposition (b) wavelet decomposition structure.

LL – subband denotes the approximation of the image.

LH – subband is representing the discrimination along with horizontal directions.

HL – subband denotes the discrimination along with vertical directions.

HH – subband show the high frequency components of the image.

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Super pixel as energy features

In this section, the proposed method decompose the image into various subimage based on multiresolution. The energy of each multiresolution considered as super pixel then we extract the energy or entropy from each super pixel based energy. Let N be the number of pixels in the image, and K the number of super pixels that we want to obtain. We represent a partitioning of the image into super pixels with the mapping s

$$s: \{1 \dots N\} \rightarrow \{1 \dots K\} \quad (1)$$

where s represent super pixel which belong to i , the statistical features such as spectrum of energy (μ) is computed in given eq.

$$\text{Spectrum of energy} = \frac{1}{MN} \sum_{i=1}^M \sum_{j=1}^N |X_{ij}| \quad (2)$$

Color feature extraction

The color features are extracted from H subband image which show in section-II. Here color correlogram color features incorporated in the proposed work. Let I be an $n \times n$ image with pixels $p(x, y)$. Let $[C]$ a set of C colors c_1, \dots, c_c that can denotes in the image I . Pick a pixel $p_1 = (x_1, y_1)$ and pixel $p_2 = (x_2, y_2)$ randomly form the image I . Let random variables c_1 and c_2 denotes the color values of p_1 and p_2 respectively. Color correlogram can be represented as in the given eq 3.

$$P_r(c_1 = c_i, c_2 = c_j, |p_1 - p_2| = d) = \frac{I_{c_i c_j}^{(d)}(I)}{n^2 \times 8d} \quad (3)$$

In the proposed work, advantages of using color correlogram are taking into consideration the spatial correlation of colors, being easy to implement, and producing fairly a small size index. Based on the features a feature vector is formed which is shown in equation (4)

$$f = [\mu, \Sigma] \quad (4)$$

where f is feature vector. The entire process of the proposed system is presented in the algorithmic form:

- Step0: Start
- Step1: Read image and convert into HSV color space.
- Step2: Use Daub-4 wavelet decomposes an image and constructs optimum level
- Step3: Compute color and texture characteristics at the optimum level.
- Step4: Construct feature vector using features and placed them in feature database.
- Step5: Find the similarity between query image and target image using and Cosine divergence methods.
- Step6: Adopt the recall-precision method to test the performance of proposed system and existing system.
- Step7: Stop.

Algorithm-1. The overall process of the proposed system.

In order to test the efficiency of the proposed methods we used test of orthogonality to employ on query image and target image which is discussed in section-II. In the orthogonal space query and target images consider as independent to each other and it compute the distance between two images and return angle value which in mentioned equations 5 and 6. The angle θ can be described as a function of \vec{q} and \vec{p} where \vec{q} and \vec{p} are formed from the coefficient of Daub-4 wavelet transform and empirical results are shown in table-1.

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$$\cos \theta = \frac{\vec{q} \cdot \vec{p}}{||q|| ||p||} \quad (5)$$

and

$$\theta = \arccos \left(\frac{\vec{q} \cdot \vec{p}}{||q|| ||p||} \right) \quad (6)$$

Table-1

Angle, degree and radian between query and target images

Image	Cos(θ)	θ
Title0002 vs. Title0002	0.9176	21.4954
Wood vs. Wood	1.0000	0
Titles0004 vs. titles0005	0.9482	13.8830
Flower vs. squirrel	0.9871	7.2372
Decose0007 vs. Brickpaint001	0.2712	11.9538
Lena vs. Lena	1.0000	0
Prisonwindow.001 vs. Sand.004	0.9561	23.4839
Valleywater.003 Vs. Groundwatercity.01	0.9888	15.7641

IV. EXPERIMENTAL RESULTS

The proposed method implement in proposed image database which is constructed from both VisTex[31] and Corel[33] databases. The images considered more than 3500 images sizes such as 512x512, 256x256, 128 x 128 with various categories. For sample, 30% of the images considered for the experiment and few image presented in the sample. In the first column, the query images are presented subsequence column represent the relevant images according distance Minkowski-form distance [16]. The distance values are obtained from table 2.

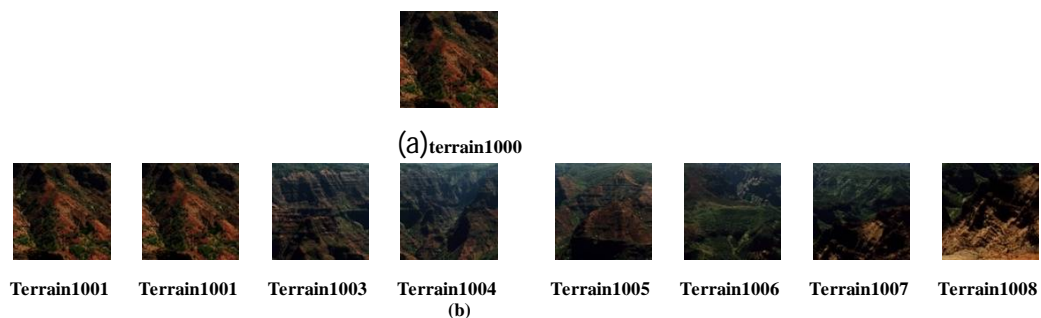


Fig.4 (a) Query image (b) retrieved relevant image by proposed system from VisTex Database

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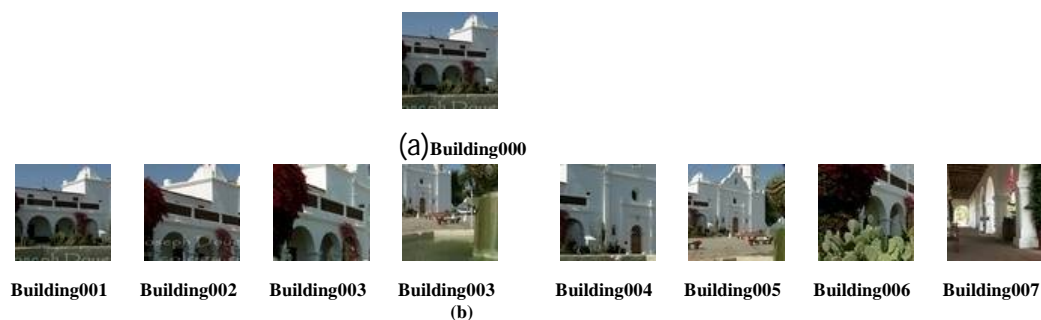


Fig.5 (a) Query image (b) retrieved relevant image by proposed system from Corel

Table-2

Distance values between query and relevant images in indexed order.

Terrain1	0.0561	0.0949	0.0951	0.4388	0.6458	0.6615	0.0676	0.7628	0.7526
Title001	0.0437	0.3004	0.3338	0.5457	0.5966	0.6302	0.7916	0.8168	0.9163
Fabric002	0.2488	0.3284	0.3956	0.4103	0.4781	0.5085	0.5512	0.7878	1.2610
prison window01	0.6737	0.4397	0.4651	0.5234	0.6425	0.8800	0.9256	0.9395	1.0398
Food001	0.1234	0.3049	0.4672	0.8213	0.8878	1.5657	2.2153	2.2477	2.3576
Wood002	0.3623	0.3822	0.3973	0.4597	0.4973	0.5232	0.5924	0.6913	0.7334
Building02	0.1029	0.2599	0.2649	0.2738	0.3245	0.4850	0.6573	0.9698	1.4163

To evaluate the performance of the proposed system by making comparison with two existing methods such as Wavelet moment, BDIP+BVLC and the obtained results are presented in the table-3. The proposed method is consider uniformly quantizing color pixel values with minimum storage space when compared to that of existing methods.

Table-3

Feature vector dimension and color space of the retrieval methods

Specification Methods	Color space	Dimension	Remarks
Wavelet moment	RGB	96	number of decomposition levels: 8
BDIP-BVLC	RGB,V	96	-
Multi-resolution with BDIP+BVLC	HSV	92(60+32)	number of decomposition levels: 2
CSD	HMMD	128	-
Proposed work	HSV	36	number of decomposition levels2

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Table-4
Performance measure of proposed work with existing methods

Databases	Proposed method		BDIP-BVLC		Wavelet moment		CSD method	
	Precision	Recall	Precision	Recall	Precision	Recall	Precision	Recall
Vistex	0.876	0.721	0.821	0.713	0.841	0.691	0.831	0.701
Corel	0.791	0.712	0.761	0.703	0.751	0.691	0.741	0.681

In order to test proposed worth we used precision and recall methods [32] are mentioned in equations (7) and (8) are employed to measure the retrieval performance of the proposed system.

$$P(q) = \frac{|X(q) \cap Y(q)|}{|X(q)|} \quad (7)$$

$$R(q) = \frac{|X(q) \cap Y(q)|}{|Y(q)|} \quad (8)$$

where $|.$ returns the size of the set, precision $P(q)$ represents the ratio of the number of images relevant to the query q among retrieved images to the number of retrieved images; recall $R(q)$ represents the ratio of the number of images relevant to the query q among retrieved images to the number of images relevant to the query in a image database

V. CONCLUSION

In the proposed method, we used super pixel with multi-resolution image for content based image retrieval. The super pixel based images are used extract features such as color correlogram and energy features in subband of decomposed image. The color features are extracted from H and S components and energy features are extracted V component. Super pixel plays an important role in image retrieval since instead single pixels a group of pixel in an image called super pixel. Super pixel has computationally efficient, representational effective and near-complete future and completely meaningful. Based on super pixel color and texture features are extracted and the formed feature vector. Cosine similarity method is incorporated to find the distance between query image and target image in image database. The proposed method is very efficient since we proposed super pixel concept which provide fast and memory efficient because of feature are extracted in multiresolution environment. The proposed method is implemented in standard databases. In order to implement proposed method, the precision and recall performance method are incorporated to measure accuracy system. The proposed method obtains better result when compared to that of the existing techniques.

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