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Image Characterization Based Adaptive Wavelet Transform in Image Retrieval

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Abstract: The paper presents the image retrieval based on adaptive wavelet transform. Improving the retrieval efficiency in the image database set using discrete wavelet transform and different distance calculation. The adaptive wavelet transform is better retrieval performance, less computation time and less complexity compared to existing methods i.e., Gabor wavelet. The proposed method is computing the image characterization for every possible separable or non separable adaptive wavelet filter. Second step is to characterize the distribution of the detail coefficients at any analysis scale using multi feature such as kurtosis and standard deviation. Then the distance between query feature and database features in image database is calculated. The comparison of the experimental results show that the adaptive wavelet transform in CBIR has better retrieval efficiency and less computation time.

Index Terms—Content-based image retrieval (CBIR), wavelet adaptation, wavelet transform.

I. INTRODUCTION

With the rapid growth of digital image and video, content Based image retrieval (CBIR) has become important research area to help people to search and retrieve useful information. High retrieval efficiency and less computational complexity are the desired characteristics of CBIR system. CBIR finds applications in advertising, medicine, crime detection, entertainment and digital libraries. Computational Complexity and retrieval efficiency are the key objectives in the design of CBIR system [1]. However, designing of CBIR system with these objectives becomes difficult as the size of image data base increases. CBIR based on color, texture, shape and edge information are available in the literature [2-6]. Gabor filter (or Gabor wavelet) is widely adapted to extract texture features from the images for image retrieval [5, 7] and has been shown to be very efficient. Manjunath and Ma [5] have shown that image retrieval using Gabor features outperforms that using pyramid-structured wavelet transform [PWT] features, tree structured wavelet transform [TWT] features. These techniques have less accuracy and high computation time.

This paper is organized as follows: In section 2, explains the CBIR Architect and Adaptive wavelet transform. Multiple features are discussed in section 3. Distance calculation is described in section 5. Experimental results are given in section 5. Concluding remarks are given in section 5.

II. PROPOSED METHOD OF ARCHITECTURE

The architecture of proposed method is shown in figure 1. It consists of three methods. They are adaptive wavelet transform, multiple features and distance as explained in next section. The proposed method has high image retrieval performance and less computation time. The proposed method contains two issues in CBIR system. First, extract the features from adaptive wavelet transform in CBIR system. Then retrieve relevant images from database.

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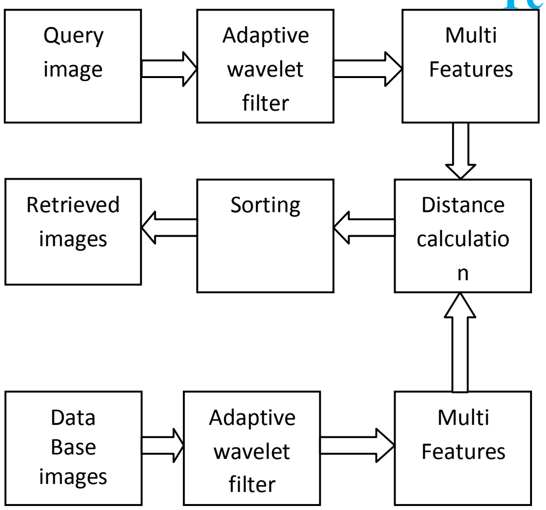

Fig.1. Block diagram of proposed architecture

The steps of proposed method are as shown below

1) Apply the wavelet transform to query image and all database images
2) Calculate the multiple features such as kurtosis and standard deviation of all images
3) Compare similarities between input image and database by using multiple distances.
4) Sort the distance values
5) The relevant images are retrieved from data base.

This work presents an image retrieval technique based on adaptive wavelet with multiple features. Multiple features is the strong relationship with semantic meaning of the image. The proposed method retrieves the relevant images from the image data base for the given query image based on comparing the feature of the query image and images in the database. Relevant images are retrieved according to minimum distance or maximum similarity [7] measure calculated between features of query image and every image in image database.

A. Adaptive wavelet transform

In adaptive wavelet transform, convert the image into blocks B_k. Each block B_k is partitioned into four sub-blocks, t = 0, · · , T−1, denoted as Bt $_{k,j}$, j = 0, · · , 4_{t-1}. The best direction is selected based on each sub-block Bt $_{k,j}$ as shown in equation, and denoted as dt $_{k,j}$.

$$d_k = argmin_i \sum_{l_0 \in \prod_0 \cap B_k} \left| X[l_0] - P_i(X_e, l_0) \right| + \lambda R_{k,i}$$

Each sub-block size represents a block-mode, and the best block-mode for block Bk is denoted by bk. For each Bt k,j ,we denote the sum of absolute difference (SAD) in the high-pass samples predicted with dt k,j by SADt k,j , the overhead for selecting dt k,j by Rt k,j and that for selecting bk = t by Rt, then bk is determined by

$$b_k = argmin_t \sum_{j=0}^{4^t-1} SAD_{k,j}^t + \lambda \sum_{j=0}^{4^t-1} R_{k,j}^t + \overline{R_t}$$

Using Taylor expansions to calculate the characterization map and the characterization derivative maps. The exact approximation characterization and characterization derivatives are computed for a finite set of fast wavelet filters, which is also called as key wavelet filters, and the remainder of each map is approximated using Taylor expansions as shown.

$$f(w) = \sum_{i=0}^{n_T} \frac{f^{(i)}(w_0)}{i!}(w - w_0)^i + 0(\|w - w_0\|_2^{n_T})$$

Where n_T denotes the order of the Taylor expansion

The wavelet coefficients of fast wavelet is given by

$$\|w\|_2 = \sqrt{\frac{1}{(2K+1)(2L+1)} \sum_{k=-K,\dots,K,l=-L,\dots,L} w_{k,l}^2}$$

III. MULTIPLE FEATURE CALCULATION

A wavelet filter partitions the image into J = 4(3*L+1) sub-images. The normalized kurtosis was computed on each sub-image and defined as

$$k_s = \frac{m_{s},4}{\sigma_s^4} - 3$$

where ms,4 is a polynomial function of the wavelet transform and is given by

$$m_{s,d} = \frac{s^2}{MN} \sum_{i\in_s, j\in_s} x_{i,j,s}^d$$

Where M X N is the size of the sub image

S is a constant

X is the sub image

The standard movement σ is given by

$$\boldsymbol{\sigma} = \alpha \sqrt{\frac{\Gamma(3/\beta)}{\Gamma(1/\beta)}}$$

The standard deviation of sub image is given by

$$\boldsymbol{\sigma}_s = \sqrt{m_{s,2}}$$

To combine of kurtosis and standard deviation to get the multiple feature vector as shown below

F= [Ks σs]

Where f is the multiple feature vector

Ks=kurtosis feature vector

σs=standard deviation

IV. DISTANCE MEASUREMENT

In this paper, we consider two distance measurements. They are 1) Euclidian distance 2) Canberra distance

A. Euclidian distance

Euclidean distance is the distance between multiple feature of images from database and multiple feature of query image. The formula of Euclidean distance is given by

$$d = \sqrt{\sum_{i=1}^{N} (F_Q[i] - F_{DB}[i])^2}$$

Here

Query is the energy of query image and dbimages is the energy of database images.

B. Canberra distance

We take Canberra distance between two vectors p and q is shown below

$$d^{CAD}(p,q) = \sum_{i=1}^{n} \frac{|p_i - q_i|}{|p_i| + |q_i|}$$

Here,

Pi is the energy vector of Query mage

Qi is the energy vector of database images

In Canberra distance, the numerator signifies the difference and denominator normalizes the difference. Thus distance values will never exceed one, being equal to one whenever either of the attributes is zero.

V. RESULTS

The data base is collected from the California Institute of Technology. It consists of 500 images of objects belonging to 10 categories. This is about 1 to 50 images per category; most categories have about 50 images. The size of each image is roughly 300 ×200 pixels. The proposed system is developed using MATLAB tool for performance metrics evaluation. The obtained simulation results were processed on coil database images. The simulation results obtained are illustrated below.

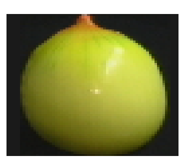

Fig.2.Query image of mango coil

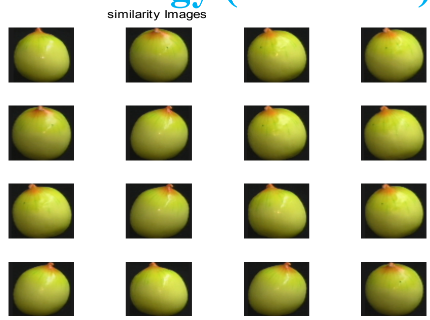

Fig.3.similar images retrived using adaptive wavelet filter

In fig 3. simulated output shows 16 similar images out of 16 images are retrived. So the accuracy is 100%

The time required for computation took 63 seconds for 900 images in proposed method where as in existing methods it took around 5 to 6 minutes. So the computation time is less compared to Gabor wavelet.

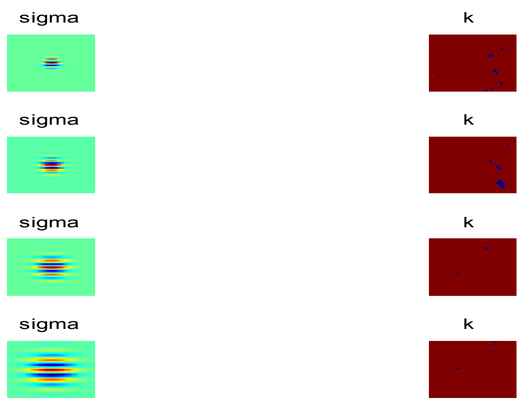

Fig.4. Examples of characterization maps computed, at different analysis scales and orientations, for images in the coil data set.

VI. CONCLUSION

Image retrieval based on adaptive wavelet filter with multiple features has been proposed. The computational steps are effectively reduced with the use of wavelet filter. Substantial increase in the retrieval speed is also obtained. Better retrieval accuracy and low computation time are achieved.

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