An Efficient Approach for Content Based Image Retrieval (Colour&Texture) by Wavelet & Gabor

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ABSTRACT
Advances in data storage and image acquisition technologies have enabled the creation of large image datasets. In this scenario, it is necessary to develop appropriate information systems to efficiently manage these collections. The most common approaches use Content- Based Image Retrieval (CBIR).The goal of such CBIR systems is to support image retrieval based on *content* e.g., shape, color, texture. Retrieval of images based on visual features such as color, texture and shape have proven to have its own set of limitations under different conditions. In this paper we propose a novel method with highly accurate and retrieval efficient approach which will work on large image database with varied contents and background.

Keywords
Color Histogram, Wavelet Transform & Gabor filter Texture analysis.

1. INTRODUCTION
CBIR or Content Based Image Retrieval is the retrieval of images based on visual features such as color, texture and shape. In CBIR, each image that is stored in the database has its features extracted and compared to the features of the query image. It involves two steps:

Feature Extraction: The first step in the process is extracting image features to a distinguishable extent.

Matching: The second step involves matching these features to yield a result that is visually similar.

1.1 Color:
Usually colors are defined in three dimensional color spaces. These could either be ***RGB*** (Red, Green, and Blue), ***HSV*** (Hue, Saturation, and Value) or ***HSB*** (Hue, Saturation, and Brightness).information. The method of representing color information of images in CBIR systems is through color histograms. A color histogram is a type of bar graph, where each bar represents a particular color of the color space being used. Bars in a color histogram are referred to as bins and they represent the x-axis. In other words it gives the count of pixels in an image representing a particular color.

Quantization in terms of color histograms refers to the process of reducing the number of bins by taking colors that are very similar to each other and putting them in the same bin.

1.2 Texture
Texture is a property of all surfaces that describes visual patterns. It contains important information about the structural arrangement of a surface, such as; clouds, leaves, fabric, etc. It describes the distinctive physical composition of a surface.

1.3 Wavelet transform
Textures can be modeled as quasi-periodic patternswith spatial/frequency representation. Wavelet analysis represents a windowing technique with variable-sized regions. Wavelet analysis allows the use of long time intervals where we want more precise low-frequency information, and shorter regions where we want high-frequency information.

One major advantage afforded by wavelets is the ability to perform local *analysis.* Wavelet analysis is capable of revealing aspects of data that other signal analysis techniques miss. Because it affords a different view data than those presented by traditional techniques, wavelet analysis can often compress or de-noise a signal without appreciable degradation. A wavelet is a waveform of effectively limited duration that has an average value of zero. Signals with sharp changes might be better analyzed with an irregular wavelet than with a smooth sinusoid, just as some foods are better handled with a fork than a spoon. It also makes sense that local features can be described better with wavelets that have local extent.

Filters Used to Calculate the DWT
For an orthogonal wavelet, in the multiresolution framework we start with the scaling function and the wavelet- Function. One of the fundamental relations is the twin-scale Relation (dilation equation or refinement equation):

$$\frac{1}{2}\emptyset\left(\frac{x}{2}\right) = \sum_{n \in z} Wn\emptyset\,(x-n)$$

All the filters used in DWT and IDWT are intimately related to the sequence.

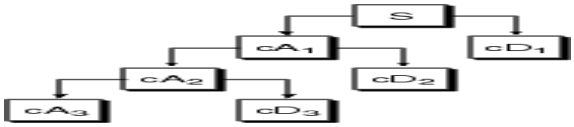
n∈Z

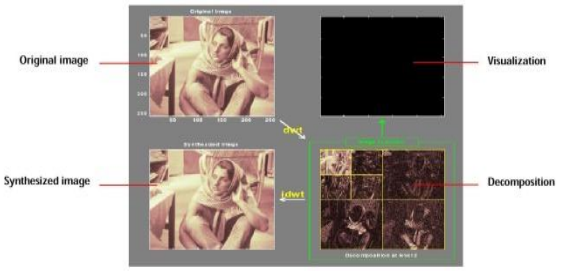
clearly if is compactly supported, the sequence (w_n) is Finite and can be viewed as a filter. The filter W which is called the scaling filter, is -

- Finite Impulse Response (FIR)
- Of length 2*N*
- Of sum 1
- Of norm /
- Low pass filter

Given a signal *s* of length *N*, the DWT consists of $\log_2 N$ stages at most. Starting from *s*, the first step produces two sets of coefficients: approximation coefficients cA_1, and detail coefficients cD_1. These vectors are obtained by convolving *s* with the low-pass filter Lo_D for approximation, and with the high-pass filter Hi_D for detail, followed by dyadic decimation. The length of each filter is equal to 2*n*. If *N*= length (s), the signals *F* and *G* are of length *N*+ 2*n* - 1, and then the coefficients cA_1 and cD_1 are of length

$$\frac{(N-1)}{2} + n$$





The wavelet transform transforms the image into a ulti-scale representation with both spatial and frequency characteristics. This allows for effective multi-scale image analysis with lower computational cost.

Daubechies Wavelet:

Daubechies wavelet family is defined as

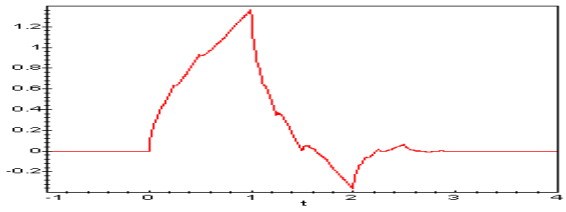


Figure: Daubechies Wavelet Example

1.4 Gabor Filter

The Gabor filter is basically a Gaussian
(With variances sx and sy along x and y-axes
respectively) modulated by a complex sinusoid (with centre frequencies U and V along x and y-axes respectively)
Described by the following equation

$$G(x,y) = \frac{1}{2*pi*sx*sy} * \exp\left(\left[-\left\{\left(\frac{-1}{2}\right)\left(\frac{x\wedge}{sx}\right)2+\left(\frac{y\wedge}{sy}\right)2\right\}+2*pi*i*(Ux+Vy)\right]\right)$$

Description:
I: Input image
Sx & Sy: Variances along x and y-axes respectively
U & V: Centre frequencies along x and y-axes respectively
G: The output filter as described above
Gabout: The output filtered image

2. PROBLEM STATEMENT

The problem involves entering an image as a query into a software application that is designed to employ CBIR techniques in extracting visual properties, and matching them. This is done to retrieve images in the database that are visually similar to the query image.

3. PROPOSED WORK

This section summarizes the culmination of the literature survey carried out in order to put forth the necessity for carrying out the proposed research work. It is proposed:

- Design and Develop a system for Features Extraction of images for Content Based Image Retrieval (CBIR)
- Extract Color & Texture features of image database
- Optimize the effectiveness and accuracy of the CBIR To implement and evaluate proposed CBIR system for Image Retrieval of real-time image databases.

4. ARCHITECTURAL DESIGN

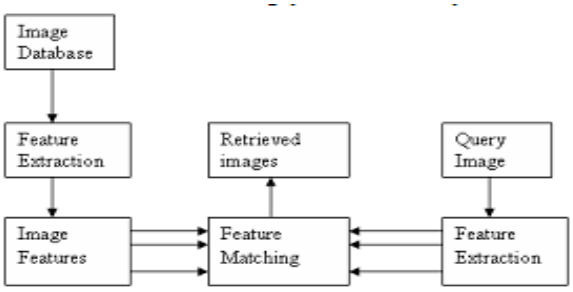


Fig.1 Block Diagram of CBIR

5. ALGORITHM

1. **Collection of Image Database**
- We consider a database containing 651 images with any one of the formats .bmp, .jpg.
- The images will be from RGB color model.

2. **Feature Extraction**
- Feature Extraction is carried out by using colours, using textures. For color feature extraction, color histograms such as Global Color Histogram (GCH) are used. For extracting textures Structural, Spectral approaches are used. In addition to this, Gabor filter and Wavelet Transform are used.
- The images are registered with their corresponding features such as color, texture.
- These extracted features will be forwarded to Feature Vector Module.

3. **Similarity Measures**
The Direct Euclidian Distance between an image P and query image Q can be given as the equation below ED=∑ (Vpi -Vqi). (Vpi -Vqi).
    - where, Vpi and Vqi be the feature vectors of image P and Query image Q respectively with size 'n'

4. **Comparison of results with other techniques**
- When the user passes a query image, the composite feature vector of both query image and the image which is stored in database will go through Similarity Comparison

5. **Finally the image will be retrieved**.

6. METHODOLOGIES

The image features under consideration were color, & texture. Thus, using matching and comparison algorithms, the color, texture features of one image are compared and matched to the corresponding features of another image. These metrics are applied one after another, so as to retrieve database images that are similar to the query. The similarity between features is to be calculated using algorithms. Following methodologies will be used in the proposed work

- Collection of Image Database
- Feature Extraction
- Similarity Measures
- Comparison of results with other techniques

7. IMPLICATIONS

- The application performs a simple search in an image database for an input query image, using color, texture to give similar images.
- The number of search results may vary depending on the number of similar images in the database.

Possible outcomes

- Input → Query Image
- Output → The set of images from the image database with matching features with Query image

8. RESULTS

To check the performance of proposed technique we have used precision and recall. The standard definitions of these two measures are given by following equations.

$$Precision = \frac{Number\_of\_relevant\_images\_retrieved}{Total\_number\_of\_images\_retrieved}$$

$$Recall = \frac{Number\_of\_relevant\_images\_retrieved}{Total\_number\_of\_relevent\_images\_in\_database}$$

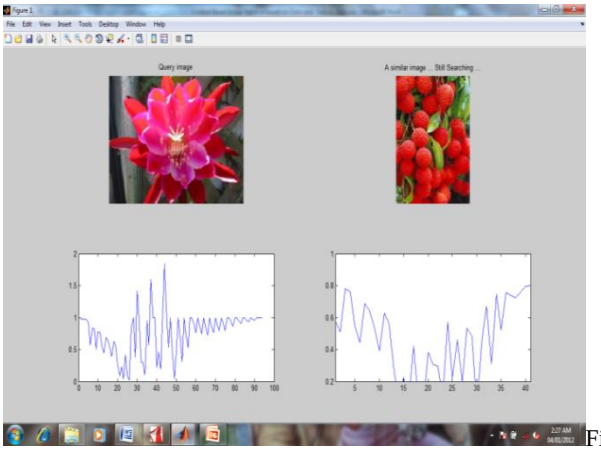


Fig .2: Query image for search

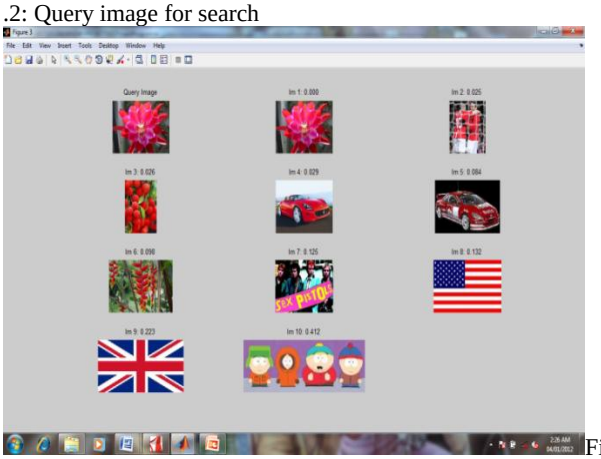


Fig .3: color results search

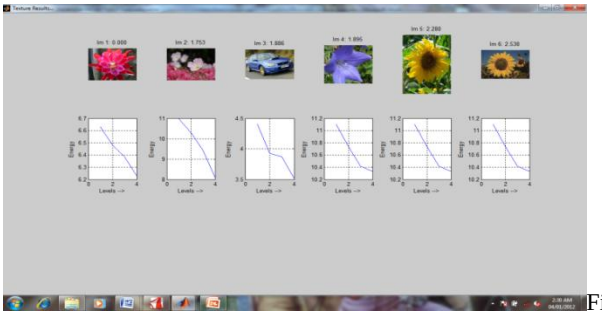


Fig .4 : Texture results search

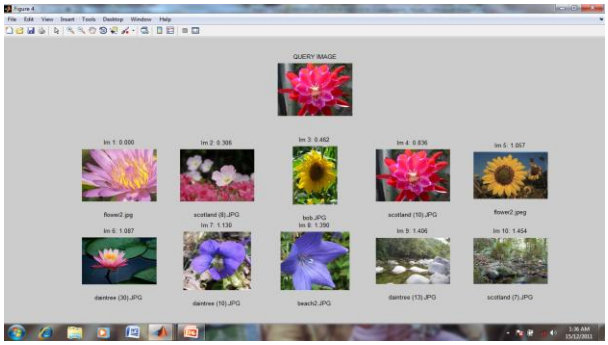


Fig.5: Gabor based Texture Results search

Table1. Proposed Precision Result(%)

S. N.	Query Image	Color Feature	Texture Feature By Wavelet	Texture Feature By Gabor
1	Tiger	20	40	50
2	Building	20	40	50
3	Building	40	40	50
4	Flower	60	40	75
5	Tiger	60	30	50
6	Flower	60	40	50
7	Flower	60	40	60
8	Flower	70	50	60
9	Flower	70	40	70
10	Flower	70	60	70

Table2: Average Precision (%)

S.N.	Images	TFOR[11]	CLDG[12]	GFIR
1	Buildings	54.0	39.2	58.3
2	Buses	91.0	39.5	92.0
3	Flowers	92.0	89.3	94.5

Table 3: Proposed Recall Results (%)

S.N.	Query Image	Color Feature	Texture Feature by Wavelet	Texture Feature by Gabor
1	Tiger	10	50	60
2	Building	10	50	50
3	Building	30	94	95
4	Flower	50	50	50
5	Tiger	50	94	97
6	Flower	50	75	40
7	Flower	50	75	50
8	Flower	60	80	40
9	Flower	60	75	50
10	Flower	60	83	87

Table4: Average Recall (%)

S.N.	Images	TFOR[11]	GFIR
1	Buildings	10.8	14.5
2	Buses	18.2	19.0
3	Flowers	18.4	19.0

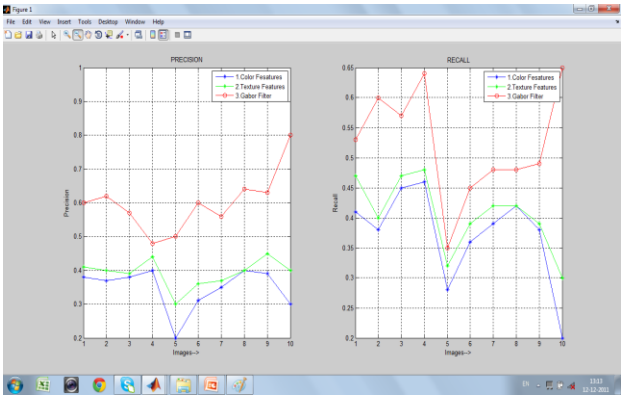


Fig.6: Precision & Recall Graph for Color, Texture (Wavelet) &Texture (Gabor)

9. CONCLUSION

The dramatic rise in the sizes of images databases has stirred the development of effective and efficient retrieval systems. The application performs a simple color-based search in an image database for an input query image, using color, texture and shape to give the images which are similar to the input image as the output. The number of search results may vary depending on the number of similar images in the database. CBIR is still developing science. As image feature extraction techniques become more developed, CBIR maintains a steady state of development in the research field.

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