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Image Retrieval and Image Categorization by Content based Information

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ABSTRACT

Fast retrieval of images from database is done by unsupervised image categorization technique. CBIR effectiveness is based on the image categorization. For image categorization technique, the image features are extracted by using Scale Invariant Feature Transform (SIFT). Image Categorization and Content-Based Image Retrieval (CBIR) allows automatic extraction of target images according to object feature contents of the image itself. Haar Transform is used to decompose color images into multilevel scale. D4 wavelet Transform is used for the conversion of wavelet coefficients. A progressive image retrieval strategy is achieved by flexible CBIR. In terms of recall rate and retrieval speed, the retrieval performance of D4 and Haar wavelet is compared with its wavelet histograms. Efficient retrieval can be achieved experimentally and the results can be reflected in the form of CBIR wavelets. Image Retrieval system is a system for searching and retrieving similar images from a large database of digital images. Images are ranked based on their similarities.

General Terms: CBIR algorithm, SIFT algorithm, Transforms, Documentation, Performance.

Keywords*:* Content Based image Retrieval (CBIR), Scale Invariant Feature Transform (SIFT), image features, Haar wavelet and D4 Wavelet.

1. INTRODUCTION

The main purpose of the classification process is to categorize all pixels in a digital image into one of several classes or themes [1]. This categorized data may then be used to produce a useful representation (e.g. map) for an image [2-4]. Features are derived directly from the images and they are extracted and analyzed by means of computer processing, which are used for image categorization and to retrieve images [5-11]. CBIR is a bottleneck of the access of multimedia databases that deal with text, audio, video and image data which could provide us with enormous amount of information. Many commercial and research CBIR systems have been built and developed (e.g.: QBIC, Virage, Pichunter, visual *SEEK,* Chabot, Excalibur, photobook, Jacob).

2. BACKGROUND

The increase in computing power and electronic storage capacity has lead to an exponential increase in the amount of digital content available to users in the form of images and video, which form the bases of many entertainments, educational and commercial applications. Consequently, the searches for the relevant information in the large space of image and video databases have become more challenging. How to achieve accurate retrieval results are still an unsolved problem and an active research area. A typical image retrieval system includes three major components:

i) Feature extraction (usually in conjunction with feature selection)

ii) High dimensional indexing and

iii) System design.

Image can be represented as a set of low-level visual features such as color, texture and shape features. While several image retrieval systems rely on only one feature for the extraction of relevant images, it has been shown that an appropriate combination of relevant features can yield better retrieval performance [12-14]. The process of determining the combination of features that is most representative of a particular query image is called feature selection.

3. MODULES

In this work, the following are the major modules for image categorization and image retrieval by unsupervised manner.

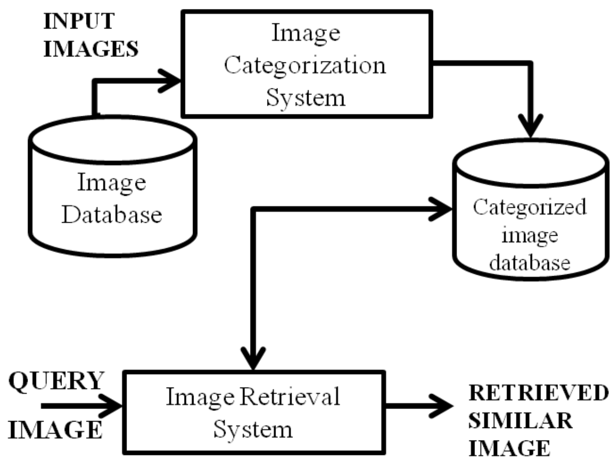

Figure1: Overall System architecture

Module 3.1 Image Indexing and Image Decomposition

Image Indexing and Image Decomposition involves two major wavelet transforms namely

Haar Wavelet Transform

Daubechies D4 Wavelet Transform

3.1.1:Haar Wavelet Transform

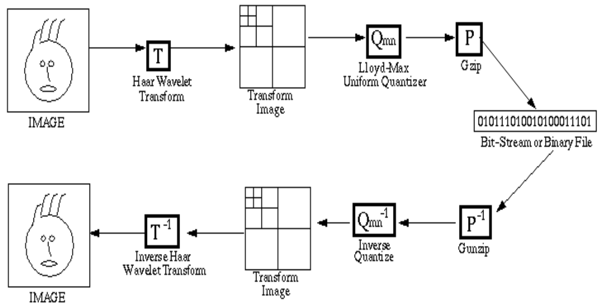

Figure 2: Haar Wavelet Transform Architecture

If a data set S_0, S_1 ….S_{N-1} contains N elements, there will be N/2 averages and N/2 wavelet coefficient values. The averages are stored in the upper half of the N element array and the coefficients are stored in the lower half as shown in the Figure 3.1. The averages become the input for the next step in the wavelet calculation, where for iteration i+1, $N_{i+1} = N_{i/2}$. The recursive iterations continue until a single average and a single coefficient are calculated. This replaces the original data set of N elements with an average, followed by a set of coefficients whose size is an increasing power of two (Ex: 2^0, 2^1, 2^2 ...$2^{N/2}$). The arrow represents a split operation that reorders the result so that the average values are in the first half of the vector and the coefficients are in the second half. To complete the forward Haar transform there are two more steps. The next step would multiple the average values i_a by a 4x4 transform matrix, generating two new averages and two new coefficients which would replace the averages in the first step. The last step these new averages are multiplied by a 2x2 matrix, generating the final average and the final coefficient.

3.1.2: Daubechies D4 Wavelet Transform

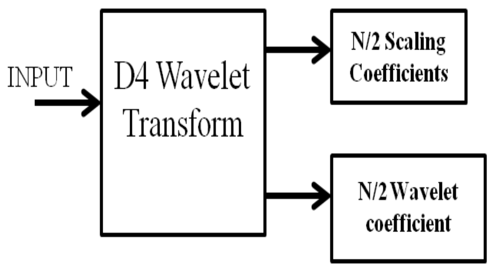

Figure 3: D4 Wavelet Transform Architecture

The D4 transform has four wavelet and scaling function coefficients. The scaling function coefficients are:

$$h_0 = \frac{1+\sqrt{3}}{4\sqrt{2}} \quad h_1 = \frac{3+\sqrt{3}}{4\sqrt{2}}$$

$$h_2 = \frac{3-\sqrt{3}}{4\sqrt{2}} \quad h_3 = \frac{1-\sqrt{3}}{4\sqrt{2}}$$

Each step of the wavelet transform applies the scaling function to the data input. If the original data set has N values, the scaling function will be applied in the wavelet transform step to calculate N/2 smoothed values. In the ordered wavelet transform the smoothed values are stored in the lower half of the N element input vector.

The wavelet function coefficient values are:

$$g_0 = h_3;\ g_1 = -h_2;\ g_2 = h_1;\ g_3 = -h_0$$

Each step of the wavelet transform applies the wavelet function to the input data. If the original data set has N values, the wavelet function will be applied to calculate N/2 differences (reflecting change in the data). In the ordered wavelet transform the wavelet values are stored in the upper half of the N element input vector. The scaling and wavelet functions are calculated by taking the inner product of the coefficients and four data values.

The equations are shown below. Daubechies D4 scaling function

$$a_i = h_0 s_{2i} + h_1 s_{2i+1} + h_2 s_{2i+2} + h_3 s_{2i+3}$$

$$a[i] = h_0 s[2i] + h_1 s[2i+1] + h_2 s[2i+2] + h_3 s[2i+3]$$

Daubechies D4 wavelet function

$$c_i = g_0 s_{2i} + g_1 s_{2i+1} + g_2 s_{2i+2} + g_3 s_{2i+3}$$

$$c[i] = g_0 s[2i] + g_1 s[2i+1] + g_2 s[2i+2] + g_3 s[2i+3]$$

Each iteration in the wavelet transform step calculates a scaling function value and a wavelet function value. The index *i* is incremented by two with each iteration, and new scaling and wavelet function values are calculated.

Module3.2 Image Categorization

Image categorization is carried by extracting the image features by means of Scale Invariant Feature Transform (SIFT) and clustering of the features are carried out to categorize the datasets in the database. For any object in an image, interesting points on the object can be extracted to provide a "feature description" of the object. SIFT key points of objects are first extracted from a set of reference images and stored in a database. An object is recognized in a new image by individually comparing each feature from the new image to this database and finding candidate matching features based on Euclidean distance of their feature vectors. From the full set of matches, subsets of key points that agree on the object and its location, scale and orientation in the new image are identified to filter out good matches.

Module3.3 Image Retrieval

Progressive retrieval strategy is used in order to balance between computational complexity and retrieval accuracy. Three filtering techniques are used:

- Rough filtering
- Progressive rough filtering
- More Precise filtering

Rough filtering helps to find the query image from the database. Progressive rough filtering helps to deal with high and low frequency components. More precise filtering helps to retrieve similar images from database based on threshold.

4. EXPERIMENTAL RESULTS

The Proposed method have been implemented and tested on digital images of Caltech 101 object categories. Each data set have minimum of 35 images to 101 images. Digital image retrieval is carried by extracting the image feature present in the images and generating feature vector to analyze the features present in the image.

4.1 Before categorization

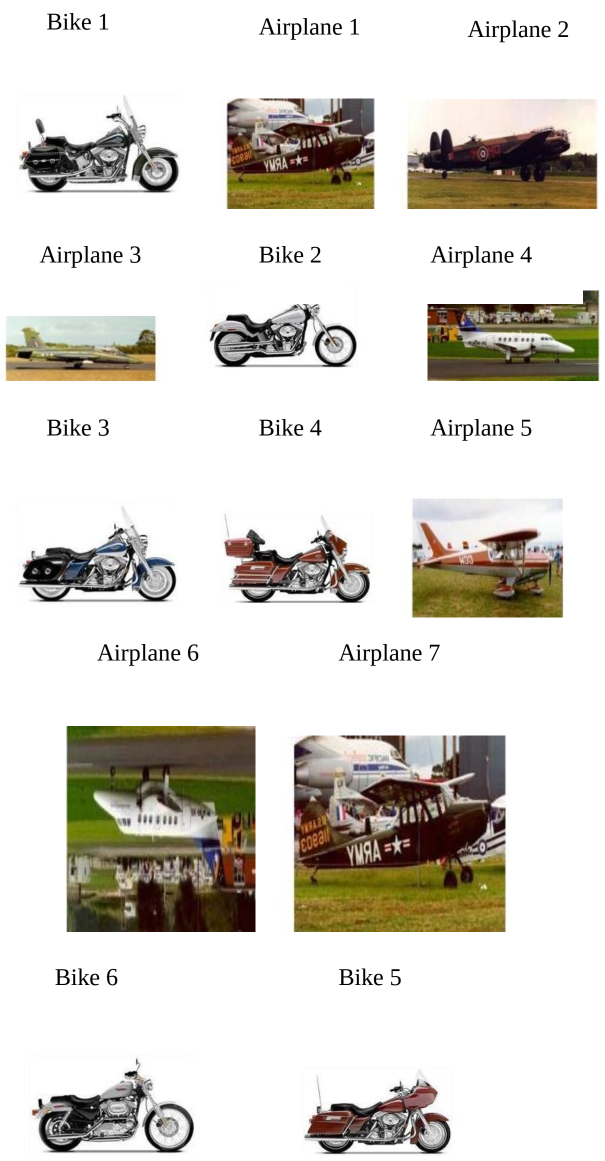

Figure 4: Sample images of a data set before categorization

4.1 After categorization

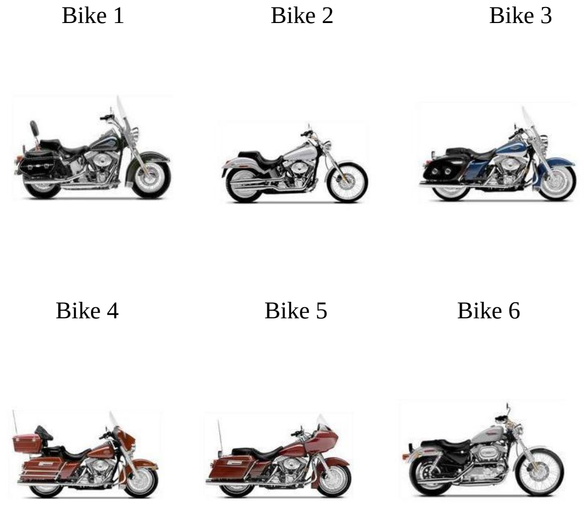

Figure 5: Sample images of bike data set after categorization

4.2 Image retrieval

Query Image

4.3 Retrieved images

Figure 6: Sample images Retrieved from categorized database images for the query image given by the user

4. RESULT PERFORMANCE

Figure 7 &8 and Table I shows the precision and recall value of the images which is implemented.

Table I

Technique	Airplane class	Bike class	Horses class	Fishes class	Sunflower class	Average of all classes
Precision value	1	0.86	0.89	0.87	0.92	0.91
Recall value	0.80	0.65	0.69	0.67	0.75	0.71

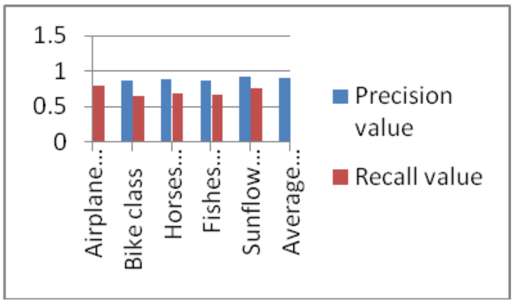

Figure-7

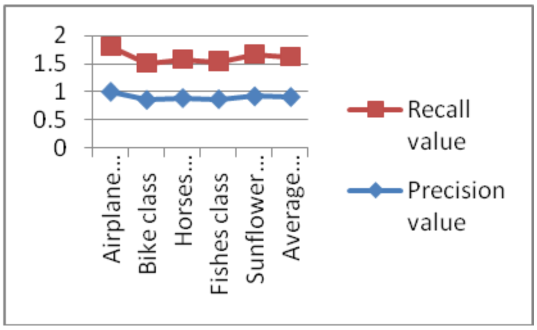

Figure-8

5. CONCLUSION

Image categorization and Content Based Information Retrieval (CBIR) approach are carried by wavelet decomposition of images, followed by feature extraction by Scale Invariant Feature Transform (SIFT) and similarity match under F-norm theory. D4 wavelet has greatly speeded retrieval as well as ensured enough recall rate comparable with Haar wavelet and wavelet histogram. In addition, the progressive retrieval strategy helps to achieve flexible compromise among retrieval indices. Finally we conclude from the results that wavelets achieve high retrieval performance in real time CBIR systems. In retrieval system, images of various size and also images which undergone transformation and illumination changes are identified.

6. ACKNOWLEDGEMENT

We have presented a comprehensive survey, emerging directions, publication trends, and scientific impact of the young and exciting field of content-based image retrieval. We believe that field will experience a paradigm shift in the foreseeable future, with the focus being more on application-oriented, domain-specific work, generating considerable impact in day-to-day life. We have laid out guidelines for building practical, real-world systems that we perceived during our own implementation experiences. We have compid research trends in CBIR using Google Scholar's search tool and citation scores. Further analysis has been made on the impact CBIR has had in merging interests among different fields of study. We have discussed the new ideas, sub-fields, and sub-problems emerging out of core CBIR in the recent years. Meanwhile, we do believe that the quest for robust and reliable image understanding technology should continue.

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