Multiple Feature Extraction in CBIR with Relevance Feedback

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Abstract— **Rapid expansion of image data on internet opens the way to image retrieval systems. Most commercial image retrieval systems include text based approach which is incompetent as some features are nearly impossible to describe with text. In an effort to overcome these problems and to improve image retrieval performance researchers are focusing on Content Based Image Retrieval (CBIR). CBIR system uses the contents of image such as color, shape and texture features. This paper presents superior feature extraction technique in CBIR using multiple features like color and texture than the single feature. The performance of CBIR systems is further enhanced by relevance feedback (RF) mechanism that incorporates human perception subjectivity into the query process and provides users with opportunity to evaluate retrieval results.**

Keywords—***CBIR; color; texture; feature extraction; relevance feedback***

I. INTRODUCTION

Traditional image retrieval system was based on textual annotations to retrieve the image from database. The main drawback of traditional image retrieval system is manual text annotation. Since the database consists of large volumes of images, it becomes very cumbersome to annotate images manually. The same image may be annotated differently by various users or different images can be annotated same. This has attracted researcher's attention to Content Based Image Retrieval (CBIR). CBIR is the process of searching images on the basis of their visual features like shape, color and texture [1]. These low-level visual features determine the similarity of images [2]. Color is the most intuitive and straight forward feature. It is most widely used visual content because it does not depend on image size or orientation. Texture is used to specify the roughness or coarseness of the object surface. Shape feature refers to shape of a specific region. CBIR extracts these visual features from images and describes them by forming multidimensional feature vectors. For image retrieval, users provide the retrieval system with example image known as query image. The system then forms feature vectors of query image. These feature vectors are then compared with feature vectors of the images in database and similar images are retrieved with the help of an indexing scheme [3]. Thus feature extraction plays a vital role in CBIR system. Though there has been plethora of feature extraction techniques; we present feature extraction technique using multiple features by combining color and texture.

The most challenging issue in results retrieved by above method is user subjectivity i.e. semantic gap between low level features and users perception. Different users may perceive the same image in various ways. Moreover computer cannot interpret the image as human being can. There is no rule to formalize the content of images as human can. All of the above problems make user interaction with system a necessity. The active user interaction is provided by incorporating relevance feedback in CBIR. Relevance feedback is a powerful technique for interactive image retrieval. It refers to the ability of users to communicate the relevance of retrieved results to the CBIR system. The system then refines the search on the basis of feedback given by users to improve results [4]. Fig.1 shows the basic architecture of RF based CBIR system. As shown in the Fig. 1, user formulates an input image query and submits it to the system. The resultant query images retrieved by above method are further refined by relevance feedback where user comments on the items that were retrieved. The user provides feedback on retrieved images about relevance of retrieved results. This feedback is used by system to give more accurate results. The rest of paper is organized as follows. Section II describes construction of CBIR systems with RF mechanism. In section III we discuss experimental results. Finally paper is ended with conclusion and prospects in CBIR using relevance feedback.

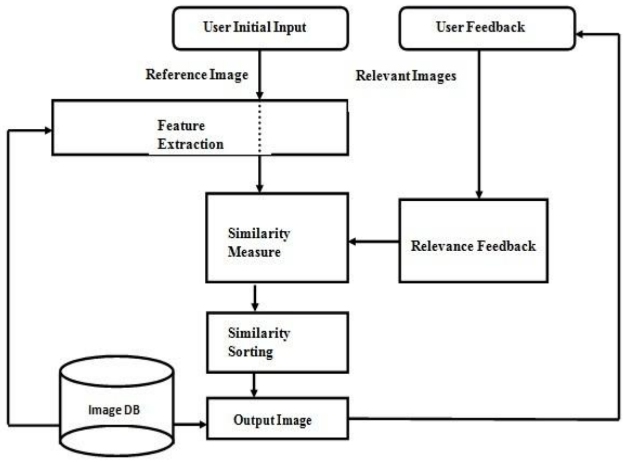


Fig.1 RF based CBIR system

II. CONSTRUCTING CBIR WITH RF

Many CBIR systems have been evolved including MARS, QBIC, NETra, Photobook, VisualSEEk and others. The performance of these conventional systems can be enhanced by interactive mechanism called Relevance Feedback. Relevance feedback is widely adopted technique to deal with the issue of user subjectivity. User subjectivity refers to different perceptions in different users for a given image [11]. Various supervised learning approaches like Support Vector Machines (SVM), Neural Networks, Bayesian methods and decision trees are used to implement Relevance Feedback. These still have not been perfect descriptors for semantic features due to visual feature diversity. This has diverted researcher's focus towards other methods like CAFé. CAFé (Classificatory Analysis based Feedback) is a reweighting strategy based on a rough set theoretic analysis of user feedback and is independent of retriever. A modified CAFe i.e CAFe with PRF strategies based on Euclidean distance retriever is also proposed [12]. Some relevance feedback mechanisms use feature weighting heuristics methods. Algorithms like Query point movement, Query expansion, Qcluster, FALCON, query decomposition and reweighting are used for weighting heuristics. We construct CBIR system with RF using following modules.

A. Web based GUI

This module is responsible to take input from admin. The GUI is developed in HTML and JAVA script. Server is web based application and takes input through this GUI where proper validations are supported. This includes new users registration, new image upload etc. We create package com.servlet that contain all servlets used to create web application. Fig. 2 shows package com.servlet.

B. Database Manager

This module handles all database related activities. The database connection polling system is used to avoid repeatedly opening and clashing database connection. The JDBC driver manager ensures that correct drivers are used to access each data source. It is capable of supporting multiple concurrent drivers connected to multiple heterogeneous databases. We create package com.dbmanager that contains database connectivity and database helper classes. Database connectivity class is used to connect to database and helper class is used to perform operation like insert, update, delete and select on table. Fig.3 shows com.dbmanager package.

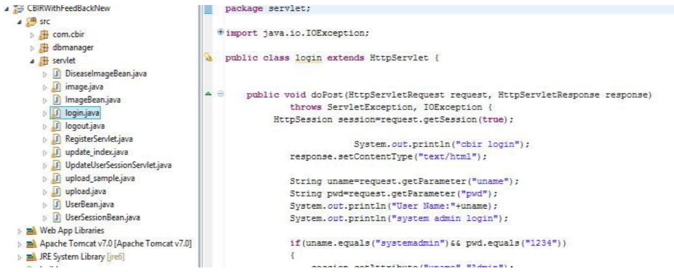


Fig. 2 Classes under com.servlet package

Fig. 3 Classes under com.dbmanager

C. Feature Extraction

Visual features are the elements in an image as we differentiate image based on these visual features. Visual features are further classified as low level features and high level features. This work extracts low level features color and texture.

1) Color Feature Extraction

Color is the most widely used feature in CBIR as it is a human perception that depends on visual system of light [5]. A digital image consist of three colors red, green and blue and different colors can be formed by using combination of these three colors. Color feature is defined subject to a particular color space or model such as RGB, HSV, CMYK. Many techniques have been used for color feature extraction. The most traditional way of describing color attribute of an image is global color histogram (GCH). It is constructed by computing the normalized percentage of color parts corresponding to each color element [6]. Color histrogram is another widely used technique for color based image retrieval [7]. Fuzzy Color Histogram (FCH) proposed by K. Satya Sai Prasad and RMD Sundaram is more promising as it spreads each pixel's total membership value to all histogram bins, which reduces computational complexity [8]. We use following technique for color feature extraction. It is carried out in two steps. First is to convert RGB to HSV color space. We convert RGB to HSV as RGB color space is the way computer treats the color but HSV tries to capture the component as human perceives the color. RGB defines color whereas HSV describe the image using color, vibrancy and brightness. The next step is to calculate Color Moments. It is a measure to differentiate the image based on color feature of an image. Color moments assume that the distribution of the color in an image can be interpreted as probability distribution. Thus if the color in an image follows certain probability distribution, moment of that distribution can be used as a feature to identify an image based on color. Stricker and orengo used three moments for image color distribution. They are as follows. a) Color Expectancy (Mean): It is defined as an average color in an image. So we calculate average red color, average blue color and average green color as follows.

Color Expectancy of red color

$$E_r = \sum_{i,j=1}^{n} P(i,j)/n$$

Color Expectancy of Green Color

$$E_g = \sum_{i,j=1}^{n} P(i,j)/n$$

Color Expectancy of blue Color

$$E_b = \sum_{i,j=1}^{n} P(i,j)/n$$

b) Color Variance: It is the difference of red, green and blue color to the mean red, blue and green color. It gives idea about how far the color is from mean color. It is calculated as follows

Variance of Red Color

$$V_r = \sum_{i,j=1}^{n} ((P(i,j) - E)^2)/n$$

Variance of Green Color

$$V_g = \sum_{i,j=1}^{n} ((P(i,j) - E)^2)/n$$

Variance of blue Color

$$V_b = \sum_{i,j=1}^{n} ((P(i,j) - E)^2)/n$$

Where E= Color Expectancy of Red, green and blue.

c) Color Skewness: It is used to measure symmetry or lack of symmetry. It gives idea about shapes of color distribution. It is calculated as follows.

Skewness of Red Color

$$S_r = \sum_{i,j=1}^{n} ((P(i,j) - E)^3)/n$$

Skewness of green Color

$$S_g = \sum_{i,j=1}^{n} ((P(i,j) - E)^3)/n$$

Skewness of blue Color

$$S_b = \sum_{i,j=1}^{n} ((P(i,j) - E)^3)/n$$

Where E= Color Expectancy of Red, green and blue.

The extracted color moments for sample image are as shown in Fig.4. Extracting only color feature is not sufficient in CBIR. So after color extraction, we extract texture feature.

2) *Texture Feature Extraction*

It is another important property of images. It measures look for visual pattern in an image and their spatial distance. Two images with different content can usually be distinguished by their texture feature even when image share similar color. Gabor filter or Gabor wavelets are widely used to extract texture feature from images [9]. Texture co-occurrence matrix and wavelet transforms are other widely adopted techniques for extraction of texture feature from an image [10].

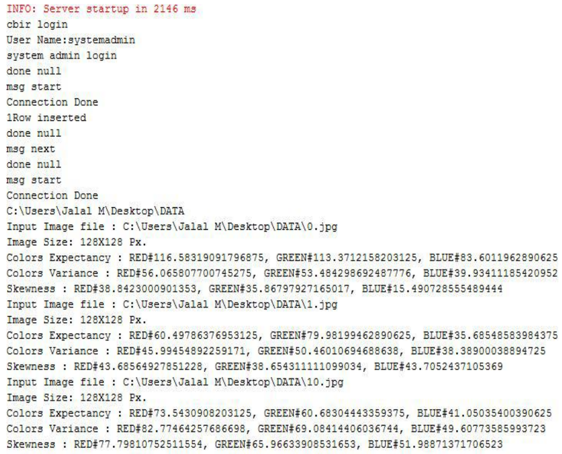


Fig. 4 Color moments

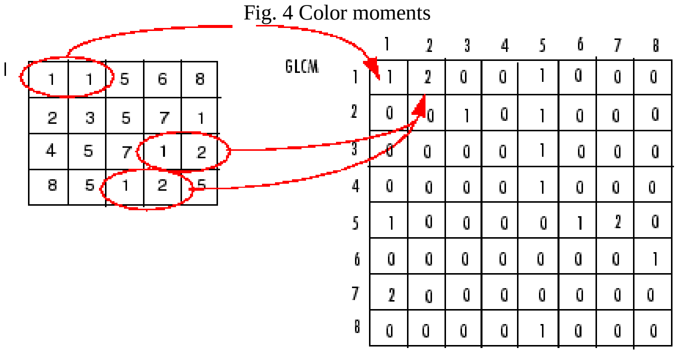


Fig.5 GLCM

We extract texture feature using GLCM (Gray level co-occurrence matrix). It creates the gray co-matrix function by calculating how often a pixel with intensity value i occurs in a specific spatial relationship to a pixel with value j. Here spatial relationship is pixel of interest and pixel to its immediate right. Fig. 5 shows GLCM matrix. Element (1,1) contains the value 1 because there is only one instance in the input image where two horizontal pixels have values 1 and 1 respectively. GLCM contains the value 2 because there are two instances where two horizontal adjacent pixels have values 1 and 2. Element (1,3) has value 0 because there are no instances of two horizontally adjacent pixels with values 1 and 3. This process is continued to form Gray co-matrix. We generate class "GLCMFeatureExtractor.java" to generate GLCM of given input images as shown in Fig.6. It extracts four features energy, contrast, entropy and inverse difference as shown in Fig.7

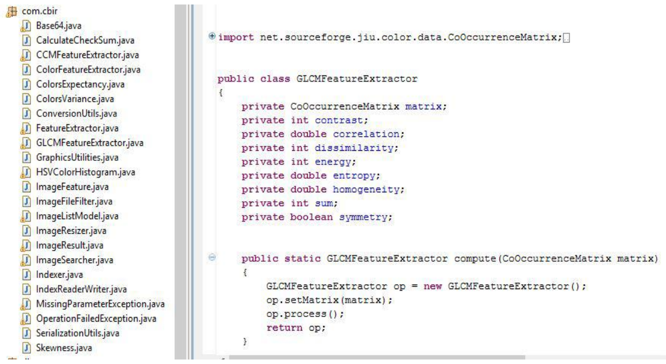


Fig. 6 GLCMFeatureExtractor.java

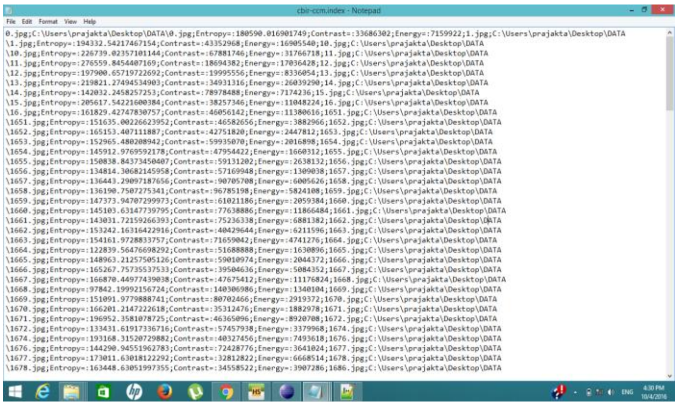


Fig. 7 Texture feature extraction

D. RELEVANCE FEEDBACK

After extracting all features these features are then compared with the features present in data base and using some threshold value the results are retrieved. The retrieved results may be relevant or irrelevant. If users find that the retrieved results are irrelevant then users gives feedback to system. The feedback given by user helps the system to refine the retrieval results. The system learns from the user feedback and trains itself to give more accurate results.

Here we present algorithm for CBIR using RF

Algorithm:

Input: Image File

Steps

1. Resize the image as per database images size.
2. Converts RGB values to gray scale values by forming a weighted sum of the R, G and B components.
3. Create an empty GLCM matrix
4. For every pixel:

(a) Calculate how often a pixel with the intensity (gray-level) value i occurs in a specific spatial relationship to a pixel with the value j.

(b) Sum the number of times that the pixel with values i occurred in the specified spatial relationship to a pixel with value j in the input image.

(c) Update GLCM matrix[i,j] with above sum value

(d) Any more pixel, yes continue no break

5. After GLCM created, calculate :

(a) Contracts-Measures the local variations in the gray-level co-occurrence of the specified pixel pairs

(b) Correlation-Measures the joint probability occurrence of the specified pixel pairs

(c) Energy-Provide the sum of squared elements in the GLCM also known as uniformity or the angular second moment.

(d) Homogeneity-Measures the closeness of the distribution of element in the GLCM to the GLCM diagonal.

6. Compare contracts, correlation, energy, histogram of the input image and database images to find best match
7. Ask user for its input on final answer
8. Next time if user uploads the same image, then show result from database.

III. EXPERIMENTAL RESULTS

Our system incorporates relevance feedback in CBIR. We have created a database of annotated images. Fig.8 shows sample dataset of images used for carrying work. The CBIR feedback system provides two logins mainly admin and user. Admin login has its own credential to access the website but users needs to register first to access the website. Fig.9 shows the registration and login modules for above two requirements. Admin can populate the image data in database and upload images accordingly. Indexing is performed that create text files with proper timestamps.

When user gives the query image, this image is converted to .jpg format. Fig.10 shows user giving query in the form of an image. Basic color and texture feature are extracted from query image as shown in Fig.11

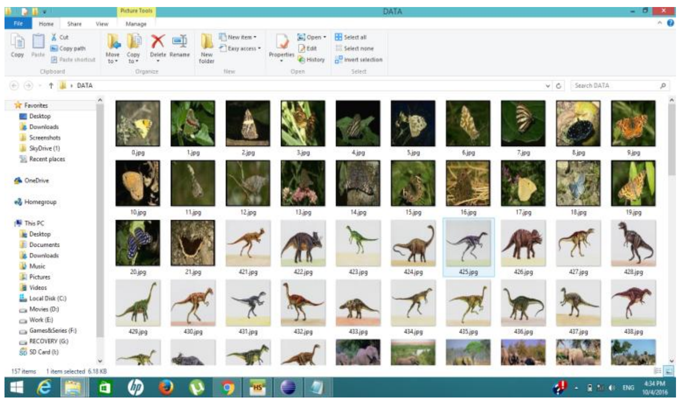


Fig.8 Image Dataset

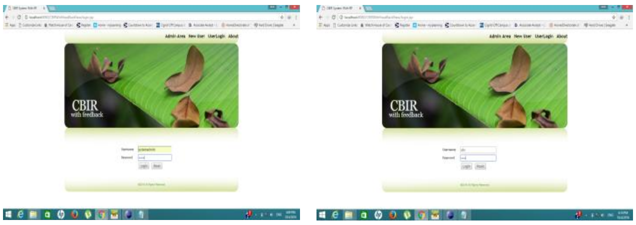


Fig.9 Admin and user login credentials

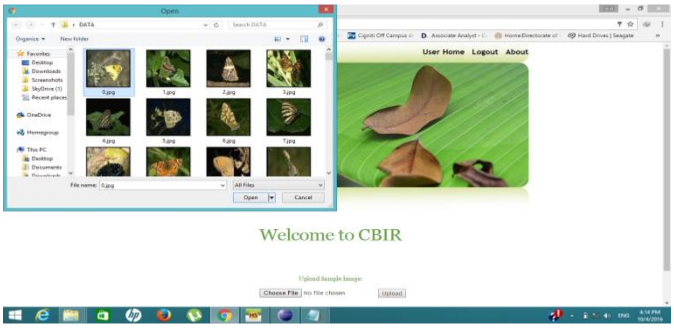
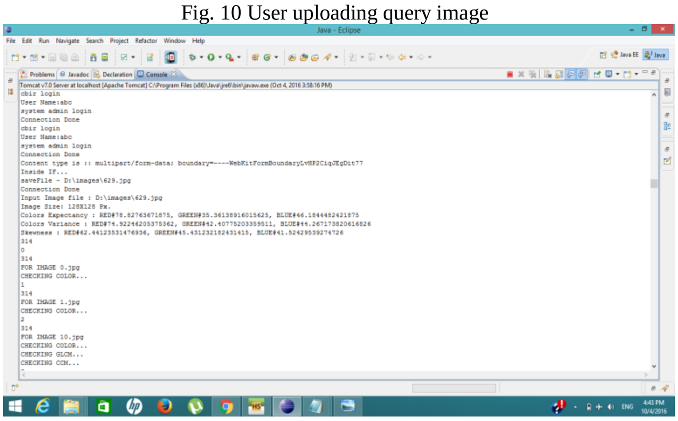


Fig. 10 User uploading query image



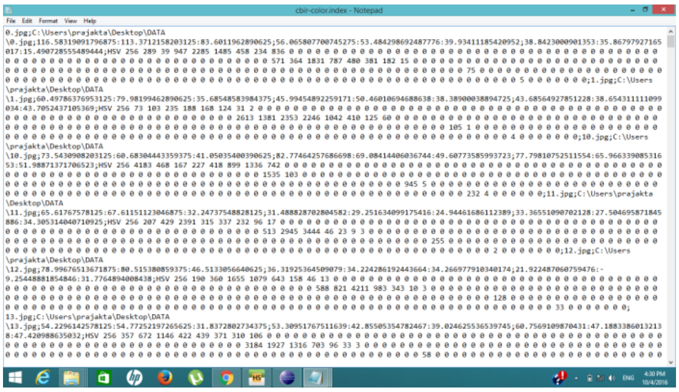


Fig. 11 Color and Texture feature extraction

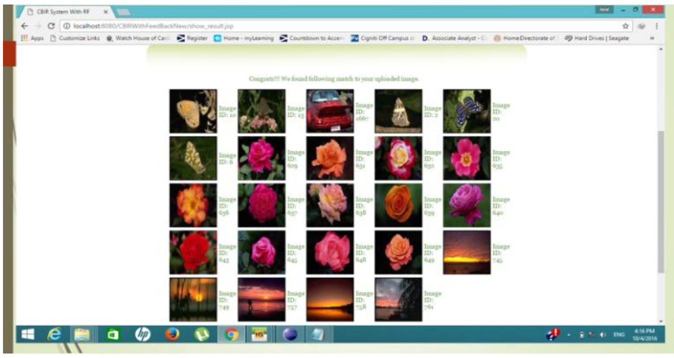


Fig. 12 Retrieved images

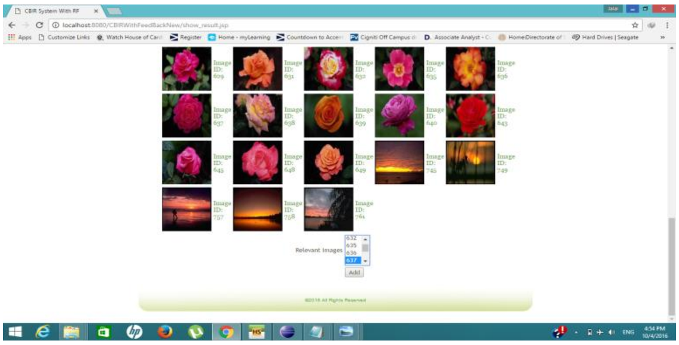


Fig. 13 User giving Relevance Feedback

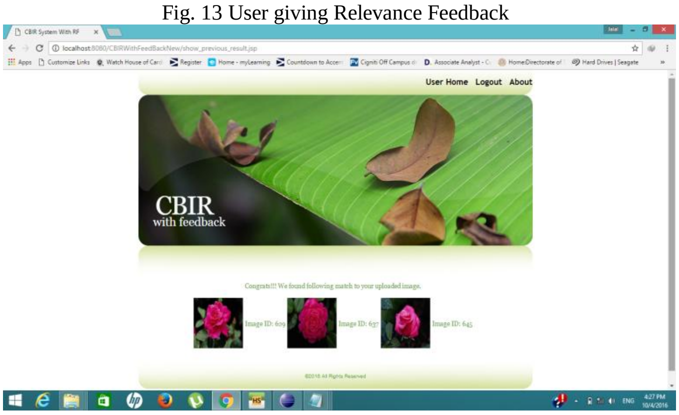


Fig. 14 Final results after relevance feedback

After extracting all features these features are then compared with the features present in data base. These features are then compared **a**nd using some threshold value the results are retrieved. Fig. 12 shows retrieved results. The retrieved results may be relevant or irrelevant. If users find that the retrieved results are irrelevant then users gives feedback to system as shown in Fig.13. The feedback given by user helps the system to refine the retrieved results. Fig. 14 shows final retrieved results after relevance feedback. The system learns from the user feedback and train itself to give more accurate results.

IV. CONCLUSION

This paper proposed a web-based content-based image retrieval system using feature extraction algorithm and relevance feedback scheme. The proposed framework can efficiently merge image features and user's feedback for image retrieval systems. Experimental results show that our strategy of combining multiple features outperforms the CBIR system with single feature significantly. We have used color moments and GLCM for color and texture features extraction in contrast to traditional methods of feature extraction. Further the semantic gap between these features and user's perception is reduced by relevance feedback where user refines the search by marking results as relevant or irrelevant. Since we give users the control to give feedback, improvement of retrieval performance is assured.

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