An Efficient Approach for Image Retrieval Using Semantic Relevance

Sukhada Aloni

***Abstract*— Advances in medical imaging have led to growth in large image collections. Computer technologies and the advent of the World Wide Web have increased the amount and the complexity of multimedia information. A content based image retrieval (CBIR) system has been developed as an efficient image retrieval tool, whereby the user can provide their query to the system to allow it to retrieve the user's desired image from the image database. We propose a relevance feedback framework to take advantage of the semantic contents of images in addition to low-level features. By forming a semantic network on top of the keyword association on the images, it is possible to accurately deduce and utilize the images' semantic contents for retrieval purposes. The pooling method collects top ranked images from submitted retrieval systems resulting in possibly a very large pool of images. Inevitably, the pool may contain outliers. Here we introduce an automatic outlier detection method to remove outliers and preprocess the pooled images. Fuzzy logic system for categorization of the image into different categories for faster retrieval.**

***Index Terms*— Text based image retrieval, content based image retrieval, CBIR, Fuzzy logic..**

I. INTRODUCTION

Biomedical image analysis is highly interdisciplinary field. It is the application of image processing technique with biological or medical problems. In this technique human body images are processed to examine the various types of diseases. Medical imaging technology has revolutionized health care by allowing doctors to find disease earlier and improve patient outcomes. Medical imaging is having its immense benefits, both personally and empirically. As the medical imaging is playing a part of life the storage and retrieval of those medical images is having higher complexity. Even though we manage to store those data but retrieval of that data is one of the most challenging tasks. So there are different ways to access that data from dataset. Modality is important aspect if image in medical imaging. It acts like a filter for searching of image.

Timely retrieval of desired image(s) from a huge varied database has thus become a challenging problem. To cater to this problem initially a text-based image retrieval technique was proposed. In this technique images were first examined and assigned keywords and/or titles that were most appropriate to portray their contents. These keywords were stored as an attribute associated with the image in the database. During retrieval stage the system accepts one or many word string constituting the search criteria to retrieve images having keywords related with the given search string. Figure 1 shows a block diagram for content based image retrieval system.

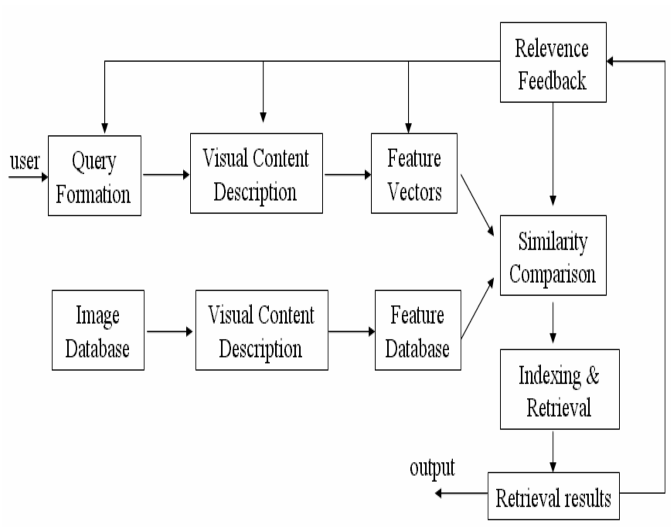

Fig 1 CBIR System Using Relevance Feedback

The main issue with text based image retrieval system is that the keywords used to describe an image often ambiguous and rather inadequate to efficiently perform image database search and query processing. This is due to the fact that the content of an image is much richer than the keywords and phrases used to describe the content of images. Further as the textual annotations are language based, variations in these annotations pose a severe challenge to image retrieval [1]. This makes text-based retrieval techniques prone to errors, weighty and complicated.

To overcome the difficulties of content-based image retrieval system came into being and has been an important area of research since the early 1980's. Content Based Image Retrieval (CBIR) uses the visual content of the images to process, search and retrieve the images from a database. CBIR techniques makes use image processing algorithms to extract feature vectors from the image representing image properties such as color, texture, shape, etc [2]. Unlike keywords for text-based image retrieval systems, visual features for CBIR system haul out from the image itself thus making them more descriptive of the image and less subjective.

Further CBIR systems can be categorized on the basis of the type of features used for retrieval process as: low level features or high level features. Low level features include color, texture, shape, spatial relations, etc, whereas high level features used today includes refining of these low level features such as based spatial arrangement of chromatic contents of an image, use of fuzzy logic rules to determine similarity between searched shape and given object shape, etc.

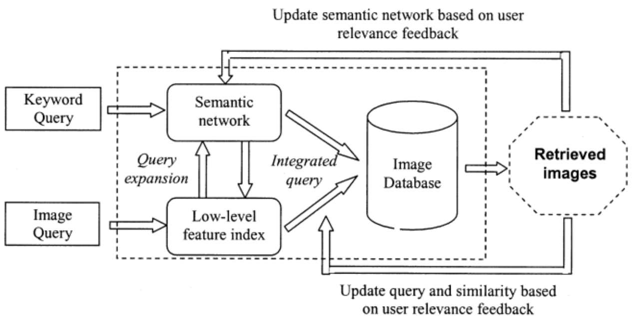

Fig.2: Infrastructure for Integrated query In CBIR

Figure 2 above shows The framework supports both query by keyword and query by image example through semantic network and low-level feature indexing. Besides relevance feedback, system supports cross-modality query expansion. That is, the retrieved images based on keyword search are considered as the positive examples, based on which the query is expanded by features of these images. In this way, the system is to extend a keyword-based query into feature-based queries to expand the search range. In addition, a relevance feedback process refines the retrieval results, updates the semantic network and feature weightings in similarity measures.

However with progress in CBIR techniques it was found that image retrieval process can be made effective by recognizing the image class prior to any kind of processing or similarity matching. Such a technique helps to successful categorize images thereby enhancing the performance of the system by sorting out extraneous images, requiring similarity matching step to be performed between query and images in the filtered set only.

II. Literature Survey

Data retrieval techniques came into picture right in early 1970s and with increased use of digital imaging techniques shifted its way to digital image retrieval in the late 1980s. T. Kato in 1992 presented his experiments of automatic retrieval of images from a database, based on the colors and shapes and formally introduced the term CBIR [4].

The paper by A. Smeulders, M. Worring, S. Santini, A. Gupta and R. Jain [5] presents a review of about brief review of about 200 references in CBIR and discusses working of CBIR systems in respect to conditions like type of images, role of semantics and sensory gap. In [6] several approaches to improve both time and quality performance of CBIR systems have been implemented. Variety of techniques catering to issues such as time efficiency, disk space consumption and high quality in the results have been evaluated. One key contribution of the work is the use of Hamming signatures to improve clustering and the addition of a weak geometry consistency check to further enhance the stability of key points in an image.

In [7] two methods for describing the contents of images based on global descriptor attributes and color histogram approach are investigated. The result shows that global descriptor attributes containing texture feature attribute (cross correlation) achieve better results than all color descriptor (color expectancy, color variance, skewness). Further it is shown that images retrieved by using the global color histogram might not relate semantically, even though they had similar color distribution. However this drawback can be minimized to an extent by calculating color feature attributes along with efficient implementation.

In [8] clustering techniques for extraction hidden pattern from huge data sets are discussed and analyzed. The work proposes a method HDK that uses more than one clustering technique to improve the performance of CBIR, which employs hierarchical, and divide and conquer K-Means clustering technique with equivalency and compatible relation concepts to improve the performance of the K-Means for using in high dimensional datasets. It also introduced the feature like color, texture and shape for accurate and effective retrieval system. In [9] CBIR system is used as diagnosis aid in medical fields. The proposed system uses extracts Texture features by using pyramidal wavelet transform. The proposed system is evaluated on Diabetic Retinopathy Database (DRD) to obtain an improved precision rate of about 60%.

In [10], the existing problems in CBIR and biometrics systems have been addressed. The work investigates the use of a number of different colors, textures and shape features for image retrieval. In [11] paper various methodologies used Content Based Image Retrieval using Relevance Feedback have been discussed and a comparison of these methods has been done. The Relevance Feedback technique when incorporated in CBIR system to obtain the higher values of the standard evaluation parameters, the CBIR system leads to better retrieval performance.

III. Proposed Method

The proposed image retrieval method uses the CBIR using Relevance Feedback and Semantic Relevance. In Relevance Feedback the user can give the feedback for the query image and the no. of hits for the image are given for reference to the user. In Semantic Relevance query image content and its semantic are checked for giving output. It speeds up the image retrieval process. The designed system can be categorized into two main sections:

A. Database Creation

This is where the input images are saved after some pre-processing into the database. These preprocessing steps are used to calculate some of the parameters of the image which are later used in the image retrieval step. This is achieved using following steps:

1) Calculate the edge map of the given input image
   There are many ways to perform edge detection. The most common can be grouped into two categories, gradient and Laplacian. The gradient method detects the edges by looking for the maximum and minimum in the first derivative of the image. The Laplacian

method searches for zero-crossings in the second derivative of the image to find edges. In our method we have used Canny operator. The canny edge detector first smoothes the image to eliminate and noise. It then finds the image gradient to highlight regions with high spatial derivatives. The algorithm then tracks along these regions and suppresses any pixel that is not at the maximum [5].

2) Calculate the extended histogram of the image

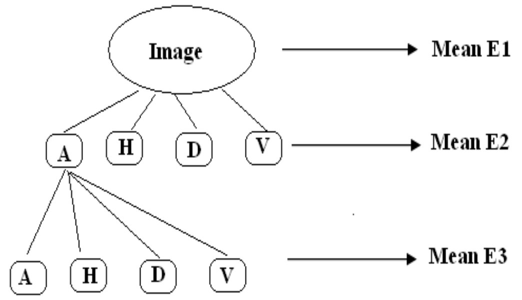

Fig 3.Application of 3rd level wavelet transform on the input image.

3) Calculate the energy of the image.
On this step we calculate the energy of the image (e1, e2 and e3) by applying 3rd level wavelet transform on the image. We have used Haar wavelet for our proposed method. DWT is applied on the image, which gives the approximation, horizontal, diagonal and vertical components of the image. From this we calculate the mean energy E1. Then a second level of DWT is applied on the image to get the mean energy E2. And finally a third level of DWT is applied to get the mean energy E3. This is illustrated in Figure 5 below. The energy of the image is calculated using the following formulae:

$$E = \frac{1}{MN}\sum_{i=1}^{m}\sum_{j=1}^{n}|x(i,j)| \qquad (4.1)$$

where M and N are the dimensions of the image, and X is the intensity of the pixel located at row i and column j in the image map.

4) Save the image into the database along with above three calculated parameters and its textual description and category.

B. Database Evaluation

This is where the given image is compared and searched from the database. At this step the prime focus is to retrieve images based on the input image and/or its text description and display them in a rank order with best matching image on the top. For evaluation the following steps are performed:

1) The user enters the input image along with its text description to search the available images in the database.
2) We first calculate the edge map, extended histogram and energy (e’1, e’2, and e’3) of the image.
3) We then fetch the input image’s energies (e’1, e’2, e’3) and the energies (e1, e2, e3) of the images in the database to the fuzzy logic system. In this system we calculate the energy difference between the input image and database images and look for the images where the difference is minimum. The image with output minimum difference in the database is considered and its category is taken as the category of the input image.
4) Figure 6 above shows the rule set for the designed fuzzy system. As can be seen that id the difference d1=e’1~e1=1 (very close), d2=e’2~e2=1(very close), and d3=e’3~e3=4 (far), then the output of the fuzzy system is 1 (very close). Similarly the other rules can be seen and logically understood. The complete list of these rules is given in the Appendix of this thesis.
5) Next in this category compare the edge map and extended histogram values for the input image with all the images in the category to get the scores [s1, s2, s3, s4 ...].
6) The given query text is matched with the description of each image in the category and a semantic value is calculated on the basis of the words matched with each of the images.
7) Finally a product of these semantics and scores is calculated to get the ranks [r1, r2, r3, r4 …].

The images are displayed in a descending order of their ranks i.e., the highest rank image is the best match and is displayed at the top.

IV. PROPOSED METHOD RESULTS

The proposed content based image retrieval method is implemented using MATLAB. To test the proposed image retrieval technique we have created a database of more than 1500 images and are saved into the database along with their text and categories. The categories are subjected to the user saving a particular image into the database. However this subjectiveness while saving the images in the database, doesn’t affect the performance of the proposed system as can be seen from the results obtained. The text based image retrieval, the CBIR and the fuzzy system used to determine the category, work in together to cater to this problem.

Figure 4 shows the query image given to the system and for this there is Extended Color Histogram and Edge map will be given for matching in database. The query image falls in category ‘Brain’.the output with ranks has been obtained. Further the semantic scores of the displayed retrieved images can also be seen in the figure.

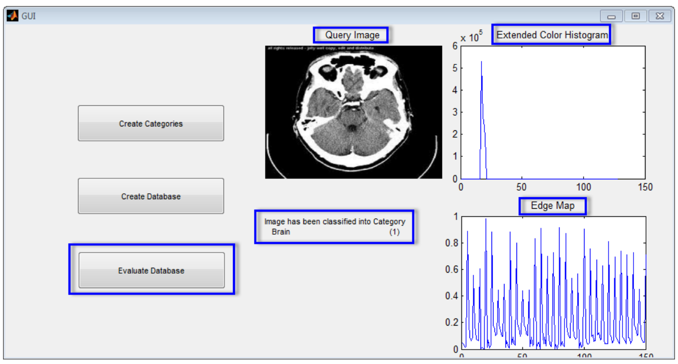

Fig.4 Query image

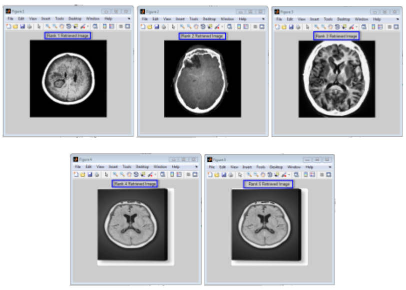

Fig.5 Output using Relevance Feedback Method

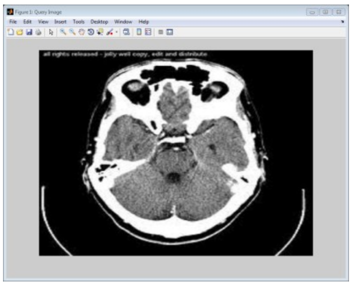

Fig.6.Query image for Semantic Relevance Method

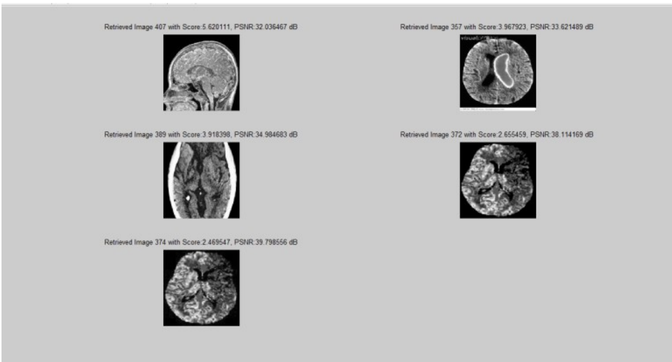

Fig.7.Output of Semantic Relevance with semantic score

Figure 7 above shows the matching with query image and the text for this image is 'Brain'. Figure 7 shows the output of the retrieved images as per the query image and text.

V. CONCLUSION

Due to the enormous increase in the size of image databases as well as its vast deployment in various applications, the need for Content Based Image Retrieval (CBIR) development arose. It describes a hybrid feature extraction approach of our research and solution to the problem of designing a CBIR system manually. For collections of images that lack proper annotations, CBIR promised to be the solution In order to achieve a substantial progress in the field of Content-Based Image Retrieval (CBIR) this breakthrough can be enforced by: optimizing user-system interaction, combining the wealth of techniques from text-based Information Retrieval with CBIR techniques, exploiting human cognitive characteristics, especially human color processing, and conducting benchmarks with users for evaluating new CBIR techniques.

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