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DICOM Image Retrieval Using Novel Geometric Moments and Image Segmentation Algorithm

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Abstract

The Medical image database is growing day by day [1]. Most of the medical images are stored in DICOM (Digital Imaging and Communications in Medicine) format. There are various categories of medical images such as CT scan, X- Ray, Ultrasound, Pathology, MRI, Microscopy, etc [2]. Physicians compare previous and current medical images associated patients to provide right treatment. Medical Imaging is a leading role in modern diagnosis. Efficient image retrieval tools are needed to retrieve the intended images from large growing medical image databases. Such tools must provide more precise retrieval results with less computational complexity. This paper compares the various techniques for DICOM medical image retrieval and shows that the proposed geometric and image segmentation based image retrieval algorithm performs better as compared to other algorithms.

Keywords

Medical Image Retrieval, Image Enhancement, Relevance Feedback, Medical Image Processing, Soft Computing, Medical Image Formats.

1. Introduction

Various researches are carried out in recent past years for efficient medical image indexing and retrieval. Some recent research papers include various methodologies for indexing and retrieval of images. The overview of some of these researches is given in this paper. This paper includes the comparison of image retrieval techniques with the proposed Geometric Moment combined with Image Segmentation. The comparison is carried out between proposed technique and various image retrieval techniques such as Web base Medical IR in Oracle, Pattern Similarity based Medical IR, Indexing for RF in IR, Entropy Based IR, Similarity Based Online Feature Selection, Entropy Based Feature Selection and Localized CBIR. QBIC, Virage, Photobook, Chabot, VisualSeek, SurfImage and Netra [2] these are several popular content based image retrieval systems. All these systems can't be useful for retrieving medical images. These systems uses some simple feature extraction methods which may provide unwanted results and are not that much precise.

In content based image retrieval systems the queries, used to retrieve images, can be classified as primitive, logical and abstract [3]. Primitive query is based on features, such as color, shape and texture, extracted from images. Sketch-based and linguistic queries in which the user describes objects or regions in the desired spatial positions and ascribes attributes, such as class label, size, color and shape properties, to them can also be considered as logical queries. Abstract queries are based on notion of similarity. Logical and abstract queries are sometimes called as semantic queries.

QBIC allows queries based on sample images, sketches and selected color or texture patterns. To measure the similarity between two images Euclidian distance is used. Virage provides the GUI for image insertion, image query, weight adjustment for re-query inclusion of keywords and image canvas. The image canvas allows user to insert queries as sketch. The features are extracted as global color, local color, texture and shape for image matching. In Photobook the user selects some images from the grid of still images displayed and enters an annotation filter. From the images displayed, the user can select another query images and again run the search. It implements three approaches to construct image representations for querying purposes, each for faces, shapes and texture.

In Chabot the user has a list of search criteria such as keyword, photographer, film format, shooting date, location and colors. Color criterion offers limited options for the user. It combines text based description with image analysis in retrieving images from a collection of photographs. In VisualSeek the user sketches a number of regions, positions and dimensions and selects a color for each region. Also boundaries for size and spatial relationships between regions can be specified in the query. For feature

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computation each image is automatically decomposed into regions of equally dominant colors. Feature and spatial properties are retained for the subsequent queries.

The low-level and high-level features are combined in Surfimage. RGB color histogram, edge histogram, texture signature these are the low-level features that are used for the feature extraction. While providing query the user can select image features, similarity measures and can specify weights to define the importance of each feature in the retrieval. In Netra images are segmented into regions. Then for every regions color, texture, shape and spatial features are extracted. User can provide image as query from the database. Then user can select the image region along with any one of the four image attributes color, spatial location, texture and shape.

2. Web Based Medical Image Retrieval System in Oracle

The implementation of web based system for medical image retrieval using Oracle Multimedia features is given in [4]. The system uses Digital Imaging and Communications in Medicine (DICOM) image file format, which contains additional information regarding image modality, acquisition device and patient identification in its header along with raw image data. The DICOM feature was introduced in Oracle Database 10g Release 2. The system is developed by using Oracle 11g multimedia Database, Oracle JDeveloper, JDK 1.6 (Java Development Toolkit), JMF (Java Media Framework) and JAXP (Java API for XML Parsing). Oracle Multimedia DICOM support includes: ORDDicom object type, DICOM metadata extraction, DICOM conformance validation and DICOM image processing and image compression. The implemented system architecture proposed in [4] is given in Figure 1.

The main goal is to demonstrate the use of the Oracle Multimedia features for image management and retrieval. Implementation is based only on the Oracle provided methods, operators and visual signatures. Six image categories are used for demonstration. Attributes weights are predefined for each image category. The reference of Picture archiving and communication systems (PACS) is also given in [3, 4]. PACS are used in many hospitals, which are basically computer networks for storage, distribution and retrieval of medical image data.

Oracle Multimedia Classes for JSP (Java Server Pages) and Servlets are used for implementing the application. ORDImage object type is used for the manipulation of multimedia data. ORDImageSignature object type is used for content-based image retrieval. isSimilar(), evaluateScore(), generateSignature() are the methods used for image data manipulation. IMGSimilar() and IMGScore() are the operators for ORDImage() object type. IMGSimilar() operator determines whether or not two images are match. IMGScore() compares the signature of two images and returns the weighted sum of the distances for the visual attributes.

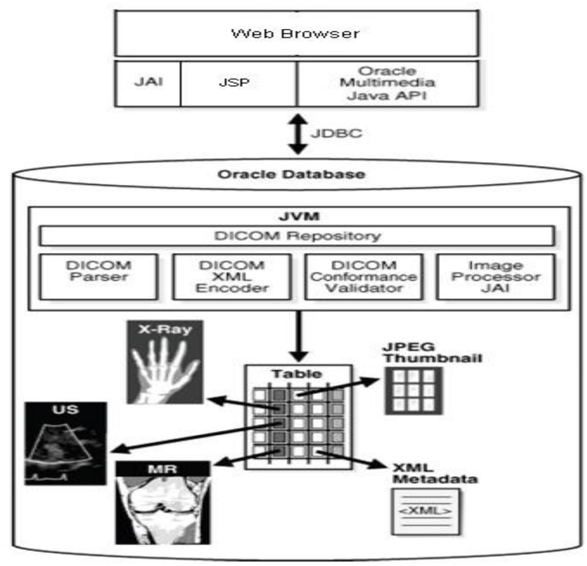

Figure 1: System Architecture

3. Medical Image Retrieval Using Pattern Similarity Scheme Based on PANDA Framework

An efficient content based medical image retrieval scheme is proposed in [4]. It is based on PAttern for Next generation DAtabase systems (PANDA) framework for pattern representation and management. It involves block based low level feature extraction (intensity and texture contrast) along with spatial coordinates (depends on patient position) from image and then clustering of feature space to form meaningful patterns. An expectation maximization [5, 6] algorithm is used for clustering feature space. The algorithm is based on iterative approach to automatically determine number of clusters. The similarity between two clusters is estimated as a function of the similarity of both their structures and the measures component. Pattern base is generated to keep information about pattern in compact way. Pattern base [6] contains pattern type (structure schema and measure schema), pattern and class. Large set of radiographic images were used from the Image Retrieval in Medical Applications (IRMA) dataset [7] to carry out experiments.The proposed methodology in [5] is represented in figure 2.

The idea of Pattern Base which is adopted from PANDA framework is used in [5]. The pattern base contains pattern type, pattern and class. The pattern structure is described by pattern type. A pattern is an instance of the corresponding pattern type and class is a collection of semantically related patterns of the same pattern type. The pattern type can be simple or complex. The pattern type is combination of structure schema (SS) and measure schema (MS). The medical image representation is treated as complex patterns. Each complex pattern consists of set of simple patterns representing clusters of image regions. A novel scheme is proposed for the assessment of the similarity between complex patterns.

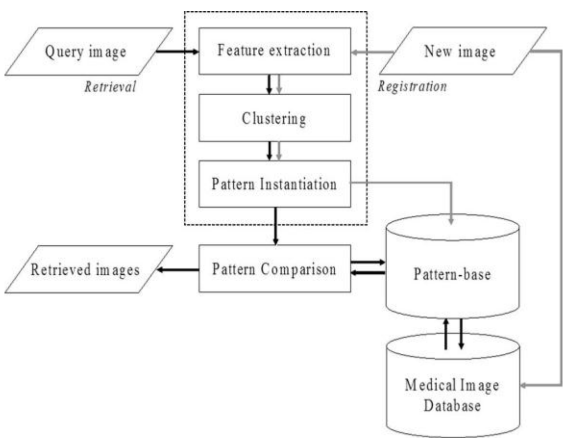

Figure 2: Content Based Image Retrieval System Architecture. Black arrow indicates the data flow for image retrieval and the grey arrow indicates the data flow for new image registration.

4. Optimal Indexing for Relevance Feedback in Large Image Databases

A fast clustering based indexing technique for exact nearest neighbor search that adapts to the Mahalanobis (generalized Euclidean) distance is described in [8, 9, 17]. A cluster distance estimation technique was developed that provides tight distance estimates while adapting to changes in the distance metric at low storage and computation cost. There is need to adapt user's perceptions of similarity, which could be significantly different from that provided by standard Euclidean. The proper relevance feedback combined with Mahalanobis distance metric can adapt user perceptions. A clustering-based indexing scheme is proposed, where relevant clusters are retrieved till the exact nearest neighbours are found. Cluster distance estimation provides tight lower bounds on query-cluster distances, while adapting to changes in distance metric. The Input / Output access time of index is found to be lower as compared to VA (Vector Approximation)-Files adapted to relevance feedback.

The combination of a statistical similarity matching technique and relevance feedback scheme in medical image database is demonstrated in [10]. Here image pre-filtering is done by learning based image categorization. Machine learning approach is used to pre-filter the database images to reduce the search space. The similarity between Gaussian distributions of images is measured using Bhattacharyya and Mahalanobis distance. The comparison is given in the [10] based on Bhattacharyya and Mahalanobis with and without relevance feedback. The implemented system can be used as a front end for a medical database where search can be directed to the right place and images can be retrieved.

5. Entropy Based Image Enhancement

Preprocessing of medical images can be useful in image retrieval. Contrast enhancement is useful for radiologist or surgeons to detect pathological or abnormal regions. Local histogram equalization (LHE) is widely used for image enhancement [3]. The variation of LHE based on Entropy is given in [3] for medical ultrasound image enhancement. In many of the medical images the region of interest is usually surrounded by unwanted region which contains little information but consume lots of computational resources. Instead of enhancing the complete image only the regions that contain more information were enhanced. The information contents were computed using the entropy. The entropy can be useful for image retrieval.

Figure 3 gives the sub images of single ultrasound image. From these images image (c), (d) and (e) should get enhance all other remaining images doesn't contain any useful information for providing the diagnosis.

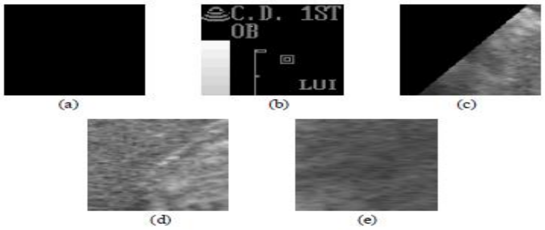

Figure 3: Five representative sub-images in a medical ultrasound image.

In simple LHE based image enhancement the complete image will get enhance as shown in figure 4. But in case of entropy based LHE the only portion which is useful for diagnosis of disease will get enhance as shown in figure 5. Therefore it reduces the computation time.

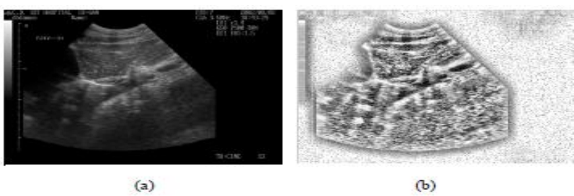

Figure 4: (a) Original image (b) LHE based enhance image.

Figure 5: Entropy based LHE enhanced image.

6. Similarity Based, Entropy Based Feature Selection and Localized CBIR

The problem of online feature selection is critical to bridge the gap between high level semantic concepts and low level visual features. Online feature selection in the relevance feedback learning process to improve the retrieval performance of the region based image retrieval system is investigated in [12]. Feature selection criterion based on calculating the similarity between the relevant and irrelevant image sets is proposed, and an effective online feature selection algorithm is implemented in a boosting manner to select the most representative feature axes for the current query concept, and to combine the incrementally constructed classifiers into an ensemble classifier to retrieve images.

The implementation of efficient entropy based features selection for Image Retrieval is given in [13]. The system retrieves only bird's images. The system is developed using eMbedded Visual C++ 4.0 and runs in a Windows environment on a Pocket PC. A collection of 183 bird species in Taiwan and their related information are stored in database. Several descriptors are used simultaneously; therefore similarity scores resulting from different feature spaces were integrated. The entropy is used to adjust the uncertainties of users. It is useful when user cannot be reasonably sure about this feature. With the assistance of the proposed user interface, user can easily describe the query formulation.

The distinction between region-based CBIR systems and localized CBIR is how the image is processed. The entire image is represented as one feature vector in case of single feature vector CBIR systems. Multiple feature vector CBIR systems represent the image as collection of feature vectors with one feature vector for a block in some pre-specified image subdivision. The image ranking methods are classified as global and local ranking methods according to the type of similarity metric used to rank the images. In global ranking methods, all feature vectors in the image representation affect the ranking. Local ranking methods select only portions of an image as relevant to rank the images. ACCIO! A localized CBIR system is presented in [14]. This system does not consider that the objects are in a fixed location or have a fixed size.

Entropy and moments have been used for image retrieval in past years. Improved entropy and moments based image retrieval is presented in [15]. Bit plane distribution entropy (BPDE) to describe gray information for image retrieval is presented in [16]. The BPDE is found robust to translation, scaling and rotation.

7. Proposed Geometric Moments with Image Segmentation Based Image Retrieval

Image Segmentation and Fuzzy Connectedness Theory

Consider a 2D image composed of two regions corresponding to two objects O_1 and O_2 as illustrated in Figure. 6, O_2 being the background. O_2 itself may consist of multiple objects which are not of interest in distinguishing [19] since object of interest is O_1. Determine an affinity relation that assigns to every pair of nearby pixels in the image a value based on the nearness of pixels in space and in intensity (or in features derived from intensities). Affinity represents local "hanging togetherness" of pixels. To every "path" connecting every pair of pixels, such as the solid curve p_{co1} connecting c and o_1 in Figure 6 a "strength of connectedness" is assigned which is simply the smallest pair wise affinity of pixels along the path. The strength of connectedness between any two pixels such as o_1 and c is simply the strength of the strongest of all paths between o_1 and c. Suppose, p_{co1} shown in Figure 6 represents the strongest path between o_1 and c. If the affinity is designed properly, then p_{co1} is likely to have a higher strength than the strength of any path such as the dotted curve between c and o_1 that goes outside O_1.

In the original fuzzy connected method, an object such as O_1 is segmented by setting a threshold on the strength of connectedness. This threshold defines a pool of pixels such that within this pool the strength of connectedness between any two pixels is not less than the threshold but between any two pixels, one in the pool and the other not in it, the strength is less than the threshold. The basic idea in relative fuzzy connectedness is to first select reference pixels o_1 and o_2, one in each object, and then to determine to which object any given pixel belongs based on its relative strength of connectedness with the reference pixels. A pixel c, for example, would belong to O_1 since its strength of connectedness with respect to o_1 is likely to be greater than that with o_2. This relative strength of connectedness offers a natural mechanism for partitioning pixels into regions based on how the pixels hang together among themselves relative to others. A pixel such as a in the boundary between O_1 and O_2 will be grabbed by that object with whom a hangs together most strongly. This mechanism not only eliminates the need for a threshold required in the original method but also offers potentially more powerful segmentation strategies for two reasons. First, it allows more direct utilization of the information about all objects in the image in determining the segmentation of a given object. Second, considering from a point of view of thresholding the strength of connectedness, it allows adaptively changing the threshold depending on the strength of connectedness of objects that surround the object of interest.

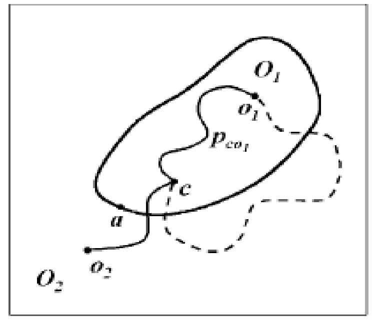

Figure 6: Illustration of the main ideas behind relative fuzzy connectedness The membership of any pixel, such as c, in an object is determined based on the strength of connectedness of c with respect to the reference pixels o_1 and o_2 specified in objects O_1 and O_2. c belongs to that object with respect to whose reference pixel it has the highest strength of connectedness.

According to the fuzzy topology theory, a field $H = \{\eta(p)\}$ can be derived from any digital image by simply normalizing the pixel-intensity value. A fuzzy-connectedness degree can be computed for each pixel *p*, and this measure refers to the absolute maximum membership value. However, with the aim of image processing, one can extract a fuzzy-connectedness measure with respect to any image pixel *a*, given the appropriate transform that is applied to each pixel *p*. For the sake of clarity, such a transformation, which gives rise to the modified field X^a (Equation 1), is given as

$$\boldsymbol{x^a(p) = 1 - |\eta(p) - \eta(a)|}$$
(1)

Pixel *a* – seed point assumes the maximum value in the modified field, as shown in Figure 7.

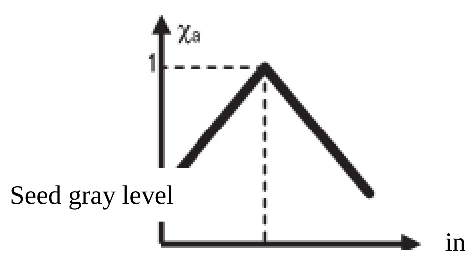

Figure 7: Modified X^a value as a function of the original value (in).

If we define *P* (*q, p*) as connected path of points from a pixel *q* to a pixel *p* and if the seed point represents and belongs to a structure of interest, it is possible to measure the connectivity (Equation 2) associated with the structure by applying, for every *p*, the following:

$$\boldsymbol{C_{X^a} = c_{X^a}(p) = conn(X^a, a, p) = \max_{P(a,p)}\left[\min_{z \epsilon P(a,p)} X^a(z)\right]} \qquad (2)$$

The max is applied to all paths *P* (*a*, *p*) from *a* to *p* and thus refers to the optimum path connecting *p* to the seed point, while the min is applied to all points *z* along the optimum path *P* (*a*, *p*).

Above equation is named "χ-connectivity" or "intensity connectedness," and its application results in an image where every pixel value represents the degree of membership to the searched object. The new image produced is called the "connectivity map," where each image element has a gray level that is dependent on the degree of connectivity with respect to seed point *a*.

Isocontour segmentation is an interactive application that exploits the power and generality of the fuzzy intensity connectedness theory. It is able to deal with various kinds of images, and it shows better performance with objects affected by low contrast.

Geometric Moments

Geometric moments, which are also, know as Cartesian moments or regular moments are the simplest among moment functions, with the kernel function defined as a product of the pixel coordinates. Functions of geometric moments that are invariant with respect to image plane transformations have found many applications in object identification and object pose estimation

Geometric moments have proven to be a very efficient tool for image analysis. The various examples of the use of moments are aircraft identification, scene matching, shape analysis, image normalization, character recognition, accurate position detection, color texture recognition, image retrieval and various other image processing tasks.

For a two-dimensional density function p(x, y) the (p + q)th order geometrical moments m_{pq} (Equation 3) are defined as:

$$\boldsymbol{m_{pq} = \int_{\infty}^{\infty}\int_{\infty}^{\infty} x^p\, y^q p(x,y)dxdy} \quad (3)$$

If p(x, y) is a piece-wise continuous function and has non-zero values only in the finite part of the x-y plane, then moments of all orders exist for p(x, y), and the moments sequence m_{pq} is uniquely determined by p(x, y) and vice-versa. Although originally described in continuous form, discrete formulae are commonly in use for practical reasons. If an image is considered as a discrete function f(x,y) with x = 0, 1, ….., M and y = 0, 1, …, N then (p+q)th order geometric moments m_{pq} (Equation 4) are defined as :

$$\boldsymbol{m_{pq} = \sum_{x=0}^{M}\sum_{y=0}^{N} x^p\, y^q f(x,y)} \quad (4)$$

It should be noted that second equation can assume very large values, especially for high order moments (large p, q). This often leads to numerical instabilities as well as high sensitivity to noise. Furthermore, image reconstruction is not straightforward.

Proposed Image Segmentation and Geometric Moments For Shape Analysis

Image Segmentation is used to find the (x, y) co-ordinates of the largest image segment and (x, y) co-ordinates of the boundary of the largest image segment. Store the information of all consecutive pixels having same discrete level. Determine whether a group of pixels are coherent or not.

Get the color and pixel count. After scanning a new line, look for any coherent group of pixels that does not extend to the new line and determine whether they are coherent or incoherent by comparing the pixel count with threshold. Check whether i-th pixel is the boundary of the largest image segment or not. Three algorithms are explained below; shape is analyzed using the combination of these three algorithms.

Algorithm for Image Segmentation

Input: Image and Seed point.
Output: Segmented Image.

1. Initialization
   1.1 Seed point 'a'
   1.2 P(q,p) ←path of points from a pixel q to pixel p
2. Obtain modified field by normalize the pixel intensity values.
3. Pixel 'a' selected as seed point assuming that it has maximum value in the modified field.
4. If 'a' represents and belongs to a structure of interest then
   4.1 Measure the connectivity associated with the structure by applying $\boldsymbol{conn(X^a, a, p)}$
5. Return the connectivity map
6. Adjust threshold if necessary
7. Select best segmented result

Algorithm for Shape Module

Input: Query Image
Output: Parameters useful in geometric moments

1. Initialization

1.1 Array pixel ← composed of foreground and background pixels only
1.2 mx ← width
1.3 my ← height
1.4 sum← 0
2. Normalize the number of pixels and update the dimension if necessary
3. For i = 1 to mx*my do
3.1 sum ← sum + (pixel[i]/foreground)
4. a ← sqrt(totalpixels/sum)
5. Find out foreground and background pixels and return results
6. Compute object weight of the input pixel array
7. For i = 1 to height*width do
7.1 If pixel[i] == foreground then
7.1.1 sum ← sum+1
8. For i = 1 to height do
8.1 xsum ← xsum + i
9. For j = 1 to width do
9.1 ysum ← ysum + j
10. Compute object projection along x-axis and y-axis
11. Result1 ← xsum/sum
12. Result2 ← ysum/sum

Algorithm for Geometric Moments
Input: Query Image
Output: Set of similar images to query image from the set of *N* images

1. Initialization
1.1 pValue, qValue ← 1 for second order geometric moment
1.2 size ← height*width
1.3 Array pixel[size]
1.4 Declare vector geometricMoment
1.5 moment ← 0
2. For j = 1 to height do
2.1 For i = 1 to width do
2.1.1 If pixels[j*width + i] == foreground then
2.1.1.1 moment = moment + $(i\text{-weight}[0])^{pValue} * (j\text{-weight}[1])^{qValue}$
3. Add moment to feature vector geometricMoment
4. Compare this feature vector with the feature vectors of *N* images stored in the database using distances between them. According to the distances the system returns nearest neighbors as the query result.

8. Implementation Details

For the implementation of the application Java is selected as platform so that application can get the feature of platform independence [19]. The various java tool kits that are used [19] for implementation:

- Java Development Kit
- Java Advance Imaging
- Oracle 11g Release 1
- Java Activation Framework for Java Beans

Some of the packages used in building the application are org, com, jfreechart and contrib. Initially user selects the URL from the server side where all images are stored [19]. After selecting URL all the images present on that location are indexed using feature extraction methods (currently Color Moments, Co-occurrence, LCH, GCH, Image Segmentation & Geometric). Then the user selects a query image which he wants to search from an image database [19]. Then he selects the retrieval method [19]. Then the features are extracted from the query image according to the selected retrieval method. These features are then matched with the features of the indexed images in the database and then the best matched images are provided as an output of query [19].

All the features extracted from images are stored in the table named FEATURE_TABLE [19]. This table contains four fields ID, FEATURE_NAME, IMAGE and VECTOR [19]. The last field contains all feature extracted from the images. Every feature has assigned an id. IMAGE indicates the location of an image where it is stored. For retrieving the features the query is fired [19] in the following format on the database:

"SELECT * FROM {4} WHERE {1}=?"

To add the features into the FEATURE_TABLE the following query is fired:

"INSERT INTO {4} ({1},{2},{3}) VALUES (?,?,?)"

Different packages are created to make programming and application development more modular. The packages action, db, image, query, ui and util are developed. These all packages are used in the main application program file "CBIRS.java".

Images are ranked according to the similarity between image given as query and the retrieved images. At any time after firing query if user finds any image which is more relevant to him as per his query, he can change the rank of that image. This updated rank can be useful in the next retrieval. Precision is calculated as the ratio of number of relevant images retrieved to the total number of images retrieved.

$$\text{Precision} = \frac{\text{Number of relevant images retrieved}}{\text{Total number of images retrieved}}$$

9. Experiment carried out on DICOM Images Database

The performance of the proposed implemented algorithms is evaluated by analyzing the images retrieved and comparing it with the images retrieved by various other approaches. The collection of 100 DICOM images is taken for carrying out the results. Total time required to extract the features from all these images is 46 sec. Table 1 indicates the total number images retrieved by using five different techniques. It can be observed from the table that the methods that work on the basis of color features such as Color Moments, LCH and GCH does not provide relevant results. The images that are used for evaluation are gray scale images and in practice most of the medical images are gray scale images.

Therefore the image retrieval technique which uses color feature for retrieval fails. As shown in Table 1 it is found that the techniques designed for gray level feature and shape feature extraction works better. Table 2 [1] shows the precision values computed as per the relevance of the retrieved images as per the query image.

Table I: Comparison histogram, global color histogram, co-occurrence and geometric moments on the basis of number of images retrieved of color moments, local color

Image Class	Color Moments/ LCH/ GCH	Co-occurrence	Geometric Moments
	Images retrieved	Images retrieved	Images retrieved
DICOM	100	12	15

Table II: Precision Values

Image Class	Co-occurrence	Geometric Moments	SIMPLICITY	Histogram Based
DICOM	0.67	0.76	0.78	0.26

The overview and comparison of the systems discussed in section 2, 3, 4, 5 and 6 is given in Table 3 [1] based on the various parameters. The proposed Geometric Moment Image Segmentation techniques are also included in the table. As it can be observed from Table 3 Web based medical image retrieval system in Oracle uses the features and indexing technique provided by Oracle. It only works on the Oracle supported feature.

The second system is based on the pattern similarity. It is not a web based image retrieval system. This system doesn't support the retrieval of various kinds of medical images such as ultrasound and endoscopic images. Both these systems do not support relevance feedback. All other systems that are discussed are not web based. The third system uses the indexing for relevance feedback. The feature extraction methods are not given. The indexing is based on distance between two images. This distance is also used as measure of similarity between images. The next system uses entropy for image enhancement and its application in image analysis. Only ultrasound images are considered for image enhancement. LHE is used for image enhancement. The actual application to the image retrieval is not implemented. The remaining system does not support medical image retrieval. The last two entries in Table 3 are for the proposed techniques. These techniques are not web based but it is observed that these techniques provides precise results as compared to some other techniques.

10. Conclusion and Discussion

This paper gives the various aspects of medical image processing [1]. This paper will motivate the researchers to utilize the methods that are available for medical image retrieval, image indexing and image enhancement to get the better result of retrieval and to provide better treatment to the patient. While implementing any efficient medical image retrieval system the above discussed aspects should be taken into consideration [1, 19].

In Section 2 Web based medical image retrieval system in Oracle is discussed. The implemented system uses the features and indexing technique provided by Oracle. It only works on the Oracle supported feature. This system doesn't support the automatic threshold selection [1] for the image comparison. So the performance and accuracy of the system can be improved by using various feature extraction methods and run time threshold selection instead of using Oracle supported methods and fixed threshold. The second system is based on the pattern similarity. It is not a web based image retrieval system. This system doesn't support the retrieval of various kinds of medical images such as ultrasound and endoscopic images. Both these systems do not support relevance feedback. All other systems that are discussed are not web based. The third system uses the indexing for relevance feedback. The feature extraction methods are not given. The indexing is based on distance between two images. This distance is also used as measure of similarity between images. The next system uses entropy for image enhancement and its application in image analysis. Only ultrasound images are considered for image enhancement. LHE is used for image enhancement. The actual application to the image retrieval is not implemented. The remaining system does not support medical image retrieval.

The proposed techniques gives precise results but those can be further extended to utilize Oracle supported DICOM image features. These features provide more information about the retrieved images. These features will be helpful for identifying the relevance of the images that are retrieved as result.

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