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A Novel Approach for Information Content Retrieval and Analysis of Bio-Images using Datamining techniques.

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Abstract

In Bio-Medical image processing domain, content-based analysis and Information retrieval of bio-images is very critical for disease diagnosis. Content-Based Image Analysis and Information Retrieval (CBIAIR) has become a significant part of information retrieval technology. One challenge in this area is that the ever-increasing number of bio-images acquired through the digital world makes the brute force searching almost impossible. Medical Image structural objects content and object identification plays significant role for image content analysis and information retrieval. There are basically three fundamental concepts for content-based bio-image retrieval, i.e. visual-feature extraction, multi-dimensional indexing, and retrieval system process. Each image has three contents such as: colour, texture and shape features. Colour and Texture both plays important image visual features used in Content-Based Image Retrieval to improve results. In this paper, we have presented an effective image retrieval system using features like texture, shape and color, called CBIAIR (Content-Based Image Analysis and Information Retrieval). Here, we have taken three different features such as texture, color and shape. Firstly, we have developed a new texture pattern feature for pixel based feature in CBIAIR system. Subsequently, we have used semantic color feature for color based feature and the shape based feature selection is done using the existing technique. For retrieving, these features are extracted from the query image and matched with the feature library using the feature weighted distance. After that, all feature vectors will be stored in the database using indexing procedure. Finally, the relevant images that have less matched distance than the predefined threshold value are retrieved from the image database after adapting the K-NN classifier.

Keywords: *Datamining, Bio-Image Analysis, Pattern recognition, Medical Images Processing, Texture, Color, Shape, image retrieval Content-Based Image Analysis and Information Retrieval, (CBIAIR).*

1. Introduction

Data mining is the extraction of hidden predictive information from large data bases and Bioimages analysis is one of the most active research areas in computer image processing, and it relies heavily on many types of data-mining techniques [3]. With the development of advanced imaging techniques, the number of biomedical images (e.g. CT Scan, MRI, PET, as well as other medical images) acquired in digital forms is growing rapidly. Large-scale bioimages databases are becoming available. Analyzing these images sheds new light for doctors to seek answers to many medical diagnosis problems. For example, analysis of the spatial distribution of proteins in molecular images can differentiate cancer cell phenotypes. Comparison of in-situ gene expression pattern images during embryogenesis helps to delineate the underlying gene networks. Image analysis related techniques (e.g. wavelet) have also been found useful in bioinformatics problems such as sequence analysis. The potential of mining the information in bioimages to answer biological questions is enormous and it cries for advanced techniques of bioimages data mining and Medical informatics. The present day technology helps to develop new information processing technologies appropriate for extracting detailed understanding of biological processes from images depicting the distribution of biological molecules within cells or tissues. This will be accomplished by developing new methods for information processing at the sensor level to enable high speed and super-resolution imaging, by applying pattern recognition and data mining methods to bio-molecular images to fully automate the extraction of information from those images and the construction of statistically-sound models of the processes depicted in them, and by developing distributed database methods for large sets of biological images [21].

The broad bio- image processing areas are:

- Acquisition of micro array, CT Scan, MRI, Ultra sound, cellular, molecular and other bioimages; novel bioimaging techniques; novel bioimages data.
- Bioimages registration and comparison.
- Bioimages pre-processing and segmentation of bio-images like X-ray, Ultra sound, CT image, MRI image etc., and other data (e.g., microarray, protein interaction feature measurement, description, extraction, and selection[3].
- Joint analysis using both X-ray, Ultra sound, CT image, MRI image etc., and other data (e.g., microarray, protein interaction, etc.).
- Microarray image analysis and data mining.
- Object/pattern recognition and understanding in bioimages.
- Object segmentation and tracking in bioimages
- Clustering/classification of bioimages or patterns derived from bioimages like X-ray, Ultra sound, CT image, MRI image etc., and other data (e.g., microarray, protein interaction)[21].
- Bioimage related biology, bioinformatics, and biomedicine applications, e.g. 3D protein structure reconstruction, protein structure analysis and prediction, gene regulatory network/pathway modeling, etc.
- Bioimages ontology and related data mining.
- Bioimage data visualization.
- Other bioimaging related techniques, including transmission, compression, storage, database, etc.
- Other bioinformatics problems where image pattern analysis, signal processing, and computer vision methods can be applied.
- Tools/software for bio-image data processing and data mining.

The rest of the paper is organized as follows: Section 2 reviews the recent research works with respect to content-based video retrieval, Section 3 describes the proposed system for content-based video retrieval, Section 4 gives out the data sets and results of the experiment and Section 5 concludes the paper.

2. REVIEW OF RELATED WORKS:

In this section, a brief review of some important contributions from the existing literature is presented.

Darshana Mistry [9] has proposed that in content Based Image Retrieval, images were retrieved based on color, texture and shape (low level perception). There was a gap between user semantics (high level perception) and low level perception. Relevance feedback (RF) learns association between high level semantics and low level features. Bayesian method, nearest neighbour search method, Log based RF; Support Vector Machine (SVM) was methods of Relevance Feedback. Bayesian method was good for understand but it has been not worked for fast access. Survey of different methods of Relevance feedback, SVM has been the best method because of structure risk minimization. Using of SVM, Using of relevance feedback with SVM, results were more efficient as user perception. SVM classification could be even better if the feature vector used in more relevant to images.

3. PROPOSED APPROACH OF IMAGE RETRIVAL TECHNIQUE:

Content based image retrieval plays an important role in many of the fields such as medical imaging, education, surveillance applications and more. In order to retrieve image based on the given query image, the features of the database may either low level or high level features. One challenge in this area is that the ever-increasing number of images acquired through the digital world makes the brute force searching almost impossible. Hence the image retrieval is an important objective for our proposed approach. The Block diagram of the proposed technique is shown schematically in Fig 1.

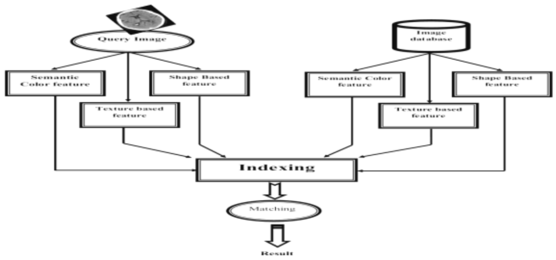


Fig 1: Overall block diagram of the proposed approach

3.1 Semantic Color Feature extraction:

A color image is a digital image that includes color information for each pixel. Although millions of colors can be defined in computer system, the colors that can be named by users are limited. Here a color image is taken as the input image and the input image shows how the pixel varies. First of all the image is segmented and each region is characterized by their texture and color. Here we are using the average HSV value as the color feature of a region. The average HSV value is then converted to a semantic color name i.e., the input image is converted to HSV space. Hue, saturation, and value (HSV) color spaces are often used by artists. "Hue" is what we normally think of as color. It is the attribute of a color by which we give it a name such as "red" or "blue". "Value" is another word for "lightness," the attribute of a color that makes it seem equivalent to some shade of gray between black and white. Saturation is a measure of how different a color appears from a gray of the same lightness. The hue value is uniformly quantized in to 10 base colors, red, orange, yellow, green, aqua, aquamarine, and blue, violet, purple and magenta from the HSV space we are taking H matrix. The value of H matrix varies from 0-255; from these values we are normalizing the output to 0 to 1.

Table 1: Color Naming Model

Value of HSV	Base Color Names
0 - 0.1	Orange
0.1-0.2	Yellow
0.2-0.3	green
0.3-0.4	aqua
0.4-0.5	aquamarine
0.5-0.6	blue
0.6-0.7	violet
0.7-0.8	purple
0.8-0.9	magenta
0.9-1.0	red

From the table: 1 it is inferred that for different values of HSV we have different base colors. The HSV value ranges from 0-1.For 0- 0.1 we obtain orange as the base color, for 0.1-0.2 we obtain Yellow as the base color, for the HSV value 0.2-0.3 we obtain green as the base color, for 0.3-0.4 we obtain aqua as the base color, aquamarine is obtained as the base color for the HSV value of 0.4-0.5, blue, violet, purple, purple, magenta, red were obtained as the base color for the HSV values 0.5-0.6, 0.6-0.7, 0.7-0.8, 0.8-0.9, 0.9-1.0 respectively. For each color we obtain the mean and variance for e.g., for red color we obtain the mean and variance by calculating how many times the corresponding color occurs in that interval.

3.2 Shape Feature Extraction:

Shape is a significant visual feature and it is one of the primitive features for image content description. Shape representation generally looks for valuable ways to capture the essence of the shape features that make it easier for a shape to be stored, transmitted, compared against, and recognized. These features must also be independent of translation, rotation, and scaling of the shape [17].

To extract the shape feature from the image, initially, the image in RGB color space is converted to gray scale image. Let I be the image of size $M \times N$ from the database D, which comprises lot of images, and I_R, I_G and I_B be the R, G, B weights of the image I respectively.

$$I_{GY} = 0.2989 * I_R + 0.5870 * I_G + 0.1140 * I_B \quad (1)$$

The above equation is the Craig's formula for converting RGB color image to gray scale image. The image I is converted to gray scale image I_{GY}, because the median filter can act on only one color channel. Particularly median filter is useful for reducing speckle noise and salt and pepper noise. It is also useful in cases where edge blurring is undesirable because it has edge-preserving nature. Hence, median filter is applied to the converted grayscale image I_{GY} to remove the noises.

The filtering operations by the median filter.The noise-free image's pixels form a 2D vector P; this 2D vector is subjected to clustering to detect different shapes present in the image. Clustering refers to the process of grouping samples so that the samples are similar within each group. The groups are called clusters [18]. Various regions in the image can be discovered by identifying groups of pixels that have similar gray levels, colors or local textures utilizing clustering in the image analysis. Various clustering techniques exist. In our work, we make use of the K-means clustering algorithm for image segmentation for the further process. After the k means algorithm is applied, again the 1D vector is converted to 2D vector and then the canny algorithm is used for the detection of different edges present in all the clustered sets of the image I_{GY}.

3.3 New Texture pattern based feature extraction:

Texture attribute depicts the "surface" of an object. This term refers to properties such as smoothness, coarseness, and regularity of an object. Generally, the structural homogeneity does not come from the presence of a single color or intensity, but requires the interaction of various intensities within a region. Texture similarity is often useful in distinguishing objects with similar colors, such as sky and sea as well as leaves and grass. Making texture analysis is a real challenge. One of the ways to perform content-based image retrieval using texture is to segment an image into a number of different texture regions and perform a texture analysis on each region.

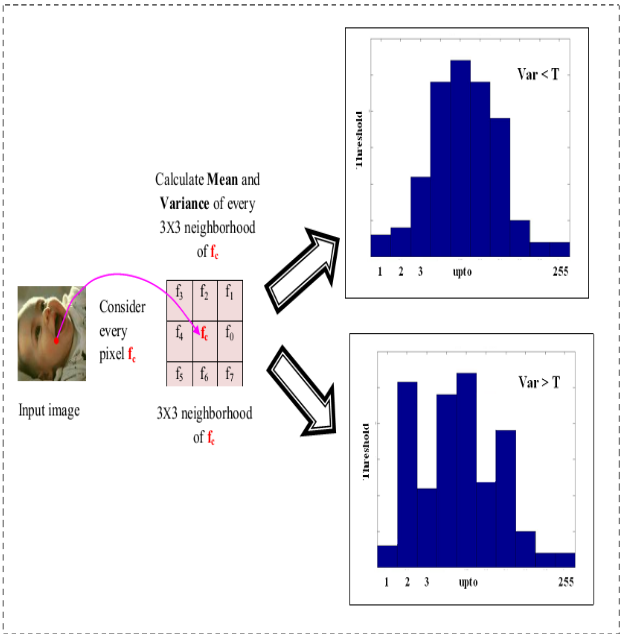


Fig: 2.Our proposed new texture pattern based feature

In our new texture method each image is segmented into number of blocks, each block carries a particular value and each block converted into 3×3 matrix form.

Consider we have taken one image I and this image is divided into multiple blocks $I_B = B_1, B_2, \ldots B_n$. and each block is created 3×3 matrix form.

$$B_n = b_{11}, b_{12}, b_{13}, b_{21}, b_{22}, b_{23}, b_{31}, b_{32}, b_{33} \quad (2)$$

Subsequently, we calculate mean and variance for every 3×3 matrix form of whole image. The mean and variance are calculated by following equations (3) and (4),

$$Mean\ \ M = \frac{\sum_{m=1}^{3}\left[\sum_{n=1}^{3} b_{mn}\right]}{9} \quad (3)$$

$$Variance\ \ \sigma = \sqrt{\frac{\sum_{m=1}^{3}\left[\sum_{n=1}^{3} b_{mn}\right]}{9}} \quad (4)$$

Here b is the value of block, m is row and n is column.

After mean and variance calculation process, we have chosen two threshold variance levels. Consequently, two histograms is plotted using this threshold value. The threshold value is chosen according to the following equation as

$$T_f = \begin{cases} H_1, & \sigma < T \\ H_2, & \sigma > T \end{cases} \quad (5)$$

Where, σ -variance

T -Threshold

3.3 Retrieval of Relevant Images Using Indexing and K-NN Classifier:

After the feature extraction, the three features such as new texture pattern, color and shape are given into indexing process.

Indexing: The purpose of storing an index is to optimize speed and performance in finding relevant documents for a search query. This process computes the image feature vectors which are then used by distance calculation and helps in image retrieval process. In indexing process, the images are stored in the particular place .The input image is searched through indexing and it is the matched with the stored image. Subsequently, each extracted feature for query image (texture, color and shape) is matched with the corresponding feature set presented in the feature library.

Similarity Matching: The feature extraction process is applied to the images presented in the input dataset in order to extract the significant features such as, texture, color and shape. The extracted features from the input images are then stored in the feature library. When a query image is given to the proposed CBIAIR system, all the features employed in the proposed system are obtained using the feature extraction process. Matching is done in many ways. In our technique, we use one distance equation namely Euclidean distance. Then using Euclidean distance, each extracted feature for query image (texture, color, and shape) is matched with the respective feature set presented in the feature library. After that, we have chosen top-K distance image in the CBIR database. Subsequently, the computed distance is utilized to identify the similarity between the query image and each database images. Lastly, the required number of images corresponding to the query image is retrieved from the database successfully by means of the top-K distance. The feature weighted distance can be determined as,

$$FWD(I^{query}, I^{data}) = (I^{query} \quad , \text{texture, color, shape}) \qquad (6)$$

Where, $E_T(I^{query}, I^{data})$ → Euclidean distance computed by matching the feature

4. RESULTS AND DISCUSSION:

The results and discussion of the proposed content-based image retrieval system is given in this section. The proposed content-based video retrieval system has been implemented using MATLAB (Matlab7.12) and the performance of the proposed system is analyzed using the evaluation metrics including precision, recall and F-measure.

4.1 Datasets description

The collected input images contains the following categories of objects presented in these images such as, MRI brain, CT brain, Ultrasound, Mammogram, CT lung and some normal color images. This image dataset contains 50 medical images and 50 color images. The sample dataset for the input images of the proposed CBIAIR system is given in fig.3.

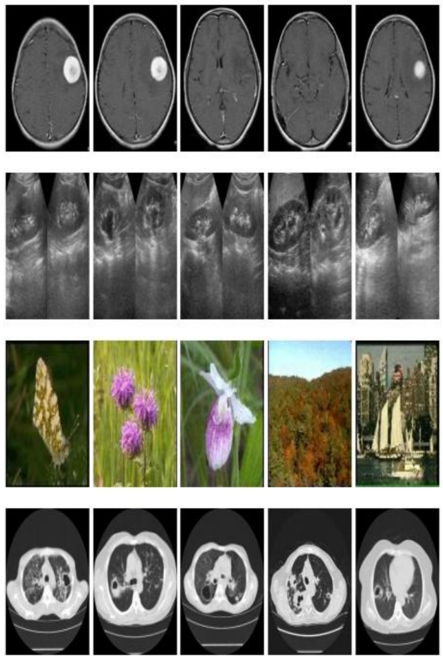
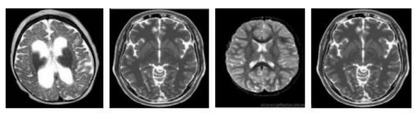


Fig 3: The sample datasets for our CBIAIR system

4.2 Image Retrieval:

The features including texture, color and shape are extracted from the input images and it is stored in the feature library. For retrieving, the images are given to the proposed CBIAIR system that extracts the features and the features are matched with the feature library using the designed image matching. The matching score computed is used to retrieve the images from the dataset and the retrieved image for the corresponding input images is given in the following figures 4 to figure 9.

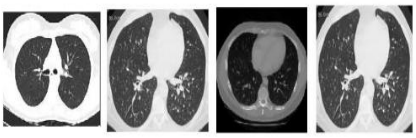
(a)



(b)

Fig.4. Retrieved videos (a) query image (b) Retrieval for the image in fig.4.a

(a)



(b)

Fig.5. Retrieved videos (a) query image (b) Retrieval for the image in fig.5.a

(a)

(b)

Fig.6. Retrieved videos (a) query image (b) Retrieval for the image in fig.6.a

(a)

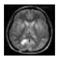
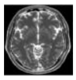
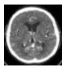
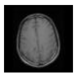
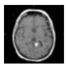
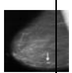
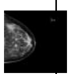
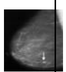
(b)

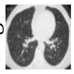
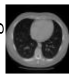
Fig.7. Retrieved videos (a) query image (b) Retrieval for the image in fig.7.a

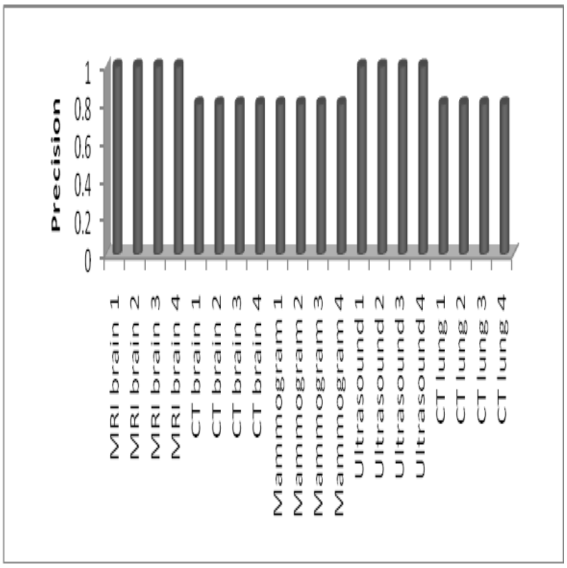
4.3 Quantitative analysis:

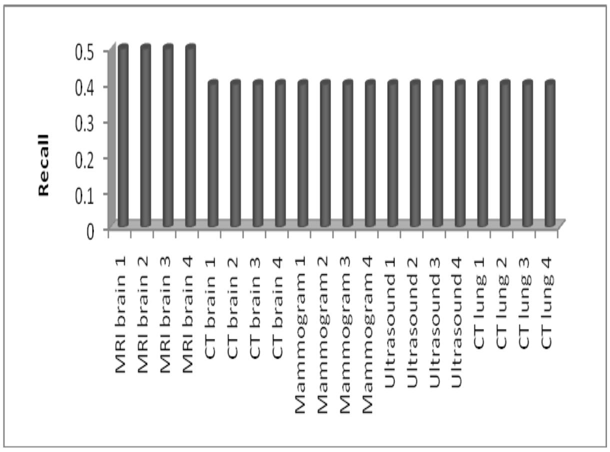
The performance of the proposed approach system is evaluated on the input dataset using the precision, recall and F-measure.

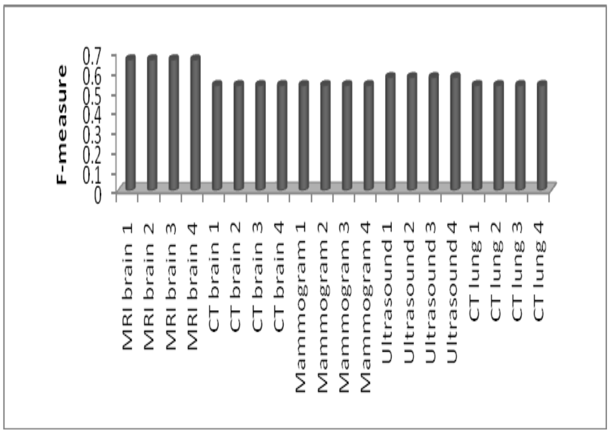
Table .2 Bio-Medical query images and corresponding precision, recall and F-measure.

Query Image	Retrieval	Manual	Correct	Precision	Recall	F-measure
MRI Brain 1 	5	10	5	1	0.5	0.66
MRI brain 2 	5	10	5	1	0.5	0.66
MRI brain 3 	5	10	5	1	0.5	0.66
CT Brain 1 	5	10	4	0.8	0.4	0.53
CT Brain 2 	5	10	4	0.8	0.4	0.53
CT Brain 3 	5	10	4	0.8	0.4	0.53
Mammogram 1 	5	10	4	0.8	0.4	0.53
Mammogram 2 	5	10	4	0.8	0.4	0.53
Mammogram 3 	5	10	4	0.8	0.4	0.53

Ultrasound 1 	4	10	4	1	0.4	0.57
Ultrasound 2 	4	10	4	1	0.4	0.57
Ultrasound 3 	4	10	4	1	0.4	0.57
CT Lung 1 	5	10	4	0.8	0.4	0.53
CT Lung 2 	5	10	4	0.8	0.4	0.53
CT Lung 3 	5	10	4	0.8	0.4	0.53







5. CONCLUSION

In this paper, we have developed an effective bio-image retrieval system using features like texture, shape and color, called CBIAIR (Content Analysis Based Image Analysis Information Retrieval). Here, we have taken three different features such as texture, color and shape. Firstly, a new texture pattern feature for pixel based feature is developed in this system. Subsequently, we have used a semantic color feature for color based feature and the shape based feature selection is done using the existing technique. For retrieving, these features are extracted from the query image and matched with the feature library using the feature weighted distance. After that, all feature vectors will be stored in the database using indexing procedure. Finally, the relevant images that have less matched distance than the predefined threshold value are retrieved from the image database after adapting the K-NN classifier.

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