Content Based Medical Image Retrieval

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ABSTRACT

A large collection of medical images surrounds healthcare centers and hospitals. Retrieving clinical images of interest from these large data sets is a stimulating task. Medical images produced by different methods like magnetic resonance imaging (MRI), computed tomography (CT), positron emission tomography (PET),and X-rays have increased incredibly with emergence of latest technologies for image asset. Content-based image retrieval systems are employed in several areas. One of the most leading area is the medical field,due to the huge volume of digital images daily generated in healthcare institutions employed for decision making. The methodology focus at evaluating the system's impact in the user's decision, inquiring the specialists about the image classification and their degree of certainty in different situations using the system.A possible use case is when the radiologist has some interruption on diagnosis and wants further case histories,the acquired clinical images are sent (e.g. MR images of brain) as a query to the content based medical image retrieval system. The system is tuned to retrieve the top most relevant images to the query. The proposed system is computationally efficient and more accurate in terms of the quality of retrieved images.

Index terms:- Content based image retrieval (CBIR), Fast Wavelet Transform, Feature extraction, Magnetic resonance imaging (MRI), Support vector machine;

I. INTRODUCTION

Medical images produced by different hospitals and health care centers are increasing slowly but surely. Medical images play a crucial role in identification of various diseases, clinical diagnosis and prognosis, medical training and surgical planning. CBIR has attracted attention of researchers due to the ever increasing digital content as well as the advantages it has over concept-based indexing methods. CBIR can be helpful to medical profession to diagnose severe diseases or any abnormal changes in body. The CBIR system automatically selects images from the reference data set, which match to a query image. Similarities among images are captured using image characterization. CBIR has a significant role in medical image retrieval such as Magneticresonance imaging(MRI),computed tomography(CT)scanimages,Positron emission tomography(PET)X- rays etc.Many medical image retrieval systems have been proposed,but each one has problems in achieving efficient and precise retrieval, so development of a competent CBIR in medical domain is still the need of the hour. In this study, a medical CBIR systemisproposedwhichwouldhelpindiagnosisinmedicalfield. Themajoraimistodevelopasystemthatiscomputationally efficient and can work for varying modalities of clinical images. Content-based image retrieval systems indexes images on the basis of its imaged content such as color, shape and texture and it uses the computer vision techniques to extract these features. The results obtained using CBIR are relevant and much more satisfactory than manual interpretation method.

II. RELATEDWORK

The papers in which different systems for CBIR are proposed are discussed below. A lot of work has been done on image retrieval systems using content based information. The author have proved that the CBIR system presents a high acceptance and viability rate regarding the radiologists interests in the clinical practice domain, providing a novel approach to analyze CBIR systems under realistic conditions. The results depict that d method has better precision and recall rate

International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 04 Issue: 10 | Oct -2020 ISSN: 2582-3930

compared to other methods [1]. Gradient method to extract shape feature have been recently used. Color Histogram and texture features are obtained by quantifying the HSV color space. For classification authors have used Support Vector Machine [2]. A methodhas beenproposedthatassistedclinicalpractitionerstoretrieverelevant medicalimagetoaqueryimageprovidedtothe system .The system makes comparisons of the data extracted and data feed in the system. These comparisons would provide a supplementary support in taking decision to decide if the patient require certain medication or treatment. The retrieval methodology based on FWT is presented [3]. In HSV color space is used for extraction of dominant colors of an image. The genetic algorithm is applied to optimize the algorithm to extract the dominant colors and is used for similarity measure for retrieval. This method has improved the retrieval process in terms of time and precision rates[4].

III. METHODOLOGY

This proposed method would assist clinical practition ersto retrieve relevant medical image to aquery image provided to the system.

A. Color FeatureExtraction

I. ColorHistogram : Color histogram is a representation of the distribution of colors in an image. For digital images, a color histogram represents the number of pixels that have colors in each of a fixed list of colorranges that span the image's color space,the set of all possible colors. In a more simple way to explain, a histogram is a bar graph, whose X-axis represents the tonal scale (black at the left and white at the right), and Y-axis represents the number of pixels in an image in a certain area of the tonal scale. HSV (Hue, Saturation, value) color space has used that corresponds to human perception. Hue distinguishes color. Saturation is percentage of white light added to pure color. Value is perceived light intensity. HSV space also separates chromatic and achromatic components. The HSV color wheel may be depicted as a cone orcylinder.

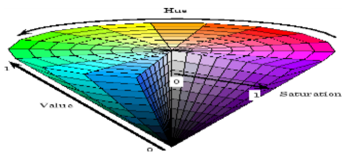


Fig.1.HSV color wheel

The color histogram can be built for any kind of color space like HSVorRGB.The values of a color histogram are from statistics. They show the statistical distribution of colors and the essential tone of an image. Color histograms can potentially be identical for two images with different object content which happens to share color information. Conversely, without spatial or shape information, similar objects of different color may be indistinguishable based solely on color histogramcomparisons.

II. ColorMoment

Images can be differentiated based on their color feature using the color moments as it provides a measurement of color similarity between them. Probability distributions depict the distribution of the color in an image and are characterized by a number of unique moments. So if the color in an image matches a probability distribution, the image can be identified on the basis of color using the moments of that distribution as a feature. Moments are calculated for each of the channels in an image. The features used are statistical parameters such as the mean (μ) and standard deviation (σ) that represent the global properties of a color image. Mean represents principal color of image and standard deviation represents variation of color. Mean and standard deviation of hue, saturation and value, viz , μH , μS, μV and σH, σS, σV, are extracted. They are given as

$$\mu = \frac{1}{N}\sum_{K=1}^{N} P_K \qquad (1)$$

$$\sigma = \left[\frac{1}{N-1}\sum_{K-1}^{N} (P_K - \mu)^2\right]^{\frac{1}{2}} \qquad (2)$$

where, P_K denotes the K^{th}pixel of an image.

B. Texturefeatures

Texture refers to surface characteristics and appearance of an object given by the size, shape, density, arrangement, proportion of its elementary parts. A basic stage to collect such features through texture analysis process is called as texture feature extraction. Due to the signification of texture information, texture feature extraction is a key function in various image processing applications like medical imaging and content based image retrieval. A typical process of texture analysis is shown in Figure 2.

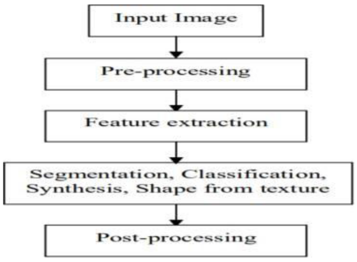


Fig.2. Various image analysis steps

I) GaborFilters

In image processing, a Gabor filter, named after Dennis Gabor, is a linear filter used for texture analysis, which means that it basically analyses whether there are any specific frequency content in the image in specific directions in a localized region around the point or region of analysis.The extraction of texture of an image can be accomplished using a set of Gabor Filters. Gabor filters are a group of wavelets which capture energy at a specific frequency and at a specific direction. Gabor filter has higher pattern retrieval accuracy.

II) Discrete WaveletTransform

Wavelethasbeen usedwidelyinimageprocessingapplications,asitprovidesmultiscaledecomposition oftheimagedata. The Discrete Wavelet Transform of the image signals provides better spatial and spectral localization of image formation and produces a non-redundant image representation. In wavelet transform, signal is represented with shifted and scaled version of mother wavelet i.e. giving infinite number of basic functions. This gives both time and frequency representation of the signal. One of the reasons why wavelet transform is preferred over traditional approaches like discrete Fourier transform (DFT) and discrete cosine transform (DCT) is the tuning ability of the wavelet basis according to the needs, e.g., optimization of compression, classification, or retrievalperformances.

Fourfrequencybandsareproducedbyonelevelofdecomposition,theyareLow-Low(LL),Low-High(LH),High-Low(HL) and High-High (HH). In each level of decomposition, there are three detail components LH (horizontal information), HH (diagonal information) and HL (vertical information) of high frequency and one approximated component of low frequency LL (picture figure). In the first level the frequency components are LL_1, LH_1, HL_1, HH_1.In the second level LL, isdecomposed intoLL_2 , LH_2 , HL_2 , HH_2 . The next level of decomposition is applied to the LL band of the current decomposition stage, which forms a recursive decomposition step.

Following figure shows the structure of 2 dimensional DWT with 3 decomposition levels. H depicts high frequency band, L depicts low frequency band and 3 depicts the decomposition level. We have applied DWT to the image with 3-level decomposition.

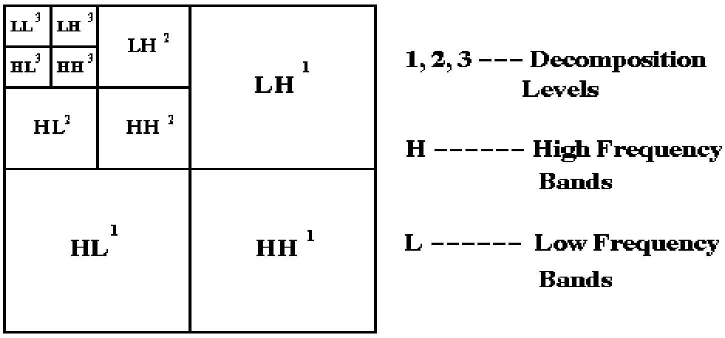


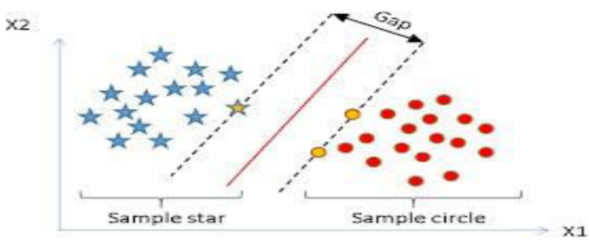
Fig. 3 . Structure of 2-dimensional DWT with 3 decomposition levels

C. Support VectorMachine

The main objective behind image classification is to label the image with appropriate identifiers. Image classification methods are categorized into two types supervised and unsupervised method, Support Vector Machines is a type of supervised learning methodwhichusestrainingsetofimagestocreatedescriptorsforeachclass.Highdimensionalityofthefeaturespaceincontent basedimageclassificationisoneofthereasonwhySVMispreferredover traditionalclassificationmethods.SVMClassification is performed by generating a hyper plane which separates all points with same label on one side of the hyperplane. Vectors near tothehyperplanearecalledsupportvectors.Optimalseparatinghyperplaneistheonehavingmaximumdistancefromtheclosest point. The perpendicular distance between the separating hyperplane and the hyperplane through the closest points is called the margin. Support vector machines can be used for text categorization, image classification, particle identification, database marketing andbioinformatics.

Support Vector Machine (SVM) is a supervised machine learning algorithm which can be used for both classification or regression challenges. However, it is mostly used in classification problems. In this algorithm, we plot each data item as a point in n-dimensional space (where n is number of features you have) with the value of each feature being the value of a particular coordinate. Then, we perform classification by finding the hyper-plane that differentiate the two classes very well.

Fig. 4. Support Vector Machine Algorithm



IV. PROPOSEDWORK

The step by step execution of the algorithm is as follows:

Step 1: Load the Query image.

Step 2: Resize image to 384*256 dimension.

Step3:HSVspaceischosen,eachHue,SaturationandValuecomponentisuniformlyquantizedinto8,2and2binsrespectively. Step 4: Apply Color Auto Correlogramon UINT8 image. The image is quantized in 4*4*4=64 colors in the RGBspace.

Step 5: Extract first 2 color moments (mean and standard deviation) from each red, green and blue color channels of the image.

Step 6: Convert image to gray scale for Gabor Wavelet transform.

Step7:ApplyGabor Wavelet(No.ofscales=4andno.oforientation=6)tocalculatemeansquaredenergyandmeanamplitude. Step 8: Apply Discrete Wavelet Transform to the image with a 3 level decomposition.

Step 9: Combine the results of step 3-8 to form a combined feature vector and store to dataset.

V. RESULT

A combination of datasets from medical and nonmedical images is used to evaluate the proposed system. Whereas the medical CBIRcanbeusedinclinicalsettings,non-medicalCBIRcanbeusedtoretrievemedicalimagesfromgeneralimagerepositories. This is specifically tested for internet based search applications where medical images are a subclass of various imageclasses

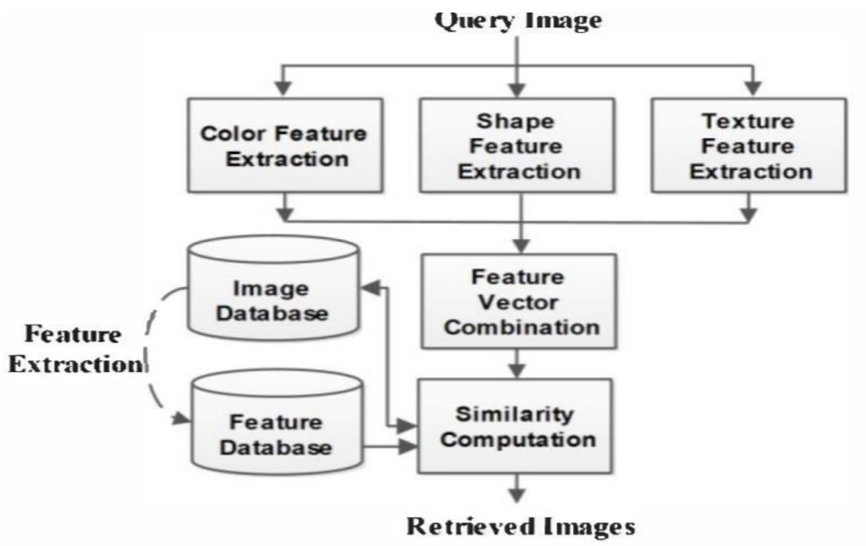


Fig.5 . Block diagram of image retrieval system

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

Recall = $\frac{number\ of\ relevant\ images\ retrieved}{total\ number\ of\ relevant\ images}$

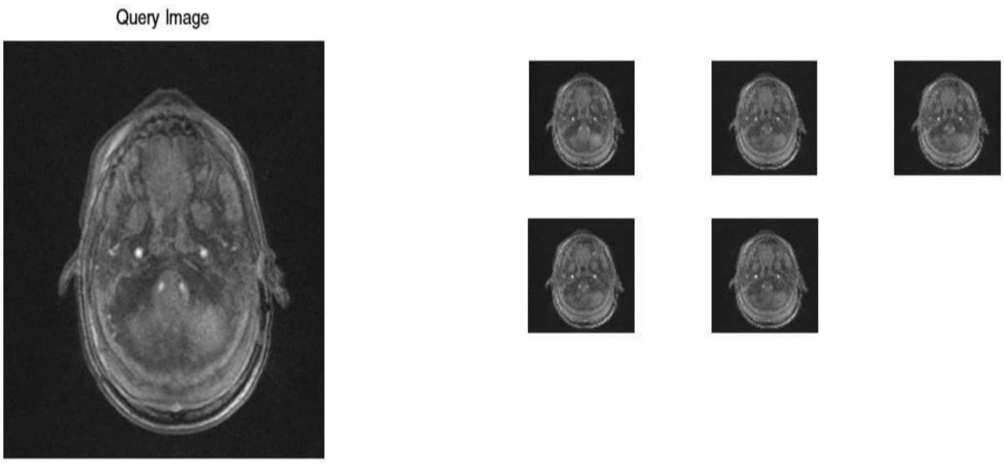


Fig. 6 .Retrieval result for query from Brain MRI

VI. CONCLUSION

Different imaging modalities like X-ray, MRI, CT, nuclear medicine etc. produce images that are stored in digital storage systems. Efficient and precise retrieval of relevant images from such a huge collection of medical images is required, so that we can use these images for clinical or research purposes. Regarding our result analysis it can be divided in quantitative and qualitative ones. The quantitative analysis shows us that a medical CBIR is useful in real environments to assist specialists, during the decision making process. The qualitative conclusions are drawn from the results obtained by the questionnaire used to measure the radiologists' satisfaction. The system usability perspective revealed that most radiologists would consider using a medical CBIR tool for decision makingpurposes.

VII. REFERENCES

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