Advanced Content based Medical Image Retrieval

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***Abstract* - A large collection of medical images surrounds health care centers and hospitals. Medical images produced by different modalities like magnetic resonance imaging (MRI), computed tomography (CT), positron emission tomography (PET), and X-rays have increased incredibly with the advent of latest technologies for image acquisition. Retrieving clinical images of interest from these large data sets is a thought provoking and demanding task. A novel Content based medical image retrieval system is proposed that can aid physicians in the identification or analysis of medical images. Here we use the fast wavelet transform for image characterization. The image signature is calculated using kurtosis and standard deviation as features. This technique can be used when the radiologist has some suspicion on diagnosis and wants further case histories, the acquired clinical images are sent (e.g. x ray images, CT scan images) 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.**

Keywords: Images, CT scan; MRI; PET.

I. INTRODUCTION

Medical images produced by different hospitals and health care centers are increasing day by day. Medical images play a vital role in identification of various diseases, clinical diagnosis and prognosis, medical training and surgical planning. Management, indexing and retrieval of such a huge collection of images tend to be very expensive and time consuming when manual methods are employed. A lot of work has been done on generic image retrieval systems using content based information [1,2]. Some of the existing medical CBIR includes IRMA, SPIRS, ASSERT, MIMS and WebMIRS [3]. These systems have their own pros and cons in their retrieval performance. So, the development of efficient and precise content based image retrieval system in medical domain is still a thought-provoking job. During the last decade, the wavelet transform has gained special attention and has become an important tool for the characterization of images. 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 retrieval performances.

Both DFT and DCT have limited number of basis functions and are of infinite duration. In wavelet transform, signal is represented with shifted and scaled version of mother wavelet i.e. giving infinite number of basis functions. This gives both time and frequency representation of the signal. Initially, wavelet adaptation (adapting wavelet according to user needs) was generally used for the approximation of a reference signal up to a chosen scale. But now it can be used for both separable and non-separable wavelet transforms. Recently, two adaptive wavelet-based image characterizations [4], [5] have been introduced and effectively applied to various problems. An important application of wavelet adaptation is content based image retrieval, which is a progressively prevalent research area in computer science. 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 Magnetic resonance imaging (MRI), computed tomography (CT) scan images, 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 system is proposed which would help in diagnosis in medical field. To develop a system that is computationally efficient and can work for varying modalities of clinical images. In our proposed system, domain specific features for image indexing need not to be extracted, rather images are indexed in a general style and fast wavelet transform (FWT) is used to build signature for each image in the dataset. In our proposed method.

II. METHODOLOGY

Our proposed method would assist clinical practitioners to retrieve relevant medical image to a query image provided to the system. For example, if there is a suspicion that patient's brain MRI has a tumor, but it is difficult to easily judge the type of tumor (benign, malign) from the MR image, then the clinician can input this image as a query to the content based

medical image retrieval system. The system will return the top five most

relevant images; which can be compared with the query image. Hence the relevant images retrieved can be compared for in terms of case histories and relevance. 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 here. A detailed block diagram is shown in Figure 1; the blocks are discussed in the following sub sections.

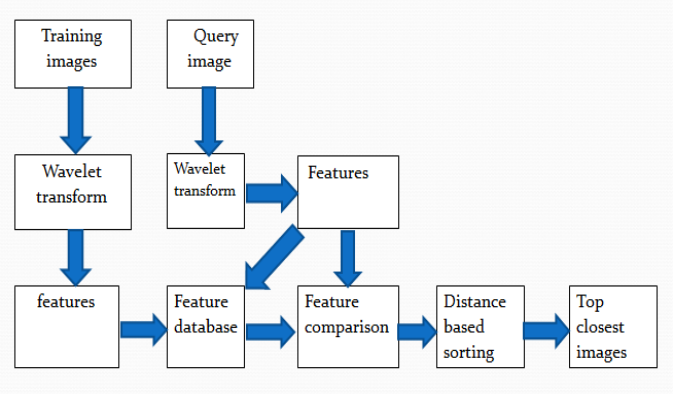

Fig. 1. Design of System hardware

A. *Proposed Algorithm*

- ***Step 1:*** Read all images from the dataset compute and store features for each of the image in the dataset.
- ***Step 2:*** Input query image to the retrieval system
- ***Step 3:*** Extract detail coefficients of input query image at any scale using wavelet transform
- ***Step 4:*** Compute image features (i.e., standard deviation and kurtosis) from the detail coefficients computed in step 3.
- ***Step 5:*** Compare Features of the query image with the features of each of the image in the database using the Euclidean distance measure.
- ***Step 6:*** Arrange the result in ascending order of distance values.
- ***Step 7:*** Retrieve and display the top five most relevant images to the query as output.

III. COMPONENTS

The software used in implementation of the code is MATLAB. Makers of MATLAB are the MathWorks. This tool is very useful in providing solutions to many real time problems. This is used for various applications of Image Processing , Speech Processing, Deep Learning, IoT, Motors etc. MATLAB has various inbuilt functions for any particular application that helps reducing the code complexity and create more complex functionalities. Image Processing Toolbox provides a comprehensive set of reference-standard algorithms and workflow apps for image processing, analysis, visualization, and algorithm development. One can perform image segmentation, image enhancement, noise reduction, geometric transformations, image registration, and 3D image processing.

- **Image Enhancement :-** The process helps in retrieving the original image and increasing the quality of the image. Contrast stretching is one of the major function in image enhancement. This process improves the contrast by stretching the range of intensity values or pixel values. This process is also referred as Normalization.
- **Pre-processing for Colour:-** This process helps obtain the image components with respect to different planes and by combining best part of all the planes to get enhanced picture.
- **Conversion of RGB to Gray images:-** For images to be processed, it must be converted from RGB to Gray scale.
- **Binary Conversion:-** The RGB image should be converted to Binary image by setting a proper threshold value between 0 and 1.
- **MATLAB for Graphics and Graphical user interface Programming:-** MATLAB supports developing applications with Graphical user interface(GUI) features. MATLAB uses GUIDE that is GUI development Environment for graphically designing GUIs. It also has tightly integrated graph plotting features in it.
- **Region props:-** This helps extraction of details like area of object, convex area, centroid, major axis length, minor axis length, perimeter, orientation, solidity, pixel list and pixel id list.

IV. RESULTS AND DISCUSSIONS

A combination of datasets from medical and nonmedical images is used to evaluate the proposed system. Whereas the medical CBIR can be used in clinical settings, non-medical CBIR can be used to retrieve medical images from general image repositories. This is specifically tested for internet based search applications where medical images are a subclass of various image classes. The computations times reported are on core i5 machine with a RAM of 4GB. The algorithm is evaluated using MATLAB R15.

A. *Data sets*

The images that have been used to evaluate the proposed system were taken from these datasets. *Caltech101:* All images from this dataset were used for the evaluation of our proposed algorithm. Each image in this dataset is of size 300 X 200 pixels [7].

B. *Rider Neuro MRI:*

This dataset consists of brain MRI. The size of each image is 256 X 256 pixels. The primary goal is the detection of tumor response to therapy. The source data was downloaded from the National Cancer Imaging Archive [8].

C. *BRAIN IX:It contains brain MR images with tumor [9].*

D. *COMUNIX:* It contains PET/CT images of cervical tumor [9].

E. *MESSIDOR:*

This data set consists of 1200 eye fundus color images, where 546 images are normal and 654 are abnormal or pathological [10].

F. Retrieval Analysis for Medical Dataset

Examples of image retrieval from two categories (Brain MRI and Fundus image) are shown in Fig. 2 and 3.

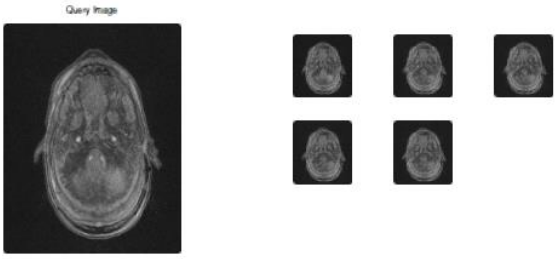

Fig. 2. Retrieval result for query from Brain MRI

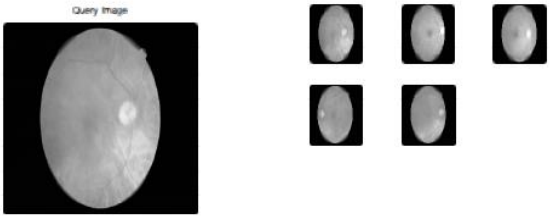

Fig. 3. Retrival result for query from MESSIDOR

The performance of the system has been evaluated using precision at five and computation time for single query processing. Precision at five represents the proportion of images at a rank ‘n’ out of the ‘r’ relevant images retrieved. The ‘r’ relevant images are selecting that satisfy the minimum distance criteria. The precision is reported for 5 images out of these ‘r’ images. The results from different datasets of different modalities are summarized in Table 1. All the medical images show good results in terms of avarage correlation. Both MRI and PET shows good results both with respect to average correlation and computation time. Computation time of PET is less then MRI. CT and PET-CT show poor results in terms of computation time as more processing is needed to process CT alone and when PET and CT are combined, as CT and PET-CT images contain more details.

V. CONCLUSION AND FUTURE ENHANCEMENT

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. A method that effectually uses maximum information of image is mainstay of an effectual content-based medical image retrieval(CBMIR) system. Our proposed CBMIR system uses wavelet transform to characterize images for retrieval purposes. It gives better retrieval results by localizing pathological areas. The proposed method has been evaluated for precision and robustness. The simulation has shown that FWT based method gives better result in terms of precision, computation time and correlation.

Kurtosis and standard deviation has been used as features to define a signature representation of each image. In future, performance can be improved by using additional features to deal with larger datasets. Moreover, there is a need for a GUI based system for making it emphatic to user and clinician`s needs.

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