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A Review on Content Based Medical Image Retrieval for Different Imaging Modalities, Organs and Diseases

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Abstract: *This paper presents a review on Content based medical image retrieval for medical imaging modalities. Theevolution in the field of medical imaging system has lead industries to intellectualize a complete automated system for the medical procedures, diagnosis, analysis, treatment and prediction.CBMIR for medical images has becomes a major necessity with the growing technological advancements. Basically the purpose of CBMIR is to include this domain specific knowledge to increase the performance of medical CBIR system and to study the stability of different methods for medical image retrievals for different imaging modalities.The successful execution of such system largely depends upon the robustness, accuracy and speed of the retrieval systems.*

Keyword: *CBIR (content based image Retrieval), CBMIR (Content based medical image retrieval), Medical imaging modalities.*

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I. Introduction

Content-based image retrieval (CBIR), a technique that uses visual contents to search images from large scale image databases according to users' interests,has been an active and fast advancing research area since the 1990s [1]Content based image retrieval (CBIR) is the application of computer vision techniques to the problem of digital image search in large databases. CBIR enables to retrieve the images from the databases [2]. Medical images are usually fused,subject to high inconsistency and composed of different minor structures. So there is a necessity for feature extraction and classification of imagesfor easy and efficient retrieval [3]Every day large volumes of different types of medical images such as dental, endoscopy, MRI, ultrasound, Radiology are produced in various hospitals as well as in various medical centres [4]In an effective image retrieval system, the user places a query and the system should search for theimages which are somehow related to the query image.Thus,a way of representing the query, a way of representing images, and a way of comparing a query and an image are needed. This kind of approach is known as querying by content.CBIR is image have rich content. This content can be extracted as various content features.CBIR has accepted different kinds of user queries for its employment such as query by example, query by color, and query by significance. When a query image is given, the image is processed to mine features in order to represent the image contents as numeric values. These values are called feature vectors which are used in the retrieval process [5, 6]for each modality and anatomic regions medical images have various formulaic compositions. The CBMIR research should be confined and also approaches should be selected according to their modality. Because the medical images are different from oneother [6].Imaging modality is an important visual characteristic that can be used to improve the retrieval performance.

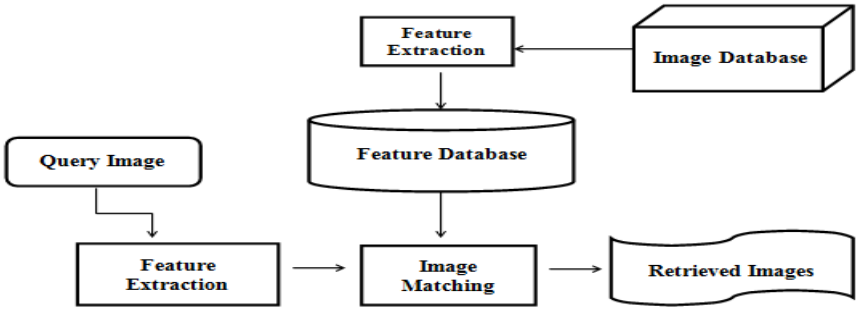

Figure (1) Basic ImageRetrieval process

Content Based Medical Image Retrieval: Image retrieval in general and Content-Based Image Retrieval (CBIR) is particular in the field of medical domain has been one of the most exciting andfastest growing research areas over the last few decade. The importance of medical image in healthcare is constantly growing, making healthcare more effective and patient friendly. With innovative imaging technology; diseases can be detected earlier with more precision, they can be treated more specific, less invasive and the beneficial result can be closely monitored. In the medical domain, the ultimate goal of image retrieval is to provide diagnostic support to physicians or radiologists by displaying relevant past cases, along with proven pathologies as ground truth. Medical images of diverse modalities such as Computerized Tomography (CT), Magnetic Resonance Image (MRI), Single Positron Emission Computed Tomography (SPECT), Ultrasound (US) from radiological departments and dermatology, microscopic pathology and histology images from other departments are generally complex in nature and require extensive image processing techniques for computer aided diagnosisDue to this reason, in most of the cases physicians or radiologists examine images in conventional ways based on their individual experiences and knowledge[7]. The management and the access to these digital medical images repositories become increasingly complex. Most of the accesses to these systems are based on the patient identification or study characteristics like description, modality.

II. Existing Content-Based Image Retrieval Systems in Medical Applications

- PACS (picture archiving and communication system):

In picture archiving and communication system (PACS), image information is retrieved by using limited text keyword in special fields in the image header (e.g. patient identifier). Content-based image retrieval (CBIR) has received significant attention in the literature as a promising technique to facilitate improved image management in PACS system [8, 9].

- IRMA (image Retrieval for medical Applications)

The Image Retrieval for Medical Applications (IRMA) project aims to provide visually rich image management through CBIR techniques applied to medical images using intensity distribution and texture measures taken globally over the entire image. This approach permits queries on a heterogeneous image collection and helps in identifying images that are similar with respect to global features e.g. all chest x-rays in the AP (Anterior-Posterior) view. The IRMA system lacks the ability for finding particular pathology that may be localized in particular regions within the image [9, 10].

- SPIRS (Spine Pathology and image Retrieval System)

The Spine Pathology and Image Retrieval System (SPIRS) provide localized vertebral shape-based CBIR methods for pathologically sensitive retrieval of digitized spine x-rays and associated person metadata [11, 12, 13].

- Image Map

Image Map is so far, the only existing medical image retrieval that considers how to handle multiple organs of interest and it is based on spatial similarity. Consequently, a problem caused by user subjectivity is likely to occur, and therefore, the retrieved image will represent an unexpected organ [14].

- ASSERT (Automatic Search and Selection Engine with Retrieval Tools)

(Automatic Search and Selection Engine with Retrieval Tools) is a content–based retrieval system focusing on the analysis of textures in high resolution Computed Tomography (CT) scan of the lung[15].

- WebMIRS system

In WebMIRS [16] system, the user manipulates GUI tools to create a query such as, "Search for all records for people over the age of 65 who reported chronic back pain. Return the age, race, sex and age at pain onset for these people." In response, the system return values for these four fields of all matching records along with a display of the associated x-ray images.

- CervigramFinder system

CervigramFinder system operates on a subset of the cervigram database. To use this system, the user defines a query by marking a region of interest on an image through GUI [17].

- SPIRS-IRMA system

SPIRS-IRMA is a CBIR system is based on the merits of two already existing systems (SPIRS & IRMA). So there is a need of absolute error free, efficient and automatic CBMIR system which can really helpful in medical stream [18].

III. Techniques For Feature Extraction

Image features may be derived from visual cues contained in an image. They are represented as alpha-numeric data in different formats such as vectors or graphs, which stand as compact surrogates for the visual context. One can distinguish two types of visual features: i) Photometric features exploit color and texture cues and they may be derived directly from raw pixel intensities, ii) Geometric features, on the other hand, make use of shape based cues.

Shape

A shape descriptor is some set of numbers that are produced to describe a given shape feature. A descriptor attempts to quantify shape in ways that agree with human intuition and these descriptors are in the form of a vector. Commonly used shape based techniques are:

Fourier Descriptor and Wavelet Transform: Fourier Descriptor (FD) is an old technique but still considered as a valid description tool. The shape description and classification using FD either in contour or regions are simple to compute, robust to noise and compact. FD is obtained by applying Fourier transform on a shape signature that is a one-dimension function derived from shape boundary coordinates. The normalized Fourier transformed coefficients are called the Fourier descriptor of the shape. A hierarchical planar curve descriptor is developed by using the wavelet transform. This descriptor decomposes a curve into components of different scales so that the coarsest scale components carry the global approximation information while the finer scale components contain the local detailed information. The wavelet descriptor has many desirable properties such as multi-resolution representation, invariance, uniqueness, stability, and spatial localization[5].

Texture

Textures are complex visual patterns composed of entities, or sub patterns that have characteristics such as brightness, color, slope, size etc. The texture in an image can be regarded as a similarity grouping. Extraction of feature in image texture analysis is a technique to compute a characteristic of digital image that is able to numerically express its texture properties.

Autocorrelation Based Texture Features and Co-occurrence Matrices Texture Features: The textual character of an image depends on the spatial size of texture primitives. Large primitives give rise to coarse texture and small primitives give fine texture. An autocorrelation function can be evaluated that measures this coarseness. This function evaluates the linear spatial relationships between primitives. If the primitives are large, the function decreases at a snail's pace with increasing distance whereas it decreases swiftly if texture consists of small primitives. However, if the primitives are periodic, then the autocorrelation increases and decreases periodically with distance. Statistical methods use second order statistics to model the relationships between pixels within the region by constructing Spatial Gray Level Dependency (SGLD) matrices. A SGLD matrix is the joint probability occurrence of Gray levels i and j for two pixels with a defined spatial relationship in an image in terms of distance d and angle θ. If the texture is coarse and distance d is small as compared to the size of the texture elements, the pairs of points at distance d should have similar Gray levels. It is converse in case of fine texture, if the distance d is comparable to the texture size, and then the Gray levels of points separated by distance d should often be quite different, so that the values in the SGLD matrix should be spread out uniformly. A good way to analyse texture coarseness would be, for various values of d, there should be some measure of scatter of the SGLD matrix around the main diagonal[19].

Color

For image representation, color is an important feature, and it is widely used in image retrieval. Once the color space is specified, color feature isextracted from image or regions. The most commonly used color extractiontechniques are:

Color Histogram , Color Moments and Color Coherence Vector (CCV): The color histogram is representation of bins where each bin is used to denote the probability of pixels in the image being of particular color. Another technique is local color histogram in which the image is segmented into blocks, and then color histogram of each block is obtained. Since the local color histogram compares regions in the same location only; when the image is translated or rotated, so it does not work well. To overcome this problem, one can use the color moment of an image.Color moments are one of the simplest features and are used in various image retrieval systems. The common moments are mean (average color value in an image), standard deviation (square root of the variance of distribution) and skewness (measure of the degree of asymmetry in the distribution). Usually they are calculated for each color component separately. The color moment method's drawback is that the moments are not enough to represent all the color information of an image.CCV incorporates spatial

information into the basic color histogram. Each histogram bin is partitioned into two types: coherent and non-coherent parts. The coherent component represents those pixels which are spatially connected and the non-coherent component includes those pixels that are isolated. As CCV captures spatial information; it usually performs better than color histogram.

IV. Literature Revive

Sr. No	Name of Paper	Name of Author	Modality And organs	Feature Extraction Technique	Retrieval Accuracy
1	Content Based Medical Image Retrieval For Histopathological, CT, MRI images	Swarnambiga Ayyachamyy	Histopathological images, CT Images, MRI Images (Brain)	Color co-occurrence matrix, Gray level Co-occurrence matrix, LBP, canny Edge detection and Oust's method with multivariable Threshold	70%
2	Content Based Image Retrieval of Ultrasound Liver Diseases Based on Hybrid Approach	Suganyya, R. and S. Rajaram	Ultrasound Images (liver)	Support Vector machine combined with relevance feedback, first order Statistics, Gray level co-occurrence Metric, Fractal Geometry	–
3	Content Based Image Retrieval System for Medical Databases (CBIR-MD) - Lucratively tested on Endoscopy, Dental and Skull Images	Ashish Oberoi and Manpreet Singh	Endoscopy Images, Dental Images, Skull Images(X-Rays)	Fourier Descriptors, Haar wavelet, Euclidean Distance, Canberra Distance	79%
4	Content based Image Retrieval for Medical Images using Canny Edge Detection Algorithm	B.Ramamurthy K.R.Chandran	MRI (Brain)	Canny Edge Detection	–
5	CBMIR Content Based Medical image Retrieval Using Shape and Texture	B.Ramamurthy, K.R.Chandran	MRI (Brain)	Edge Based Texture Feature, Edge Histogram descriptor	91%
6	Content Based Medical Image Retrieval with Texture Content Using Gray Level Co-occurrence Matrix and K-Means Clustering Algorithms	B.Ramamurthy, K.R.Chandran	MRI(Brain)	Gray level Co-occurrence Metric , K-Mean Clustering Algorithm	70%
7	CBMIR: Content-based Image Retrieval Algorithm for Medical Image Databases	Abdol Hamid Pilevar	CT,MRI(liver ,spine , skull)	Image Attribute, Regional Matching	93%
8	Content-Based Retrieval and Classification of Ultrasound Medical Images of Ovarian Cysts	Abu Sayeed Md. Sohail	Ultrasound Images (ovary)	Gray level co-occurrence matrix based on Statistical texture descriptor,Gower;s similarity coefficient, K-NN classification Technique	88%
9	Content-Based Image Retrieval of Skin Lesions by Evolutionary Feature Synthesis	Lucia Ballerina	Skin Lesions Images (skin images)	Color Co-occurrence Matrix, Generalized Co-occurrence matrix, Sum and Difference Histogram	Improve about 7%

V. Conclusion

The content based medical image retrieval system is not developed to replace doctor but just help them in diagnostic aid so that their time can be saved. The goal of CBMIR is to collection of images and in response to visual Queries, extract relevant images.

Several reviews of the literature on medical image retrieval have been published, from variety of different viewpoints, many content based medical image retrieval systems have been developed in last two decades. This paper studies CBMIR on the basis of modalities, organs and diseases like magnetic resonance Images, Computed tomography, Ultrasound, histopathological, dental, endoscopy images for diseases like Ovarian cyst,liver disease, brain tumors,dental diseases,skin lesions.

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