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Patterns for Next generation Database Systems - A study

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Abstract - **In this paper, we propose a novel scheme for efficient content-based medical image retrieval, dignified according to the Patterns for Next generation Database systems (PANDA) framework for pattern representation and management. The proposed scheme use 2-D Wavelet Transform that involves block-based low-level feature extraction from images. An expectation–maximization algorithm is used to cluster the feature space to form higher level, semantically meaningful patterns. Then, the 2-component property of PANDA is exploited: the similarity between two clusters is estimated as a function of the similarity of both their structures and the measure components. Experiments were performed on a large set of reference radiographic images, using different kinds of features to encode the low-level image content. Through this experimentation, it is shown that the proposed scheme can be efficiently and effectively applied for medical image retrieval from large databases, providing unsupervised semantic interpretation of the results, which can be further extended by knowledge representation methodologies.**

Keywords - **Content-based image retrieval (CBIR), feature extraction, patterns, pattern similarity, semantics.**

I.INTRODUCTION

Content Based Data Management has emerged as an important area. It is also known as query by image content (QBIC) and content-based visual information retrieval . The term Content-Based Image Retrieval (CBIR) seems to have originated in 1992.It is used to retrieve images based on their similarity with one or more query images. The most common method for comparing two images in content based image retrieval is using an image distance measure. An image distance measure compares the similarity of two images in various dimensions such as color, texture, shape, and others. One of the primary tools used by physicians is the comparison of previous and current medical images associated with pathologic conditions. As the amount of pictorial information stored in both local and public medical databases is growing, efficient image indexing and retrieval becomes a necessity. Christo Ananth et al. [1] proposed a method in which the minimization is per-formed in a sequential manner by the fusion move algorithm that uses the QPBO min-cut algorithm. Multi-shape GCs are proven to be more beneficial than single-shape GCs. Hence, the segmentation methods are validated by calculating statistical measures. The false positive (FP) is

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reduced and sensitivity and specificity improved by multiple MTANN. Christo Ananth et al. [2] proposed a system, this system has concentrated on finding a fast and interactive segmentation method for liver and tumor segmentation. In the pre-processing stage, Mean shift filter is applied to CT image process and statistical thresholding method is applied for reducing processing area with improving detections rate. In the Second stage, the liver region has been segmented using the algorithm of the proposed method. Next, the tumor region has been segmented using Geodesic Graph cut method. Results show that the proposed method is less prone to shortcutting than typical graph cut methods while being less sensitive to seed placement and better at edge localization than geodesic methods. This leads to increased segmentation accuracy and reduced effort on the part of the user. Finally Segmented Liver and Tumor Regions were shown from the abdominal Computed Tomographic image.

In this paper, we propose an unsupervised approach for efficient content-based medical image retrieval that utilizes similarity measures, defined over higher-level patterns that are associated with clusters of low-level image feature spaces.

II.PANDA FRAMEWORK

The efficient management of patterns extracted from medical image databases is of vital importance due to the extremely large storage requirements as well as the complexity of such kind of raw data. Taking advantage of the PANDA framework, we adopt the idea of a pattern-base (PB) keeping information about extracted patterns in a compact and unified way. A PB consists of three basic layers: the *pattern type*, the *pattern*, and the *class*. Principles of Electronic Devices have been discussed by Christo Ananth (2014) in [17].

A *pattern type* is a description of the pattern structure. A *pattern* is an instance of the corresponding pattern type and *class* is a collection of semantically related patterns of the same pattern type A pattern-type PT is called *complex* if its structure schema SS includes another pattern type, otherwise PT is called *simple*. Christo Ananth et al. [3] proposed a system, in which a predicate is defined for measuring the evidence for a boundary between two regions using Geodesic Graph-based representation of the image. The algorithm is applied to image segmentation using two different kinds of local neighborhoods in constructing the graph. Liver and hepatic tumor segmentation can be automatically processed by the Geodesic graph-cut based method. This system has concentrated on finding a fast and interactive segmentation method for liver and tumor segmentation. In the preprocessing stage, the CT image process is carried over with mean shift filter and statistical thresholding method for reducing processing area with improving detections rate. Second stage is liver segmentation; the liver region has been segmented using the algorithm of the proposed method. The next stage tumor segmentation also followed the same steps. Finally the liver and tumor regions are separately segmented from the computer tomography image.

III.RADIOGRAPHIC IMAGE RETRIEVAL USING PATTERNS

The proposed content-based medical image retrieval scheme is outlined in Fig. 1. It involves four steps:

1) low-level feature extraction from each of the registered and query images

2) lustering of the extracted feature vectors per image

3) pattern instantiation of the resulted clusters

4) computation of pattern similarities. The registration of a new image into the database involves steps 1)–3), whereas step 4) is processed during the retrieval task. Christo Ananth et al. [4] proposed a system in which the cross-diamond search algorithm employs two diamond search patterns (a large and small) and a halfway-stop technique. It finds small motion vectors with fewer search points than the DS algorithm while maintaining similar or even better search quality. The efficient Three Step Search (E3SS) algorithm requires less computation and performs better in terms of PSNR. Modified objected block-base vector search algorithm (MOBS) fully utilizes the correlations existing in motion vectors to reduce the computations. Fast Objected - Base Efficient (FOBE) Three Step Search algorithm combines E3SS and MOBS. By combining these two existing algorithms CDS and MOBS, a new algorithm is proposed with reduced computational complexity without degradation in quality. Christo Ananth et al. [5] proposed a system in which this study presented the implementation of two fully automatic liver and tumors segmentation techniques and their comparative assessment. The described adaptive initialization method enabled fully automatic liver surface segmentation with both GVF active contour and graph-cut techniques, demonstrating the feasibility of two different approaches. The comparative assessment showed

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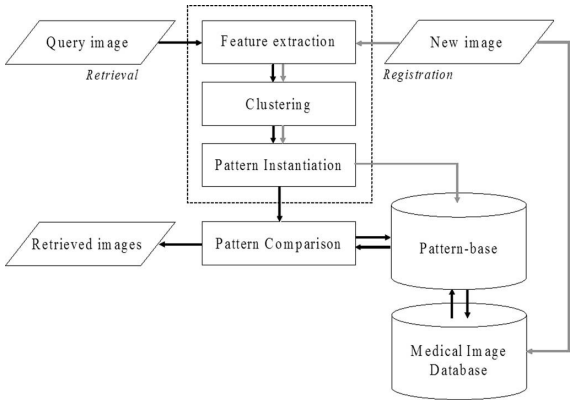
that the graph-cut method provided superior results in terms of accuracy and did not present the described main limitations related to the GVF method. The proposed image processing method will improve computerized CT-based 3-D visualizations enabling noninvasive diagnosis of hepatic tumors. The described imaging approach might be valuable also for monitoring of postoperative outcomes through CT-volumetric assessments. Processing time is an important feature for any computer-aided diagnosis system, especially in the intra-operative phase. Christo Ananth et al. [6] proposed a system in which an automatic anatomy segmentation method is proposed which effectively combines the Active Appearance Model, Live Wire and Graph Cut (ALG) ideas to exploit their complementary strengths. It consists of three main parts: model building, initialization, and delineation. For the initialization (recognition) part, a pseudo strategy is employed and the organs are segmented slice by slice via the OAAM (Oriented Active Appearance method). The purpose of initialization is to provide rough object localization and shape constraints for a latter GC method, which will produce refined delineation. It is better to have a fast and robust method than a slow and more accurate technique for initialization.



A. Low-Level Image Feature Extraction

Color, texture, and shape are the three major classes of image features commonly used in CBIR. In this paper multiscale statistical approach is used for the representation of the radiographic image regions. Because that preserves local features, and does not depend on spatial coordinates. 2D Discrete Wavelet Transform is used to retrieve the local features from the radiographic images. Each of the images in the database, as well as the query image are first raster scanned with a sliding window of user defined size. For each block, 2-DWT is applied and then a set of N features fi , i = 1, . . ., N, is calculated to form a single feature vector F. 2D Discrete Wavelet Transform is a multiresolution analysis. In DWT the image is filtered in both the horizontal and vertical directions using separable filters. This creates four subbands Subband LL1 represents the horizontal and vertical low frequency components of the image Subband HH1 represents the horizontal and vertical high frequency components of the image Subband LH1 represents the horizontal low and vertical high frequency components Subband HL1 represents the horizontal high and vertical low frequency components. Christo Ananth et al. [7] proposed a system which uses intermediate features of maximum overlap wavelet transform (IMOWT) as a pre-processing step. The coefficients derived from IMOWT are subjected to 2D histogram Grouping. This method is simple, fast and unsupervised. 2D histograms are used to obtain Grouping of color image. This Grouping output gives three segmentation maps which are fused together to get the final segmented output. This method produces good segmentation results when compared to the direct application of 2D Histogram Grouping. IMOWT is the efficient transform in which a set of wavelet features of the same size of various levels of resolutions and different local window sizes for different levels are used.

IMOWT is efficient because of its time effectiveness, flexibility and translation invariance which are useful for good segmentation results. Christo Ananth et al. [8] proposed a system in which OWT extracts wavelet features which give a good separation of different patterns. Moreover the proposed algorithm uses morphological operators for effective segmentation. From the qualitative and quantitative results, it is concluded that our proposed method has improved segmentation quality and it is reliable, fast and can be used with reduced computational complexity than direct applications of Histogram Clustering. The main advantage of this method is the use of single parameter and also very faster. While comparing with five color spaces, segmentation scheme produces results noticeably better in RGB color space compared to all other color spaces. Christo Ananth et al. [9] presented an automatic segmentation method which effectively combines Active Contour Model, Live Wire method and Graph Cut approach (CLG). The aim of Live wire method is to provide control to the user on segmentation process during execution. Active Contour Model provides a statistical model of

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object shape and appearance to a new image which are built during a training phase. In the graph cut technique, each pixel is represented as a node and the distance between those nodes is represented as edges. In graph theory, a cut is a partition of the nodes that divides the graph into two disjoint subsets. For initialization, a pseudo strategy is employed and the organs are segmented slice by slice through the OACAM (Oriented Active Contour Appearance Model). Initialization provides rough object localization and shape constraints which produce refined delineation. This method is tested with different set of images including CT and MR images especially 3D images and produced perfect segmentation results.

Christo Ananth et al. [10] proposed a work, in this work, a framework of feature distribution scheme is proposed for object matching. In this approach, information is distributed in such a way that each individual node maintains only a small amount of information about the objects seen by the network. Nevertheless, this amount is sufficient to efficiently route queries through the network without any degradation of the matching performance. Digital image processing approaches have been investigated to reconstruct a high resolution image from aliased low resolution images. The accurate registrations between low resolution images are very important to the reconstruction of a high resolution image. The proposed feature distribution scheme results in far lower network traffic load.

To achieve the maximum performance as with the full distribution of feature vectors, a set of requirements regarding abstraction, storage space, similarity metric and convergence has been proposed to implement this work in C++ and QT. Christo Ananth et al. [11] discussed about an important work which presents a metal detecting robot using RF communication with wireless audio and video transmission and it is designed and implemented with Atmel 89C51 MCU in embedded system domain. The robot is moved in particular direction using switches and the images are captured along with the audio and images are watched on the television .Experimental work has been carried out carefully. The result shows that higher efficiency is indeed achieved using the embedded system. The proposed method is verified to be highly beneficial for the security purpose and industrial purpose. The mine sensor worked at a constant speed without any problem despite its extension, meeting the specification required for the mine detection sensor. It contributed to the improvement of detection rate, while enhancing the operability as evidenced by completion of all the detection work as scheduled. The tests demonstrated that the robot would not pose any performance problem for installation of the mine detection sensor. On the other hand, however, the tests also clearly indicated areas where improvement, modification, specification change and additional features to the robot are required to serve better for the intended purpose. Valuable data and hints were obtained in connection with such issues as control method with the mine detection robot tilted, merits and drawbacks of mounting the sensor, cost, handling the cable between the robot and support vehicle, maintainability, serviceability and easiness of adjustments.

These issues became identified as a result of our engineers conducting both the domestic tests and the overseas tests by themselves, and in this respect the findings were all the more practical. Christo Ananth et al. [12] discussed about Vision based Path Planning and Tracking control using Mobile Robot. This paper proposes a novel methodology for autonomous mobile robot navigation utilizing the concept of tracking control. Vision-based path planning and subsequent tracking are performed by utilizing proposed stable adaptive state feedback fuzzy tracking controllers designed using the Lyapunov theory and particle-swarm-optimization (PSO)-based hybrid approaches. The objective is to design two self-adaptive fuzzy controllers, for *x*-direction and *y*-direction movements, optimizing both its structures and free parameters, such that the designed controllers can guarantee desired stability and, simultaneously, can provide satisfactory tracking performance for the vision-based navigation of mobile robot. The design methodology for the controllers simultaneously utilizes the global search capability of PSO and Lyapunovtheory-based local search method, thus providing a high degree of automation. Two different variants of hybrid approaches have been employed in this work.

The proposed schemes have been implemented in both simulation and experimentations with a real robot, and the results demonstrate the usefulness of the proposed concept. Christo Ananth et al. [13] discussed about a model, a new model is designed for boundary detection and applied it to object segmentation problem in medical images. Our edge following technique incorporates a vector image model and the edge map information. The proposed technique was applied to detect the object boundaries in several types of noisy images where the ill-defined edges were encountered. The proposed techniques

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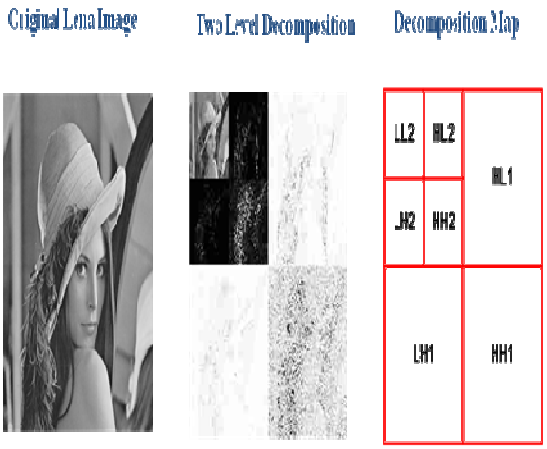
performances on object segmentation and computation time were evaluated by comparing with the popular methods, i.e., the ACM, GVF snake models. Several synthetic noisy images were created and tested. The method is successfully tested in different types of medical images including aortas in cardiovascular MR images, and heart in CT images.



B. Clustering

The low-level feature vectors are clustered using mixture models that model the data by a number of Gaussian distributions. A cluster corresponds to a set of distributions, one for each dimension of the dataset. Each distribution is described in terms of mean and standard deviation. The parameters of a mixture model are determined by the expectation maximization (EM) algorithm.

C. Pattern Instantiation

The clusters resulting from the EM algorithm are considered as patterns extracted from the image database. These patterns are represented and handled according to the PANDA formalization. EM algorithm produces M simple patterns Pi , i = 1, . . ., M. A Specimeni is instantiated for each pattern Pi representing a physical anatomic specimen in a medical image. Christo Ananth et al. [14] proposed a method in which the minimization is per-formed in a sequential manner by the fusion move algorithm that uses the QPBO min-cut algorithm. Multi-shape GCs are proven to be more beneficial than single-shape GCs. Hence, the segmentation methods are validated by calculating statistical measures. The false positive (FP) is reduced and sensitivity and specificity improved by multiple MTANN. E-Plane and H-Plane Patterns have been discussed by Christo Ananth (2014) in [16].

D. Computation of Pattern Similarities

The objective of a CBIR system is the estimation and ranking of the similarity between query and registered images.The distance between the measures of two patterns is proposed to be defined as the absolute difference of the scatter values, each one weighted by the corresponding prior probability of the patterns, normalized by the sum of the two scatter values.

$$\mathrm{dis}_{\mathrm{mean}}(P_1, P_2) = \frac{|P_1.\mathrm{pp} \cdot P_1.\mathrm{SV} - P_2.\mathrm{pp} \cdot P_2.\mathrm{SV}|}{P_1.\mathrm{SV} + P_2.\mathrm{SV}}$$

IV. CONCLUSION

This scheme utilizes rich-in-semantics *pattern* representations of medical images, defined in the context of PANDA, a framework for representing and handling data mining results. The theoretical contributions of this paper are validated by comprehensive experimentation on the IRMA reference collection of radiographic images. Future perspectives of this paper include: 1) systematic evaluation of the proposed scheme for the retrieval of various kinds of medical images, such as endoscopic and ultrasound images according to their pathology; 2) the enhancement of the retrieval performance by using image indexing techniques based on pecialized data structures; and 3) the integration of the proposed scheme with ontology-based information extraction and data mining techniques for the retrieval of medical images using heterogeneous data sources.

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