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RADIOGRAPHIC MEDICAL IMAGE RETRIEVAL SYSTEM FOR BOTH ORGAN AND PATHOLOGY LEVEL USING BAG OF VISUAL WORDS

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ABSTRACT

This research work is to develop an efficient and powerful medical image retrieval system to classify and search the radiographic medical images. It focuses on bag of visual words image representation and a similarity matching technique to represent, match and retrieve the radiographic medical images. This work uses the content based image retrieval (CBIR) system for similarity retrieval of medical images. In this system can handles different categories of medical images in organ level and the pathology level for chest X-ray images. This simple, efficient medical image categorization and retrieval system in large radiographic archives (IRMA database) is developed for a medicine physicians and researchers those who are interested in being able to retrieve medical images based on low level features. This would make these systems more helpful for radiologists to the decision making process by displaying existing content of the image content in medical settings, researches in medical analysis and medical students as well as teachers in academic healthcare environments. The methodology presented is based on local patch representation of the image content using a bag of visual words approach with a kernel based SVM classifier. The system supports the classification of X-ray images and retrieval of similar medical images for given input query image. This is first step towards similarity-based medical image categorization that has a major clinical importance in computer-assisted diagnostics. It can identify suspicious pathological X-rays and alert the referring clinicians to potential emergencies. Overall it is hoped that the development of such systems will contribute to the improvement of safety and quality of medical services.

KEY TERMS: *Content Based Image Retrieval, Picture archiving and Communication System, Bag of Visual Words, Computer Aided Diagnosis, Chest Radiography, image Patches.*

I. INTODUCTION

The main motivation of this thesis is to review the current state of the art in Content-Based Image Retrieval (CBIR) need to deal with X-ray images technique for retrieving images on the basis of automatically-derived features. Content based image retrieval refers to the ability to retrieve images on the basis of the image content. In recent decades, researchers have been on developing Content Based Image Retrieval (CBIR) systems to index and retrieve medical images. One of the reasons behind this research area is that using text alone to retrieve images might not work correctly. Throughout the world, the rapid growth of computerized Medical Imaging using Picture Archiving and Communication systems (PACS) in hospitals has generated a critical need for efficient and powerful search engines. In recent years the Growing workload on radiologists the need for computerized assisted diagnosis systems which could help the radiologist in prioritization and the diagnosis of findings [10]. Automated image categorization and retrieval system could easily support such needs once algorithmic solutions are found for diagnostic-level categorization, even on such an elementary level as healthy vs. Pathology. In this research work, develop an efficient and powerful medical search engine to classify and search the radiographic medical images.

The rest of the paper organised as follow. Section 2 discusses the overview of the CBIR system. Section 3 discusses about the clustering algorithm. Section 4 discusses the SVM classification algorithm. Section 5 denotes the related works of this paper. Section 6 discusses about the comparative analysis of existing approaches. Section 7 and 8 discusses the conclusion and future work of this paper.

II. CONTENT BASED IMAGE RETRIEVAL SYSTEM

In content-based image retrieval systems, images are indexed and retrieved from databases based on their visual content (image features) such as colour, texture, shape, etc. Commercial content-based image retrieval systems have been developed, such as QBIC, Photo book, Virage, Visual SEEK, Netra. Eakins has divided these image features into three levels as followings:
1) Level 1 - Primitive features such as colour, texture, shape or the spatial location of image elements. Typical query example is 'find pictures like this',
2) Level 2 - Derived attributes or logical features, involving some degree of inference about the identity of the objects depicted in the image. Typical query example is 'find a picture of a flower',
3) Level 3 - Abstract attributes, involving complex reasoning about the significance of the objects or scenes depicted. Typical query example is 'find pictures of a beautiful lady.'
The majority of content-based image retrieval systems mostly offer level 1 retrieval, a few experimental systems level 2, but none level 3.

III. K-MEANS CLUSTERING ALGORITHM

K means algorithms one of the simplest unsupervised learning algorithms that solve the well-known clustering problem. The procedure follows a simple and easy way to classify a given data set through a certain number of clusters (assume k clusters) fixed a priori. The main idea is to define k centroid, one for each cluster-means is one of the simplest unsupervised learning algorithms that partition feature vectors into k clusters so that the within group sum of squares is minimized.
The algorithm is composed of the following steps:
1. Place K points into the space represented by the objects that are being clustered. These points represent initial group centroid.
2. Assign each object to the group that has the closest centroid.
3. When all objects have been assigned, recalculate the positions of the K centroid.
4. Repeat Steps 2 and 3 until the centroid no longer move. This produces a separation of the objects into groups from which the metric to be minimized can be calculated.

IV. SUPPROT VECTOR MACHINE

SVM is a supervised learning method given the task of classification of query image, the objective is to classify medical images based on organ level. SVM provide a state of art performance in binary and multi class classification problems. SVM classifier has two kernel functions namely linear, nonlinear. The linear kernel function is effective to use when there is more number of classes and need to map into higher feature space for efficient classification. On linear kernel-based Support Vector Machine (SVM) classifier used for image classification.

Multiclass SVM

In multi class problem the algorithm has to learn to construct Greater number of separation boundaries to higher dimensional feature space. This can be done using non linear kernel function. Both linear and non linear provides efficient classification.

System Architecture:

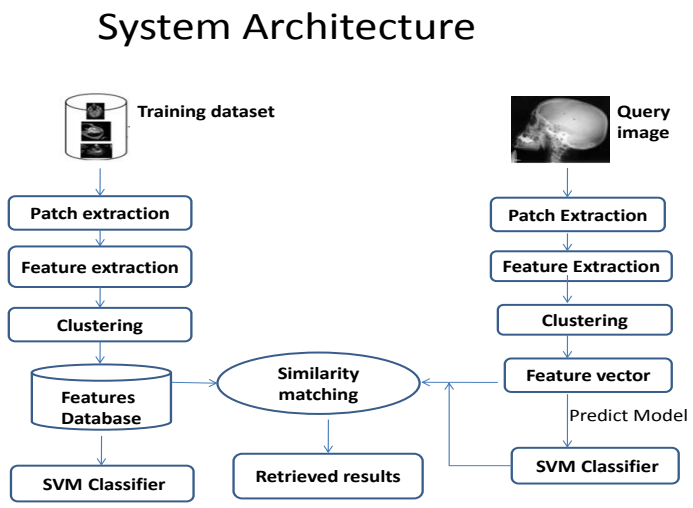

Fig no 1: Bag of visual words based medical image retrieval framework

***THE BASIC FLOW OF THIS PROJECT IS AS FOLLOWS*:**

Collect all features from patch image .Use k-means clustering algorithm to cluster those features into a visual vocabulary.

1. In the learning phase, we construct a visual vocabulary using a clustering algorithm usually; k-means is used to cluster centres of features [5] which are extracted from all images in the database. These cluster centres are then used as a vocabulary (codebook) with visual words for all images to get word vector representations.
2. For each of the training images build a histogram of the word frequency (assigning each feature found in the training image to the nearest word in the vocabulary).Feed these histograms to an SVM. Build a histogram for test images and classify them with the SVM based on trained set.
3. First organ identification task done for given test or train image then pathology level analysis will be done. For each image we add label it will mention that image is healthy or pathology image.

V. RELATED WORKS

5.1 Medical Image Retrieval Using the GMM-KL Framework

GMM-KL framework as a localized statistical framework for medical image retrieval. Image representation and matching framework for image categorization in medical image archives are done using this framework. The GMM-KL Gaussian Mixture Modelling framework is used for matching and categorizing X-ray images by body regions [2]. Unsupervised clustering via the GMM is used to extract coherent regions in feature space that are then used in the matching process. The GMM-KL framework is evaluated for image categorization and image retrieval on a dataset of 1500 radiological images [2].

The disadvantages of this approach is extending the GMM-KL framework to work on such a large dataset is yet a challenge, especially due to the computational load involved with the KL measure. GMM is a very crude (and lossy) image representation, it suffices for classification and retrieval tasks and higher resolution image representation will be needed. Matching across images that have large variations in the alignment or zoom. Intelligent search and retrieval of visual information is needed for the diagnosis procedure currently developing more efficient approximations for KL in order to enable such large archive processing.

5.2 X-ray Categorization and Spatial Localization of Chest Pathologies

An efficient image categorization system is presented for medical image databases utilizing a local patch representation based on both content and location. Image categorization is concerned with the labelling of images into predefined classes. The principal challenge of image categorization is to

capture of the most significant features within the images that facilitate the desired classification. The user can select the Region of Interest (ROI) among the regions of a particular image [11]. After finding an ROI and refining it for each image in the healthy/pathological labelled training set and run a second training stage, where sub images are cropped to the region of interest of the pathology. A new dictionary is generated for each pathology and the SVM classifiers are trained using the word histograms from the cropped regions [11]. Given a training labelled image dataset, patches are extracted from every pixel in the image. Each small patch shows a localized view of the image content. In the visual dictionary learning step, a large set of images is used. To reduce both the computational complexity of the algorithm and the level of noise, to apply a Principal Component Analysis procedure (PCA) to this initial patch collection. The final step of the visual-words model is to convert vector-represented patches into visual words and generate a representative dictionary. A visual word can be considered to be a representative of several similar patches. The vectors are clustered into k groups in the feature space using the k-means algorithm.

5.3 Distinctive Image Features from Scale-Invariant Key Points

This paper presents a method for extracting distinctive invariant features from images that can be used to perform reliable matching between different views of an object or scene. The cost of extracting these features is minimized by taking a cascade filtering approach, in which the more expensive operations are applied only at locations that pass an initial test [1].
Following are the major stages of computation used to generate the set of image features:
1. Scale-space extrema detection: The first stage of computation searches over all scales and image locations. It is implemented efficiently by using a difference-of-Gaussian function to identify potential interest points that are invariant to scale and orientation.
2. Key point localization: At each candidate location, a detailed model is fit to determine location and scale. Key points are selected based on measures of their stability.
3. Orientation assignment: One or more orientations are assigned to each key point location based on local image gradient directions. All future operations are performed on image data that has been transformed relative to the assigned orientation, scale, and location for each feature, thereby providing invariance to these transformations.
4. Key point descriptor: The local image gradients are measured at the selected scale in the region around each key point. These are transformed into a representation that allows for significant levels of local shape distortion and change in illumination.
For image matching and recognition, SIFT features are first extracted from a set of reference images and stored in a database [1]. A new image is matched by individually comparing each feature from the new image to this previous database and finding candidate matching features based on Euclidean distance of their feature vectors.

5.4Automatic Classification of Medical X-ray Images

Image representation is one of the major aspects of automatic classification algorithms. In this paper different feature extraction techniques have been utilized to represent medical X-ray images [7]. They are categorized into two groups

(i) Low-level image representation such as Gray Level Co-occurrence Matrix(GLCM), Canny Edge Operator, Local Binary Pattern(LBP) , pixel value, and
(ii) Local patch-based image representation such as Bag of Words (BoW).

These features have been exploited in different algorithms for automatic classification of medical X-Ray images. Then analyzed the classification performance obtained with regard to the image representation techniques used [7]. These experiments were evaluated on Image CLEF 2007 database consists of 11000 medical X-Ray images with 116 classes. Experimental results showed the classification performance obtained by exploiting LBP and BOW outperformed the other algorithms with respect to the image representation techniques used.

5.5 Similarity Analysis of Images Using Content Based Image Retrieval System

The Content Based Image Retrieval (CBIR) is one of the digital image processing system [9]. Most of the available image search tools are based on textual explanation of images. In these tools, images are manually annotated with keywords and then retrieved using text-based search means. This method

would not produce promising results. The goal of CBIR is to extract visual features and display the required image [9]. This paper aims to introduce the problems and challenges concerned with the design and the creation of CBIR systems using SBIR With the help of the existing methods, a possible solution how to design and implement a task specific descriptor which can handle the informational gap among a sketch and a colored image making an opportunity for the efficient search hereby. The results show that the sketch-based system allows users a shrewd access to search-tools. This technology can be used in several applications such as digital libraries, crime prevention, and photo sharing sites. Such a system has great value in apprehending suspects and identifying victims in forensics and law enforcement. A possible application is matching a forensic sketch to a gallery of mug shot images. This paper focus on retrieval of images based on the visual content of the query picture which demands on the quite wide methodology spectrum on the area of the image processing [9].

5.6 Automatic Classification of Medical X-ray Images: Hybrid Generative-Discriminative Approach

This work is presented to improve the classification performance of medical X-ray images based on the combination of generative and discriminative classification approach. A set of labelled X-ray images were given from 116 categories of different parts of body and the aim is to construct a classification model [8]. This model was then used to classify any new X-ray images into one of the predefined categories.

The classification task started with extracting local invariant features from all images. A generative model such as Probabilistic Latent Semantic Analysis (PLSA) was applied on extracted features in order to provide more stable representation of the images. Subsequently this representation was used as input to discriminative support vector machine classifier to construct a classification model. The experimental results were based on Image CLEF 2007 medical database [8]. The classification performance was evaluated on the entire dataset as well as the class specific level. It was also compared with other classification techniques with various image representations on the same database. The comparison results showed that superior performance has been achieved especially for classes with less number of training images. Thus only 7 out of 116 classes were left with accuracy rate below 60% as it differs from the results obtained using other classification approaches. This was attained by exploiting the ability of PLSA to generate a better image representation discriminative for accurate classification and more robust when less training data are available. The total classification rate obtained on the entire dataset is 92.5%.

5.7 Local Tetra Patterns: A New Feature Descriptor for Content-Based Image Retrieval

In this paper, we propose a novel image indexing and retrieval algorithm using local tetra patterns (LTrPs) for content-based image retrieval (CBIR)[12]. The standard local binary pattern (LBP) and local ternary pattern (LTP) encode the relationship between the referenced pixel and its surrounding neighbours by computing gray-level difference. The proposed method encodes the relationship between the referenced pixel and its neighbours, based on the directions that are calculated using the first-order derivatives in vertical and horizontal directions. In addition, we propose a generic strategy to compute th-order LTrP using th-order horizontal and vertical derivatives for efficient CBIR and analyze the effectiveness of our proposed algorithm by combining it with the Gabor transform.

5.8 An Approach toward the Efficient Indexing and Retrieval on Medical X-Ray Images

Today content-based image retrieval (CBIR) has become one of the most active areas of research in computer vision. With rapid advances in digital imaging modalities, the use of CBIR to search for the clinically relevant and visually similar medical images is highly felt nowadays. This paper proposes a system for content based image retrieval of X-ray images. The six classes of X-ray images used for this work are from the IRMA Image CLEF med 2008 database. Discrete Cosine Transform (DCT) coefficients [13] were used as features and the X-rays were classified using Support Vector Machine (SVM). The classified images along with the features were stored in the database using hierarchical index structure. Euclidean distance is used as the metric for retrieving the top three images from the database relevant to the given query image.

VI. COMPARATIVE ANALYSIS

Table no 1: Comparative Analysis

Feature extraction	Classification techniques	Accuracy obtained,%
GLCM, canny edge detector, pixel value	SVM with RBF	70.45
GLCM, canny edge detector, pixel value	KNN, k = 9	65.95
Local binary pattern	SVM with RBF	90.7
Local binary pattern	KNN, k = 9	86.0
Bag of visual words	SVM with RBF	90.0
Bag of visual words	Multi-modal PLSA and SVM	90.5

VII. CONCLUSION

In existing work present a new way of medical image categorization and retrieval system using bag of visual words framework. The methodology presented is based on local patch representation of the image content and a bag-of features approach for defining image categories with a kernel based SVM classifier. In a recent international competition the system was ranked as one of the top schemes in discriminating orientation and body regions in X-ray images and in medical image retrieval. The existing system handles only limited number of image categories in the organ level retrieval and the classification accuracy also comparatively less. The system shows initial capabilities in image categorization into healthy vs. pathology along with discrimination into one of the pathology states. These capabilities can be generalized to larger data collections as well as additional pathology families. Categorization is conducted on the entire image with no need for segmentation algorithms or any geometric rules.

VIII. FUTURE WORK

The future work of this project is to develop a medical image retrieval system for both organ level and the pathology level by using the bag of visual words approach. This proposed method is a first step towards similarity-based categorization that has a major clinical importance in Computer Assisted Diagnostics (CAD). It can identify suspicious pathological X-rays and alert the referring clinicians to potential emergencies. Overall it is hoped that the development of such systems will contribute to the improvement of safety and quality of medical services. The proposed system can be tuned to achieve high accuracy in general medical image classification and retrieval. Statistical analysis of the results is shown on both the Image CLEF medical dataset on the organ-level and the Sheba chest X-ray dataset, on the pathology-level. Extended the system to pathology-level discrimination and obtained results for different chest disease categorization.

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