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Classification Of Medical Images Using Visual Words

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Abstract

Data mining techniques are having applications in various fields. Medical field is one among them. Our work involves processing of the medical images specially Chest X-Rays. The process involves - *classification* of the images using *visual words*. The images are segmented into patches of Textons, known as visual words. Features are extracted from the patches to create a *feature vector*. The vectors thus formed are converted into visual words and the vector collection is clustered into k-groups using *K-means clustering*. After clustering, The images are classified using Support Vector Machine approach.

1. INTRODUCTION

With the increasing influence of computer techniques on the medical industry, the production of digitized medical data is also increasing heavily. Though the size of the medical data repository is increasing heavily, it is not being utilized efficiently, apart from just being used once for the specific medical case diagnosis. In such cases, the time spent on the process of analyzing the data is also utilized to only for that one case. But if the time and data were to be utilized in solving multiple medical cases then the medical industry can benefit intensively from the medical experts' time in providing new and more effective ways of handling and inventing medical treatments for the future. This can be made possible by combining two most prominent fields in the field of computer science – data mining techniques and image processing techniques [5]&[6].

Medical imaging is the technique used to create images of the human body for medical procedures (i.e., to reveal, diagnose or examine disease) or for medical science. Medical imaging is often perceived to designate the set of techniques that noninvasively produce images of the internal aspect of the body. Due to increase in efficient medical imaging techniques there is an incredible increase in the number of medical images. These images if archived and maintained would aid the medical industry (doctors and radiologists) in ensuring efficient diagnosis [1].

The core of the medical data are the digital images, obtained after processing the x-ray medical images; these should be processed in-order to improve their texture and quality using image Processing techniques and the data mining techniques may be applied in-order to retrieve the relevant and significant data from the existing million of tons of medical data[2].

2. RELATED WORK

Image Digitization - images acquired as x-ray images need to be processed to remove the unwanted data from the images. The medical images are usually obtained in the form of X-rays using recording techniques like *electroencephalography* (EEG), *magnetoencephalography* (MEG), *electrocardiography* (EKG), etc. These techniques produce the images; but with some added disturbances like noise, air, etc. When these X-ray images are transformed into the digital format these disturbances also get converted into digital format and become a part of the image, which may adversely affect the process of generating the accurate data required when the images are processed for medical help [9]. Thus first and foremost these unwanted data needs to be separated from the images. This is where the field of *Image processing* comes to the rescue [4]. When dealing with the medical images, many operations need to be performed on those images in-order to get more clarity in the image data. These operations are:

- Enhancement of brightness and contrast adjustments, color mapping, color balancing, quantization, or color translation to a different color space
- Image recognition, for example, may extract the text from the image using optical character recognition or checkbox and bubble values using optical mark recognition
- Image segmentation

Medical Image Mining includes the following phases: pre-processing phase, bag-of-visual-words phase, Clustering phase and Retrieval phase.

Preprocessing phase – includes the process of removing the unwanted data from the image and improve the quality of the images [10]. This process of removing unwanted data (like stop-words in the

data mining process) can be achieved by the techniques - *cropping, image enhancement and histogram equalization* [4].

Bag-of-visual words phase – consists of the complete process of obtaining the *bag-of-visual words (patches) formation and feature extraction.*

Bag-of-Visual words (patches) formation - When dealing with images it is always good to deal with the image segment-wise. Each segment will have more clarity when compared to the complete image. Each segment of the image is referred to as a patch (*visual word*). Each patch is a collection of the pixels in an image, Textons. *Textons* refer to fundamental micro-structures in generic natural images and the basic elements in early (pre-attentive) visual perception. The further operations are performed on these patches. Each patch can be treated to be an image [1].

Feature Extraction - Post image enhancement and cropping, the images are obtained in a high-quality. The features pertaining to the classification can be efficiently extracted from such clean and high quality images. The features, such as hue, saturation and brightness, are extracted for each patch and the value of these features is stored along with the respective patch. This stored data will be useful in image classification and retrieval process [3].

Clustering Phase - The images obtained from the previous phases are segregated into groups based on the similarity of the features extracted. Each segment thus formed is referred to a cluster. The patches which are similar will be grouped into one cluster and the patches which dissimilar features are placed in separate clusters. An index to each cluster may be maintained, which will be used in further image retrieval operations, reducing the number of image comparisons [4].

Classification phase- The medical images can be classified based on the feature comparison of the images stored in the clusters. Also image classification can be done for a specific region of interest (ROI) using CAD (Computer-Aided Diagnosis) algorithms. The medical image classifiers can be based on the type and nature of the features being considered [8].

PROPOSED METHOD

The proposed work includes all the phases mentioned above. In the *preprocessing phase*, an X-ray image is obtained in the gray-scale [1]. This gray-scale image is pre-processed using the *histogram equalization* inorder to improve its visual quality [7]. The thus obtained image is segmented into patches (visual-words). For each patch the hue, saturation, and brightness is calculated. Since it is a grey-scale image the hue and saturation count remains zero. Thus ultimately the feature of brightness is considered for the future processing of the image. The patches are grouped into a group and the average feature is calculated for the group [4]. The group of the patches is formed by considering the adjacent patches obtained along the horizontal and vertical lines. Finally there would be certain number of groups of feature description of each image. These feature description groups along with the images are maintained in a database for the clustering process. The images are compared against each other using the feature description groups and the Euclidean distance is calculated. The similar images are grouped together into a cluster. Initially a certain number of clusters are chosen, and then some randomly picked images are set as the centroids for each cluster. During the classification phase, the input image is initially compared to the centroids of each cluster, and based on the closeness to the centroid, a class label is attached to the image [3]. Based on the class Image is Retrieval [2].

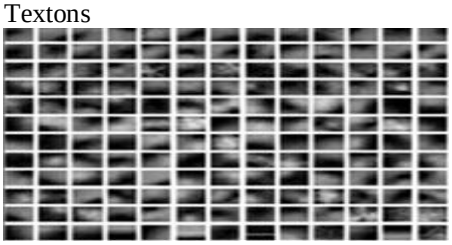
3.IMPLEMENTATION

The work is implemented in the Java language using JDBC for the database connectivity and other features of Java pertaining the images, and core Java.

Pre-processing Phase: The first phase of the work includes, the pre-processing phase. The images which are to be preprocessed are collected in a directory as Buffered Images, and one by one those images are processed [1]. Here for processing the histogram equalization technique is applied. The height and the width of the image is calculated and from this, the pixels are collected as *ints* (data type – integer) of the form 0xRRGGBB. Then from each pixel, the red, green, and blue components are extracted. From the data obtained the histogram is created. From the histogram equalization [7], we obtain much clear images.

Bag-of-Visual-words Phase: In this phase, the visual words (patches) are extracted from the equalized images, obtained from the previous phase [1]. Initially, we obtain the width and height of the image, and then divide the image into patches based upon the Textons. Thus the required bag of visual words is formed.

Textons



Image→ / Feature↓						
Hue	0	0	0	0	0	0
Saturation	0	0	0	0	0	0
Brightness	38%	9%	14%	7%	17%	0%
Gray Count	98	24	38	18	44	1

Feature description - For each patch in the image, the *HSB* (hue, saturation and brightness) are calculated. Since the hue and saturation count for the gray-scale images is zero, we take into account the *brightness feature*. The neighboring (along the vertical and horizontal line) patches are grouped into a *vector of patches*. For each patch vector we obtain the average brightness feature. This information obtained is stored into the database for the future calculations [7].

Cluster Phase: Based on the varied medical cases, we decide upon the number of clusters [6]. Then randomly few images are picked up which are considered to be the centroid of each cluster. Then the similarity between the images is found out by calculating the *Euclidean distance* between the vectors of the images being considered. The images are said to be similar if their Euclidean distance is equal to the *threshold* value (assumed). Thus the similar images are collected into a cluster (here, the cluster is a directory). Having placed all the images into their respective clusters, for each cluster based upon the containing images, new centroid image is found [5]&[6].

Classification Phase – during this phase the clusters boundary conditions are identified. The boundary conditions are defined based on the values of the feature vectors of the images available in the cluster. Non linear separable support vector machine technique is applied to find the correct class label for the new or query image [2]&[8].

4. CONCLUSIONS

The process of diagnosis is a time taking process; and only in the case where the patient is found to be affected, she/he is referred to treatment. So, in most of the healthy cases, the time spent by the human expert in the diagnosis process is being wasted; instead if the diagnosis report generation process is automated, then the human expert time and experience may be utilized in a better way for the improvement of the medical field by inventing new effective ways of dealing with the diseases. In this process, there are certain challenges to be handled as well. The challenges arise from the fact that dealing with the images and processing the images is a very time consuming process; as well the storage requirement is very high, as the images require more memory storage space than compared to the text data. The work can be expanded in the future by taking into account various other features of the images like texture, shape etc.

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