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Effective Breast Cancer detection for Medical diagnosis system using Fuzzy Logical model

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ABSTRACT

Breast Cancer is a serious threat and one of the largest causes of death of women throughout the world. The identification of cancer largely depends on digital biomedical photography analysis such a s histopathological images by doctors and physicians. Analyzing histopathological images is a nontrivial task, and decisions from investigation of these kinds of images always require specialized knowledge. However, Computer Aided Diagnosis (CAD) technique s can help the doctor make more reliable decisions. The state of-the-art Deep Neural Network (DNN) has been recently introduces d for biomedical image analysis. Normally each image contains structural and statistical information. This paper classifies a set of biomedical breast cancer images (BreakHis dataset) using novel DNN techniques guided by structural and statistical information derived from the images.This project presents a variation of fuzzy c-means (FCM) algorithm that provides image clustering. The proposed algorithm incorporates the local spatial information and gray level information in a novel fuzzy way. The new algorithm is called fuzzy local information C-Means (FLICM). FLICM can overcome the disadvantages of the known fuzzy c-means algorithms and at the same time enhances the clustering performance. The major characteristic of FLICM is the use of a fuzzy local (both spatial and gray level) similarity measure, aiming to guarantee noise insensitiveness and image detail preservation. Furthermore, the proposed algorithm is fully free of the empirically adjusted parameters incorporated into all other fuzzy c-means algorithms proposed in the literature. Experiments performed on synthetic and real-world images show that FLICM algorithm is effective and efficient, providing robustness to noisy images classification using Multi SVM.

Keywords: Digital Image Processing, Multi SVM, Segmentation, Clustering, Fuzzy Logic, CAD, DNN.

INTRODUCTION

Digital Image Processing is a component of digital signal processing .The area of digital image processing refers to dealing with digital images by means of a digital computer. Digital image processing has several advantages above analog image processing and it allows a considerably wider collection of algorithms to be apply to input data and can keep away from problems for instance the build-up of noise and signal deformation during processing. Digital Image Processing involves the modification of digital data for improving the image qualities with the aid of computer. The processing helps in maximize the clarity, sharpness of image and details of features of interest towards extraction of information and further analysis.

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Graph-Based Segmentation

Let G = (V, E) be an undirected graph with vertices vi ∈ V, the set of elementsto be segmented, and edges (vi, vj) ∈ E corresponding to pairs of neighboring vertices. Each edge (vi, vj) ∈ E has a corresponding weight w((vi, vj)), which is a non-negative measure of the dissimilarity between neighboring elements vi and vj. In the case of image segmentation, the elements in V are pixels and the weight of an edge is some measure of the dissimilarity between the two pixels connected by that edge (e.g., the difference in intensity, color, motion, location or some other local attribute). In Sections 5 and 6 we consider particular edge sets and weight functions for image segmentation. However, the formulation here is independent of these definitions. In the graph-based approach, a segmentation S is a partition of V into components such that each component (or region) C ∈ S corresponds to a connected component in a graph G0 = (V, E0), where E0 ⊆ E. In other words, any segmentation is induced by a subset of the edges in E. There are different ways to measure the quality of segmentation but in general we want the elements in a component to be similar, and elements in different components to be dissimilar. This means that edges between two vertices in the same component should have relatively low weights, and edges between vertices in different components should have higher weights.

LITERATURE SURVAY

Bag-of-visual-words approach

Sae Hwang [1], describe a Wireless Capsule Endoscopy (MRI) is a relatively new technology (FDA approved in 2002) allowing doctors to view most of the small intestine. One of the most important goals of MRI is the early detection of colorectal polyps. We introduce “Bag-of-Visual-Words” method which has been successfully used in particular for image classification in non-medical domains. Initially the training image patches are sampled and represented by speeded up robust features (SURF) descriptor, and then the bag of words model is constructed by K-means clustering algorithm. Subsequently the document is represented as the histogram of the visual words which is the feature vector of the image. Finally, a SVM classifier is trained using these feature vectors to distinguish images with polyp regions from ones without them.

Salient object detection based on context and location prior

Duzhen Zhang and Chuancai Liu, A novel automatic salient object detection algorithm, which integrates context-based saliency with location computation, based on the boundary priors. Input image is expressed as a close-loop graph with superpixels as nodes and salient object of image has a well-defined graph-based manifold ranking location [2]. The saliency of the image elements is defined based on their relevances to the given seeds or queries. Saliency object location is carried out in a two-stage scheme to extract background regions and foreground salient objects efficiently. We introduce a location weight to measure the relationship of superpixels and the centroid of the detected salient regions to eliminate the background. Saliency map is computed through context analysis and location computing based on multi-scale superpixels. Visual saliency plays important roles in natural vision in that saliency can direct eye movements, deploy attention, and facilitate tasks like object detection and scene understanding. Many models have been built to compute saliency map. There are two major categories of factors that drive attention: bottom-up factors and top-down factors. Bottom-up factors are derived solely from the visual scene. Regions of interest that attract our attention are in a bottom-up way and the responsible feature for this reaction must be sufficiently discriminative with respect to surrounding features.

Detection of small bowel polyps and Breast Cancers videos

Alexandros Karargyris and Nikolaos Bourbakis [3], describe a wireless capsule endoscopy (MRI) technology has become a very useful tool for diagnosing diseases within the human digestive tract. Physicians using MRI can examine the digestive tract in a minimally invasive way

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searching for pathological abnormalities such as bleeding, polyps, Breast Cancer, and Crohn's disease. To improve effectiveness of MRI, researchers have developed software methods to automatically detect these diseases at a high rate of success. This novel synergistic methodology is automatically discovering polyps (protrusions) and perforated Breast Cancer in MRI video frames. Finally, results of the methodology are given and statistical comparisons are also presented relevant to other works.

Multi-scale region-based saliency detection

Lei Zhu, Dominmik A. Klein [4], describe a segment-based method for saliency detection based on multi-size superpixels that combines local and global saliency cues. We extract superpixels at several scales and represent each superpixel with a normal distribution in CIE-Lab space estimated from its associated pixels. Global saliency is computed by grouping similar superpixels to estimate the spatial distribution of colors, while local saliency detection is achieved by determining the center-surround contrast of neighboring superpixels.

Enhanced Breast Cancer recognition from capsule endoscopic images

Vasileios Charisis, Leontios Hadjileontiadis, George Sergiadis [5], describe the advent of Wireless Capsule Endoscopy (MRI) and the gastroenterologists' requirement for faster and more secure diagnoses necessitated the development of effective intestinal disorder recognition systems and automated MRI image analysis/inspection techniques. The aim of MRI image processing techniques is to help the physician draw more reliable conclusions by generating enhanced and more informative images. During an examination with a stethoscope the physician instructs the patient how to breathe in order to get the best possible auscultation. In a similar way, a gastroenterologist who reviews an endoscopic video would desire the images to be as much informative as possible, but, without the opportunity to either give instructions to the patient or guide the capsule. The automated intestinal-disorder recognition systems target to detect potential regions of abnormal tissue in order to help the physician reach a diagnosis

METHODOLOGY

The following are modules which are implemented in this thesis experimental system.

- Local Statistic Feature of Nuclei [*LSFN Extraction]*
- Gabor Feature
- LDA allocation with image retrieval
- Evaluation Image Retrieval

LOCAL STATISTIC FEATURE OF NUCLEI [*LSFN Extraction]*

In this section LSFN and Gabor feature are utilized for nucleus description and texture information, respectively:

According to previous works, the diagnosis of histopathological images mostly depends on the morphology and distribution of nuclei, and a new feature by considering the neighbors of each nucleus. On this basis, we present LSFN as a novel nucleus descriptor. Meanwhile, the Gabor feature has proved capable in retrieving histopathological images that are abundant in texture. In this module find that the combination of LSFN and Gabor feature can achieve the best performance with limited computational complexity. The first step to extract our local statistic feature of nuclei (LSFN) is nucleus segmentation and visual of intermediate results. Then, each nucleus is regarded as a feature point, and attributes of the nucleus itself and its circular neighborhood are calculated and along with their significance in histopathology. By concatenating all attributes, to obtain a 27-dimensional feature vector $\boldsymbol{f}$ = $[fi]i$=1,...,27 as the LSFN of the feature point, which is located in the centroid of the nucleus.

The nucleus-based feature is to prove effective in depicting histopathological images. Nonetheless, to find that the feature could be further improved to LSFN by changing some parts

- A large part of the information about variation of a cell lies in the shape and size of its nucleus, so enforce the corresponding description by adding area equivalent diameter f.

- To limit the size of the neighborhood in a reasonable range.
- The density of nuclei is more precise than the absolute number in revealing distribution of the neighborhood, so we change the nucleus distribution item *f*9 from the quantity of nuclei to current one.
- The staining of one nucleus is uniform, which means the standard deviation of pixel grayscales in one nucleus is always close to zero, thus this item is removed [6-8].

GABOR FEATURE

In these section, Gabor feature implement a global feature for a whole image. In this module, WSI is divided into nonoverlapping square blocks and the Gabor feature is extracted from each block to represent the local texture of WSI.

Such block Gabor feature has proved effective for histopathological image retrieval. The entire procedure of block Gabor feature extraction and the histopathological image is divided into blocks of b × b pixels.

For the block a set of Gabor wavelet filters under four scales and eight orientations is used to obtain 32 grayscale response images. The mean value μi and standard deviation of the pixels in the i^{th} response image are concatenated into a 64-dimensional Gabor feature vector **g** which is located in the center of this block, balance the weight of each component, features are normalized by dimension before they are utilized.

LDA ALLOCATION WITH IMAGE RETRIEVAL

LDA is a generative hierarchical model with four levels of data: word, topic, document, and corpus; meanwhile, each level corresponds to a random variable [9, 10].In the graph, word *w* is the basic discrete data unit, topic *z* is the latent level, the document is a sequence of words, and the corpus consists of multiple documents. The *m*th document is generated by repeatedly sampling topic zmn word *w*mn from multinomial distribution with parameter $\boldsymbol{\theta}m$ and $\boldsymbol{\phi}k$, which are sampled from Dirichlet distributionwith hyperparameters α and β.

- Given the word distributions of the documents in the corpus, the inference of LDA is to estimate the topic distribution of any existing or new document. This is usually accomplished through Gibbs sampling
- In terms of WSI, a feature point corresponds to a word, a region corresponds to a document, and all the regions constitute the corpus.
- A low-level feature such as LFSN is only a vector that measures the quantitative properties of one nucleus, e.g., area, radius, etc. A word can describe the state of the nucleus such as big, small, round, or flat.
- The dictionary of BoW consists of the *k*-means clustering centers of training features.
- A topic may represent user comprehension on the region such as benign, malignant, or specific caner type.
- Correspondingly the topic histogram of a document can reflect the probability distribution of the region among different histopathology types.

Evaluation Image Retrieval

In comparison with existing methods on labeled dataset, our method is comparable with the state-of-the-art method, which is supervised. LSH dramatically improves the query efficiency with a small cost of precision. In general, our method is accurate and effective for most types of breast histopathology. The proposed approach also shows good potential to construct a powerful classifier. The experiments on a mixed dataset act as a simulation of real-world situation. The output method performs the best when UR > 4. Although the precision of our method is lower than 0.5, the correct results can provide valuable reference to pathologists in diagnosis. This validates the application capability of our method for real cases.

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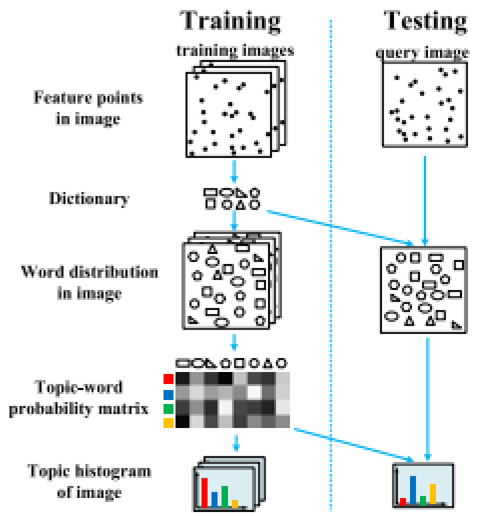

Fig . Flow chart of LDA implementation with BoW

FUZZY SUPERPIXEL SEGMENTATION

Proposed Methods and Original Contributions

In this propose paper a two-staged fully automated computer-aided detection system to detect Breast Cancers from MRI images. In the first stage, owing to the drawbacks of traditional segmentation methods focus on the automatic estimation of salient regions across the MRI images. The classical saliency extraction approaches often calculate a pixel-based saliency, ignoring the neighbor information and boundary information of the object. In addition, the human is attracted more by object instead of sole pixels. As an alternative approach, we propose to adopt superpixel representation for Breast Cancer saliency detection in the MRI images.

A superpixel is a group of pixels under some restriction of local image features such as color, intensity, or texture. It preserves most of the image structure and greatly reduces the complexity of the image processing. Furthermore, the single scale superpixel may not be able to represent the accurate contour of objects. Thus we propose the saliency calculation method based on the multi-graph region clustering algorithm for superpixel representation for the images.

Since the Breast Cancer shows significant color and texture information on the MRI mucosa surface analyze these characteristics to evaluate the corresponding saliency value for each superpixel and obtain the saliency map for each level. The final saliency map is calculated by a fusion strategy that integrates the obtained saliency maps from all levels.

In the second stage, we employ the obtained saliency maps for the Breast Cancer classification task. Inspired by the promising results of bag-of-words (BoW) or BoF model and its variants propose to classify the Breast Cancer images by coding MRI images with a modified Locality-constrained Linear Coding (LLC) method. The proposed modified LLC method integrates the original LLC method with a saliency based max-pooling to emphasize the salient region for Breast Cancer classification. The main contributions of this paper are summarized as follows:

- Instead of extracting features from the whole MRI images propose a saliency map estimation method to outline the Breast Cancer first and then extract the corresponding feature to better encode MRI images. The proposed saliency method is based on multi graph

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region clustering algorithm superpixel color and texture representation.

- Different from utilizing the existed image coding methods a saliency based max pooling method integrated with the original LLC method is proposed to carry out Breast Cancer frame classification tasks.

Fuzzy Segmentation

A Fuzzy superpixel is defined as the meaningful entity by grouping spatially neighboring pixels with the similar property. Simple Linear Iterative Clustering (SLIC) is the state-of-the-art superpixel algorithm that outputs a desired number of regular, compact superpixels with a low computational overhead. The propose system apply a SLIC superpixels as a pre-processing method for MRI image saliency detection. Because it not only provides good segmentation results, but also generates suitable size of superpixels for MRI image analysis. In the SLIC method, the local *K*-means clustering is first performed on the pixels based on the color space and spatial distances. Then the isolated small clusters are merged with the largest neighbor clusters to obtain the specific number of the superpixels.

Each segmented fuzzy superpixel is used as a processing unit in the proposed saliency model. Choosing a suitable number of fuzzy superpixels for the MRI image is empiric and case-specific. This is because that too many numbers of fuzzy superpixel lead to over-segmentation, while too few superpixels result in loss of the boundary information of the objects. In addition, using a single superpixel size to do segmentation may not be able to describe the boundary well for some cases. Therefore, a multi-level fuzzy superpixel method that first segments the image by using multiple different numbers of fuzzy superpixels (a.k.a., multiple levels of superpixels), then fuses all fuzzy superpixel segmentation in all levels later. The number of superpixels K we tested in this paper is set to be 50, 100, 150, 200, and 250 in each level, which results in level number $L = 5$.

CONCLUSION

The system is very fast in applying segmentation algorithm. This simulation software is very particular in reducing the difficulty in segmentation algorithms. Through this paper, the problem of manual pattern is eliminated. Since very less input is given, any persons can use the researches. Once the pixel value is found to be incorrect in given rectangular area, the entire area is ignored for further fuzzy pixel comparison. This experimental result in fast work and their overall recognition time is reduced. The end users are required to have minimum working experience in systems to run this software. The future clustering reduces recognition time and helps in improving error free and efficient patterns identification. The proposed system is tested well so that the end users use this software for their whole pattern recognition related operations.

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