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Image Processing Techniques Used In Digital Pathology Imaging: An Overview

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***Abstract* - Digital pathology plays one of the foremost roles in medical field and scientific research. The pathologists are responsible for the critical role of diagnosing the diseases. Pathologists carefully analyze and interpret the changes in body tissue, blood or other body fluids under the microscope. Digital image processing plays an important role on nuclei segmentation and classification, thereby reduces the human intervention. Further, digital pathology has growing applications associated to detect the nuclei through image processing techniques such as classification, segmentation and feature extraction. In this paper, we discuss the above various image processing techniques applied in pathology image analysis. These topics generally wrap up nuclei classification and segmentation and then propose solution for digital pathology imaging. The field of digital pathology image analysis and its potential impact on pathology are still growing.**

Keywords — Digital pathology, segmentation, classification.

I. INTRODUCTION

Pathology is a division of medical science that involves the study of diagnosis of diseases through the examination of tissues, surgically removed organs and bodily fluids. The area of study included cellular adaptation to injury, necrosis, inflammation, and neoplasia. Seventy percent of medical decisions depend on the digital pathology. The results from these pathology tests help doctors to diagnosis and treat correctly. A pathologist retrieves the clinical information from the sample tissue, which indicates whether the diseases are present or not. The pathologist specializes in a wide range of cancer diagnosis; this process is complicated because the tissue is very small in size. The most important types of digital pathology imaging taken for research analysis are hematology-the study of disorders in the blood, histopathology-the study of disorders in human tissue, microbiology-the study of infection diseases and organism responsible and cytopathology-the study of diagnosis of diseases in isolated cells. Digital image processing plays vital role in pathology imaging, it is essential in health care for medical diagnosis [1]. The modules of image processing are shows in Figure 1. In general, image processing covers four main areas such as image formation, enhancement, visualization and analysis.

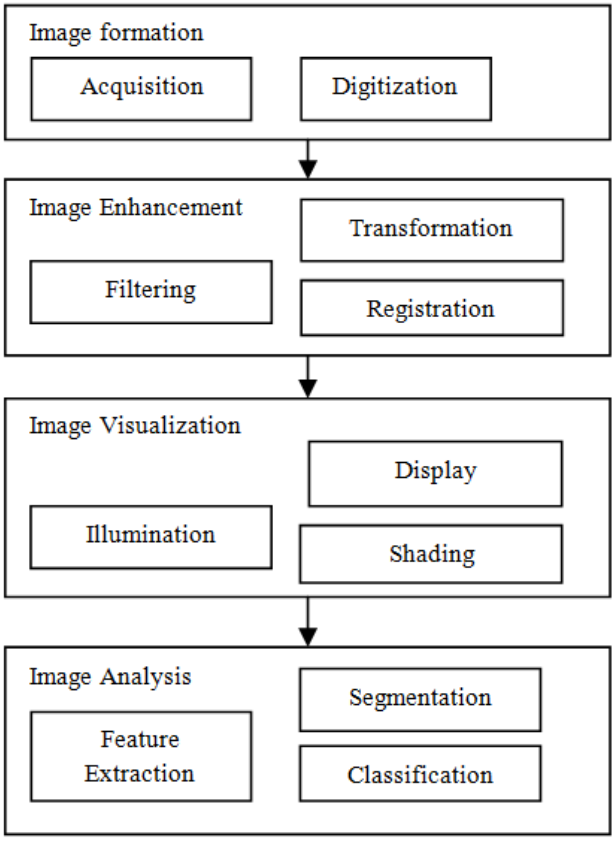

Figure 1: Modules of Image Processing

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A. Image Enhancement

Enhancement is the process of manipulating an image so that the result is more suitable than the original image. It is used to extract the useful information. Filtering techniques are applied to remove the noise in the image.

Noise removal is most important in the medical image analysis. The most frequently affected noises in the medical images are Gaussian, pepper, speckle and Poisson noises. To remove the noises from the input image and restore the quality of the original image is called as image restoration. In this function, the pixel value is restored. Median filter is applied for salt and pepper and Poisson. Wiener filter is useful for speckle and Gaussian noise [2].

B. Image Visualization

The goal of illumination is to improve the image quality by removing uneven illumination of the sensor default occurred on the image. Illumination correction is based on background subtraction. The small object of the nuclei is brighter or darker than background and so illumination is applied to improve the image quality.

C. Image Analysis

Digital pathology image is analyzed through feature extraction, segmentation and classification algorithms. These algorithms help to retrieve the information from the input images and to segment the nuclei into small regions. The techniques such as edge, region, morphological based are used to segment the nuclei.

II. IMAGE PROCESSING TECHNIQUES FOR NUCLEI DETECTION

Digital pathology is divided into three main processes such as segmentation, classification and feature extraction.

A. Segmentation

Mostly the histopathology cancer images are taken for research filed. It is used in disease analysis to find out the presence f cancer cells. The various computerized algorithms are used to detect the nuclei.[3] The pathologists analyze the valuable information and form microscopic color images. The ground truth information form microscopic cells based upon spiking neuron network (SNN). Those supervised and unsupervised training data is taken for SNN processes for segment cells [4]. Diagnosing cancer nuclei is marked otherwise unmarked a normal nuclei. By using saliency map and applied seed points to extract the boundary of the nuclei then apply back propagation to segment the individual nuclei [5]. Hematoxylin and Eosin (H&E) are stained with whole slide imaging (WSI), and then H & E stained images can be separated. Fast radial symmetry transform (FRST) is applied to mark the background and foreground. Watershed with FRST is used to segment the nuclei and cell [6].

B. Feature Extraction

Extract the characteristics from the image after segmentation. The feature such as object level is based on size and shape of the nuclei and then spatial arrangement is based on graph theory. Those are used to classify the disease stage. The SVM classifier is used to classify the images and give 98 % accuracy [7]. Morphometrical feature extraction is used for histopathology images. The fixed resolution and small number of numerical features are taken for feature extraction. The color component is used for extracting the region on the image [8]. The texture features are contrast, energy, homogeneity, correlation and contrast. The contrast is a computation of the intensity between a pixel and its neighbor over the whole image. The energy measures the entropy (sum of squares of pixel values in the segment). The homogeneity gives a value that measures the closeness of the allotment of pixels in the segment to the next segment.

C. Classification

After the feature extraction and segmentation, the images are classified through classifier techniques. Classification is used to classify the huge amount of datasets. The pathology images are classified via machine learning algorithms such as SVM, neural network, fuzzy, Bayesian classifier etc. Those are used to differentiate between cancer affected cell and others from images and identify the particular location [9].

III. TELEPATHOLOGY

Telepathology is the application of telecommunication to reassign pathology data images between laboratories and various other locations. This data is applied to research, materials for educational, tissue specimen and diagnostic. These reports of image analysis are helpful to clinical. The pathology images are very hard to cut the stain in tissue section. The pathologists have no more assurance on their own diagnosis to transfer the images to various places. Early detection of diseases through digital pathology helps to make the treatment quickly. Three

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types of telepathology are currently used such as static, dynamic and hybrid. Static type consists digital images send through email or another server. The dynamic type considered digital images are examined in real time using telecommunication on live. Hybrid type involves dynamic view of a static image in which elected areas are viewed at higher magnification.

IV. ANALYSIS OF PATHOLOGY IMAGES

The virtual microscopy technology enables the digitization of microscopy slides. It is useful for digital image analysis. Find the accuracy of tissue segmentation and validate the ground truth information. The digital data is analyzed through computer vision and applies algorithms to improve the quantification of the pathology image [10].

Here, for example we have taken a sample histology image of a human normal pancreas (a large gland behind the stomach that secretes digestive enzymes into the duodenum) from the Iowa Virtual Slide box[11]. Input image is shown in figure2.

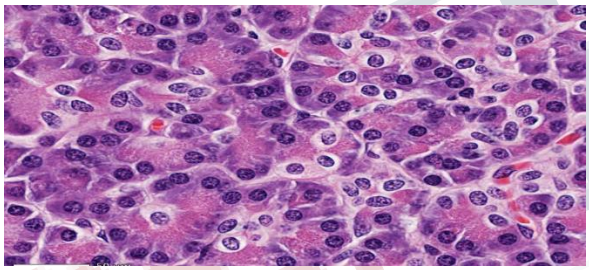

Figure 2: example of histology image of normal human pancreas

Then, applied otsu threshold and morphology algorithms to detect the nuclei from input image of pancreas. The color image is converting to the 8-bit gray image, then applied otsu threshold, after that to fill the outlines from morphological operation. Finally detect the nuclei pixels separated from background pixels. The result is shown on Figure 3.

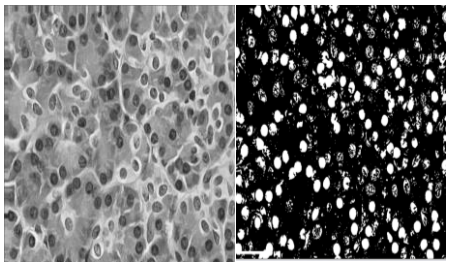

Figure 3: Examples of detect the nuclei

The input image is converted to grayscale then applied the CLAHE (Contrast-limited adaptive histogram equalization) technique to increase the block size and histogram and image contrast is enhanced. It operates in small size of regions to enhance local contrast of the image. This process is shown in figure4.

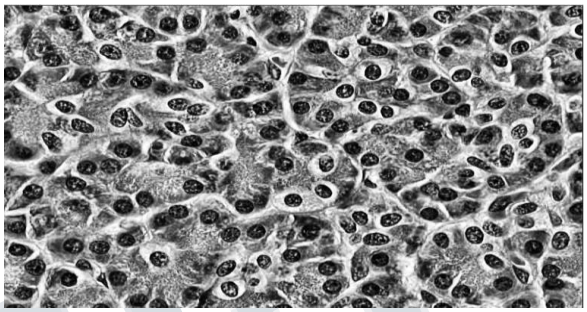

Figure 4: Example of improve contrast level of the image

V. CONCLUSION

Analysis of the microscopic image is very complicated to diagnosis the disease accurately. Digital image processing algorithms defeat this difficulty and accurately detect the nuclei, stroma and background. It increases the rate and efficiency with which pathology samples are examined in the clinic. The digital pathology images are acquired through the computerized electron microscope behind tissue slide preparation. The diverse magnification images taken for image analysis for nuclei segmentation and classification used higher magnification (40X), or else for tissue analysis low magnification (10X or 20X) is sufficient. The computer aided analysis contains three most frequently used processes such as classification, segmentation and then feature extraction. The developed computerized algorithms assist to reduce the manual mistakes.

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