Chapter 64
Digital Image Analysis for Early Diagnosis of Cancer: Identification of Pre-Cancerous State

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ABSTRACT

Cancer diagnoses so far are based on pathologists' criteria. Hence, they are based on qualitative assessment. Histopathological images of cancer biopsy samples are now available in digital format. Such digital images are now gaining importance. To avoid individual pathologists' qualitative assessment, digital images are processed further through use of computational algorithm. To extract characteristic features from the digital images in quantitative terms, different techniques of mathematical morphology are in use. Recently several other statistical and machine learning techniques have developed to classify histopathological images with the pathologists' criteria. Here, the authors discuss some characteristic features of image processing techniques along with the different advanced analytical methods used in oncology. Relevant background information of these techniques are also elaborated and the recent applications of different image processing techniques for the early detection of cancer are also discussed.

INTRODUCTION

Today digital images plays an immense importance in entire medical process and health care - from disease diagnosis to intervention and treatment (Tolxdorff et al, 2004). Different advanced image processing and analysis techniques are now have a wide spread use in different branches of life sciences as well as in medicine. In both the areas, captured data of images are widely used for scientific and clinical investigations to identify pathological changes and thereby help in an understanding of pathophysiological changes. Thus, medical images provide information that are becoming an indispensable part of today's

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patients care for disease diagnosis and thereby treatment procedure. Hence, different medical institutions across the globe capture large amount of image data. As the number of image data are increasing, so its management and thereby getting of meaningful interpretation out of them are becoming a challenge for scientists and engineers.

Today, cancer constitutes a major health problem. Global data suggest that approximately 1 out of every 2 men and 1 out of every 3 women are affected with cancer at some point during their lifetime. Such malefic scenario are correlated with increase in tobacco use and changes to urban and sedentary life-style. Fortunately, due to availability of several advanced medicines have significantly increase the life-span of the cancer patients. Moreover, early diagnosis and selection of proper treatment protocol become another two crucial factors for increased survival rate of cancer patients. Therefore, detection of pre-cancerous state becomes crucial for clinical management of cancer. Moreover, identification of malignancy level is also important in the selection of therapy. Traditionally, malignancy level is readily identified by pathologists using of histopathological images of biopsy samples, however, through empirical judgments through an assessment of the deviations in the cellular and/or tissue morphology. Overall, such assessment is subjective, and hence have a considerable variation of interpretation (Ismail et al, 1989; Andrion et al, 1995).

Empirical assessment is unreliable and hence, needs second pathologist opinion. This would make an unnecessary delay in the initiation of treatment procedure which in turn could be detrimental for the patient. So, it is very much pertinent to develop computational tools and for cancer diagnosis an automated method would be preferred. Moreover this procedure provides inferences in a quantitative manners. During the last two decades, due to availability of digital image capturing procedures, a tremendous amount of research works have initiated to conduct for automated cancer diagnosis. Though this approach holds great promise for reliable cancer diagnosis and treatment follow-up; however, it is not a straight-forward procedure and numerous challenges need to overcome.

Digital image is represented in a two-dimensional function, $f(x,y)$ where x and y are spatial coordinates of all finite, discrete quantities, and the amplitude f represent a pair of coordinates (x,y) in finite, discrete quantities. Finite set of digital value of image is called pictual elements, image elements, and pixels. A convenient tool for image processing is MatLab® (Gonzalez et al, 2009). There are many variety of disciplines and fields in science and technology such as photography, remote sensing, forensic science, industrial inspection and medical diagnosis where image processing is used. For bio-medical applications followings issues are the concern: (i) extraction of quantitative information from the acquired images, (ii) Translation of the information for developing decision support system and (iii) storage and exchange of image data without altering of meaningful information in a robust, efficient and accurate manner.

DIFFERENT LEVELS OF BIOMEDICAL IMAGE ACQUISITION

Biomedical image including cancer biopsy image data are generally occur at three levels – organ level, cell/tissue level and molecular level.

Organ Level Images

There are two different sources medical images - archival images and personal images. First one have the different image sources of the same organ while second one consisting of huge amount of image data