Wavelet Based Determination of Malignancy of the Pathological Images of the Prostate

REZA FARJAM, [1] HAMID SOLTANIAN-ZADEH, [1&2] REZA A. ZOROOFI [1]
[1]Control and Intelligent Processing Center of Excellence,
Department of Electrical and Computer Engineering,
University of Tehran,
Tehran 14395-515
IRAN
[2] Image Analysis Lab., Radiology Department,
Henry Ford Health System,
Detroit, MI 48202,
USA
E-mails : reza_dsp@yahoo.com, hamids@rad.hfh.edu, zoroofi@ut.ac.ir

Abstract-Malignancy determination of the pathological images of the prostate (PIoP) is very important for treatment planning of prostate cancer. When a cancer is suspected by clinical tests, biopsy specimens of prostate tissue are examined by pathologists for any evidence of cancer, and in the case of cancer, the specimens are used to determine its malignancy. Pathologists do this according to the architecture of the prostate glands. The aim of this paper is to automatically determine the malignancy of the PIoP. A texture based feature extraction method is applied to the image for the segmentation of glandular regions. Wavelet transform (WT) is employed to extract these features. The *K*-means clustering algorithm is then used in the segmentation process. The segmented glandular regions are labeled, and some features related to size and roundness of these regions are computed. These features are combined, and an index is computed which is proportional to the malignancy of cancer. By applying a linear classifier, the malignancy of each specimen is finally determined. To evaluate the performance of the glandular features and the proposed index, we use 161 PIoP. These images are of different magnifications and illuminations. The leave-one-out technique is used to evaluate the accuracy of these features and the index. The maximum accuracy of the features related to the size of the glands, roundness of the glands and the combination of these two, are 86%, 88%, and 92%, respectively. Also, the results show that the proposed method is robust to variations in magnification and illumination.

Key-Words: - Prostate Cancer, Malignancy, Texture Analysis, Wavelet, Linear Classifier.

1 Introduction

Cancer is the second common cause of death after cardiovascular diseases [1]. Prostate cancer is the most prevalent cancer among the men over the age of 50 with 25% of patients dying from the disease [2]. In prostate cancer diagnosis, the patient first undergoes some clinical tests like measuring prostate specific antigen (PSA), digital rectum examination (DRE), CT, MRI, and trans-rectal ultrasound (TRUS) scans [3]-[6]. If a cancer is suspected, biopsy specimens of prostate tissue are taken, stained and viewed by pathologists under a microscope with a fairly low magnification. Pathologists determine the malignancy of cancer according to the architecture of the glands. In benign cases, the glands are well differentiated and of approximately the same size. In malignant cases, the glands are erupted and have irregular shapes. Also, they are not as well differentiated as in benign cases. Malignancy determination of the PIoP is very important for treatment planning of prostate cancer. Furthermore, this is very subjective due to inter and intra observer differences among the pathologists. Also, it is a time-consuming and in some cases a difficult process. Hence, automatic determination of malignancy of PIoP is of interest.

So far, several attempts have been made towards analysis of pathological images [7]-[8]. In [7], an automatic method is proposed for classification of breast cancer in the digital mammography images. An application of gray level co-occurrence matrices and rough theory is investigated in this paper. In this area, a comparison is proposed in [8]. The effects of neural networks, fuzzy logic, genetic programming and combination of these techniques are examined and compared in this article for classification of breast cancer data.

Also, some attempts have been made for the analysis of PIoP [9]-[12]. Stotzka *et al*. [9] proposed a