A Computer Aided Diagnostic Tool for the Detection of Uterine Fibroids

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ABSTRACT

The integration of information technology with biomedicine has provided viable diagnostic tools to the medical community. Such computer aided procedures fastens the clinical decision process without any hurdle. Among different medical imaging modalities, Ultrasonic Imaging plays a vital role in detecting gynecological pathologies. Of importance, Uterine fibroid detection requires significant attention where symptoms such as, infertility and miscarriage can be predicted. This paper suggests an automated computer aided diagnostic tool for the detection of uterine fibroid. Gabor wavelets are applied for texture segmentation and statistical features such as mean, variance, standard deviation, skewness, kurtosis, Eigen values, GLCM contrast and energy are extracted from the user defined region of interest (ROI). The qualitative procedure is examined using the morphological operations and gray level intensity variations. Two neural network models, multilayer perceptron neural network (MLP) and probabilistic neural network (PNN) are applied to classify the normal and fibroid uterus image. It is found from the experimental computer simulation, a classification accuracy of 97.25% is obtained using combinational statistical features, mean and standard deviation with PNN classifier. It can be concluded that the proposed tool can applied as an efficient Medical Expert System for diagnosing the Ultrasonic Uterus images.

Keywords: Classifier, Fibroid, Gabor wavelets, Multilayer Perceptron Neural Network (MLP), Neural Network, Probabilistic Neural Network (PNN), Ultrasonic Imaging, Uterus

1. INTRODUCTION

Uterine fibroids, also referred as uterine leiomyomata are the cancerous tumors found in the women of the reproductive age group (Hassani, 1975; Yao et al., 2006; Acien, 1996)

Histologically these tumors are composed of bundles of smooth muscle cells found with in the walls of the uterus. The presence of hormones such as estrogen, progesterone merely influences the development of fibroids which are classified into the categories, submucosal, intramucosal and suberosal according to their position within the uterus (Acien, 1996; Muhopadhaya, et al., 2007; Siskin, et al., 2006; Walker et al., 2007). It is well known that the symptoms such as, heavy menstrual bleeding, irregular vaginal bleeding are the clear indica-
tors of the presence of fibroids. The challenging issue for the clinical specialists is to assess the uterus images to decide whether the tumor is benign or malignant. The less calcified benign tumor can be surgically removed whereas the malignant tumor can cause infertility as well as repeated miscarriage. In the current clinical practice, only qualitative visual procedure is adapted and there is no computer aided diagnostic tool exists to support the clinicians. Earlier literature reveals that only few study have been reported for automated uterine fibroid detection (Malarkhodi & Wahida Banu, 2012; Ratha et al., 2010; Sriraam et al., 2010). Malarkodi and Wahida Banu proposed an automated segmentation technique using local phase based level set approach (Malarkhodi & Wahida Banu, 2012). Discrete wavelet transform and histogram equalization was applied to remove the speckle noise. Shape based features, such as, total area, perimeter, diameter and eccentricity were extracted. The study was carried with only five images. Ratha and Ramar have shown a knowledge based approach for detection of fibroids (Ratha et al., 2010). A modified morphological image cleaning (MMIC) algorithm was applied to remove the speckle noise and a heuristic rule based approach was introduced for segmentation. Shape based features such as, diameter, area and compactness were applied and empirical evaluation method was adopted to determine the classification accuracy. Sriraam et al. (2010) employed wavelet packet features with backpropogation neural network classifier and have shown a classification accuracy of 95.1%. In order to achieve better pattern recognition accuracy, this research study suggests the development of computer aided diagnostic tool for automated detection of uterine fibroids using Gabor wavelet based features with neural network classifier. Section 2 highlights the proposed automated detection scheme. In section 3, gray level intensity and morphological operator analysis are described to see the distinct variation between the normal and the fibroid uterus images. Section 4 discusses the feature extraction and classification schemes. The performance evaluation of the proposed scheme is shown in section 5 and a detailed discussion is reported in Section 6. Section 7 highlights the important concluding remarks.

2. PROPOSED AUTOMATED DETECTION SCHEME

Figure 1 shows the schematic of the proposed automatic computer aided detection scheme for uterine fibroid detection. The collected uterus images from the medical databases are converted into gray scale size of 256x256 for further analysis. The presence of speckle noise in the acquired uterus image is removed by applying adaptive median filter. Unlike certain cases reported in literature (Hiransakolwon, 2005; Lee, 1996), selection of region of interest (ROI) for detection of fibroid is based on the user (i.e., Sonographer) defined area. This is due to the fact that fibroids are commonly diagnosed quantitatively by specialist through visual inspection and the real problems arise only when the size of the fibroids falls between 2 -10mm which cannot be investigated qualitatively. A computer aided quantitative approach helps a lot in such situations. Moreover, the quantitative and subjective evaluation fastens the diagnostic procedure. The suitability of the computer aided diagnosis is qualitatively checked by applying gray level intensity variation test as well as morphological operations.

For the user defined ROI, Gabor wavelet filters are then applied for texture segmentation and statistical features such as mean, variance, standard deviation, skewness, Eigen values, Kurtosis and gray-level-co-occurrence matrix (GLCM) contrast and energy are extracted. Then a set of multifeatures are applied to neural network classifier and its performance is studied using classification accuracy.

3. QUALITATIVE EVALUATION

The Ultrasonic uterus images are obtained by scanning the uterine region either abdominally or transvaginally else both. This scanning procedure is being performed in the frequency range...
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