CERTAIN INVESTIGATIONS ON TEXTURE ANALYSIS OF ULTRASOUND UTERINE IMAGE FOR CHARACTERISATION OF UTERINE LEIOMYOMAS AND ADENOMYOSIS

ABSTRACT

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ABSTRACT

The objective of this work is to develop a statistical texture based image analysis system to classify between uterine leiomyomas and adenomyosis from uterine ultrasound imaging. Ultrasound is an acoustic wave that interacts with the human body depending upon the mechanical properties of the medium. It is a non-invasive diagnostic imaging modality, which is mainly subjective. Diagnosis and classification of disease conditions using the characteristics of the acoustic signal, such as frequency, texture, attenuation and statistical characteristics, requires the knowledge of interaction between tissues and the ultrasound echo signal. The need for development of a quantitative diagnostic method for classification of uterine leiomyomas and adenomyosis using ultrasound is very medically significant. Novel quantitative ultrasound techniques are being developed for detecting diseases, classifying tumors and monitoring the effects of therapy. In this study, a quantitative ultrasound (QUS) method for classifying uterine leiomyomas and adenomyosis, based on the statistical texture analysis of echo envelopes has been introduced.

Uterine leiomyomas and adenomyosis are the common anomalies that affect women during their reproductive years. While both disease conditions may have similar clinical manifestations, surgical treatment for the two conditions differ. Hence, it is very important to distinguish between the two disease conditions before surgery for individuals, who have planned for fertility or myomectomy. Magnetic resonance imaging (MRI) has beenfound to be highly accurate in aiding differentiation of adenomyomas and leiomyomas (Mark et al. 1987). However, usage of MRI equipment is limited and the cost of expenditure for MRI based diagnosis and treatment is very

high. The recent application of transvaginal ultrasonography has given an in expensive alternative technique. Conventional imaging techniques, including ultrasound, may be sensitive to the diagnosis of diseased tissue features but the ability to characterize these tissues often lacks specificity. As a result, a large number of biopsies of tissues are being performed each year with a vast majority of these biopsies resulting in a negative result.

The proposed method includes feature extraction algorithms and classification methods to classify uterine leiomyomas and adenomyosis from ultrasound images. The classification is based on the statistical features extracted from the uterine leiomyoma and adenomyosis ultrasound images and all feature extraction methods involved in this work are based on texture based statistical features. The method proposed will aid physicians in the differential diagnosis of uterine leiomyoma and adenomyosis from an ultrasound image.

The first part in the proposed method involves the extraction of statistical texture based features using the gray level spatial domain method from uterine ultrasound images. From the features extracted, the characteristics of images are described, which help in disease classification. The region of interest (ROI) from uterine leiomyoma and adenomyosis ultrasound image is manually extracted based on the physician ground truth image. Statistical texture based features are extracted from the segmented ROI of the uterine ultrasound images, using the spatial domain feature extraction method. Statistical methods extract a set of statistical features based on the distribution of gray level values in an image.

The most commonly employed statistical method in texture analysis uses second-order statistical features. Among the second order statistical features, the most commonly used is the co-occurrence matrix method proposed by Harlick et al(1973).Using the gray level co-occurrence matrix, a set of 14 statistical texture features were extracted from the ROI of

uterineleiomyomas and adenomyosis, to characterize the tissues, based on texture statistics. It was observed that GLCM based statistical features achieved a classification accuracy of 86% in the characterization of uterine leiomyoma and adenomyosis. The inability of the method to analyze images in a different resolution is the major drawback with the spatial domain method.

The second phase of the proposed work involves extracting the statistical texture features based on transform domain methods. The transform domain method provides the advantage of both time and frequency analysis of an image. The wavelet transform provides both time and frequency information, which result in multi-resolution analysis of signal information. The multi-resolution property of the wavelet transform plays an important role in texture discrimination. An algorithm to characterize the tissues of uterine leiomyomas and adenomyosis from ultrasound using wavelet based statistical texture features was proposed. Uterine leiomyoma and adenomyosis regions are manually cropped from the ground truth ultrasound images. Four methods of wavelet based texture feature algorithm were studied in the classification of uterine leiomyomas and adenomyosis from ultrasound images. It was observed that texture energy feature, extracted using wavelet transform performed well when compared to the features extracted using Gabor filter, wavelet first order statistics and wavelet combined features.

The thesis also proposes a novel algorithm, based on wavelet packet transform to characterize the tissues of uterine leiomyoma and adenomyosis from ultrasound images. The wavelet packet transform is an extension of wavelet transform, which provides multiresolution analysis. The wavelet packet transform allows decomposition of detail sub bands, where asin pyramidal structured wavelet transform, only the approximation coefficients is decomposed. This result in analysis of other frequency sub bands that provide high energy, which are not obtained using wavelet

transform. Although pyramidal-structured wavelet transforms are suitable for analyzing low frequency regions in an image which has high energy concentration, it is not suitable for textures which are concentrated with medium frequency components. The wavelet packet transform, which involves tree structured decomposition, has proved its ability to characterize the tissues of uterine leiomyomas and adenomyosis from ultrasound images with high sensitivity and specificity.

A new algorithm based on contourlet transform based texture feature was proposed to characterize the tissues of uterine leiomyomas and adenomyosis from ultrasound images. The contourlet transform is a directional transform, which provides multiscale decomposition in different directions. The statistical texture energy features extracted from the sub bands of the contourlet transform is used to characterize the tissues of uterine leiomyomas and adenomyosis from ultrasound images. From the results, it has been observed that the contourlet transform based feature has performed well, irrespective of the type of classifiers and has proved that the multiscale directional analysis of edge, the high frequency component of an image, plays an important role in the texture based characterization of uterine leiomyomas and adenomyosis from ultrasound images.

In the proposed work, the development of Quantitative ultrasound technique for characterizing the texture feature of uterine leiomyomas and adenomyosis was studied. A new algorithm was proposed in this study to extract statistical texture features from uterine ultrasound images, by employing statistical texture features from spatial and transform domain methods. The results indicate that the proposed method of texture based statistical analysis can provide potential information for the non-invasive diagnosis and characterization of uterine leiomyomas and adenomyosis from ultrasound images.