

## **ABSTRACT**

### **CERTAIN INVESTIGATIONS ON APPLICATION OF MULTIREOLUTION ANALYSIS AND ADVANCED NEURAL NETWORKS ON MAMMOGRAMS FOR EARLY DETECTION OF BREAST CANCER**

Breast cancer, which continues to be a significant public health problem around the world, is the most prevalent cancer among women. Breast cancer is most effectively treated when detected at an early stage, and the survival probability of the patient is dependent on the stage at which it is diagnosed. Digital X-ray mammographic method is a specialized radiographic imaging technique for diagnosis of breast diseases. It identifies the morphological differences that indicate the presence of breast cancer, such as masses, micro calcifications, and architectural distortions. Detection of breast cancer at an early stage requires mammographic images which have high sensitivity and specificity with a relatively low radiation dose. This imposes challenging requirements for interactive and intelligent medical image analysis. Computerized medical image analysis method can provide effective tools to help differential diagnosis, intervention and treatment monitoring.

In the literature, various Computer Aided Diagnostic (CAD) systems are described to detect the presence of breast cancer and to classify them as benign or malignant. A detailed review of existing methods is presented in order to provide an insight about the state of the art. The objective of this research is to design advanced image processing techniques and algorithms that can aid breast cancer detection at an early stage.

Mammography remains the most effective diagnostic technique for early breast cancer detection; however, not all types of breast cancer can be detected by mammograms. For microcalcifications, the interpretations of their presence are very difficult because its sizes are in the range of 0.1mm - 1.0mm. To improve the accuracy and sensitivity of interpretation, a variety of CAD systems have been proposed. But designing an effective diagnosis system is not yet been proven effective due to its fuzzy nature and poor contrast. Therefore a CAD system with reduced human bias is always in need.

This thesis first presents a new approach to discriminate the micro calcifications from the normal tissue using Wavelet features and Extreme Learning Machine (ELM). The effectiveness of wavelet based tissue texture analysis is compared with different feature vectors extracted using Gray Level Spatial Dependence Matrix and Gabor filter based techniques. A total of 120 Region of Interests (ROIs) extracted from 55 mammogram images of mini-Mias database are used in the current research. ELM is trained with the above mentioned features and the results denote that ELM produces relatively better classification accuracy of 94% with a significant reduction in training time than the other artificial neural networks like Bayes classifier, Naïve Bayes classifier and Support Vector Machine.

Further this thesis also presents extension of the proposed method for identifying the presence of both microcalcifications and circumscribed masses from normal breast regions. The advanced Wavelet decomposition algorithm, Maximum Overlapping Wavelet Transform (MOWT) along with Extreme Learning Machine is employed for detection. A total of 117 images, including normal and abnormal are enrolled in the current research. All the literatures deal with the detection of either the microcalcification or the mass, but in the present work, two different categories of abnormalities were detected accurately and they were characterized into malignant or benign with an accuracy of 90% for microcalcifications and 94% for mass.

The work presented here also incorporates a Graphical User Interface based comprehensive tool for automated detection, characterization, and risk nature analysis of breast cancer combined with tissue density analysis. Enhanced methodologies to further improve the detection rate of microcalcifications are another salient feature of this thesis. The size of the database increases or modifies over a period of time which leads to retraining the designed system and increases the computational time and memory. A recently developed Self-adaptive Resource Allocation Network, a sequential classifier can handle data without requiring retraining and is employed in this work. It is observed that the proposed method leads to a sensitivity of 96% in detection of microcalcification. Similarly another new methodology using Curvelet transform and Phase Encoded Complex Extreme Learning Machine (PECELM) is presented. PECELM enables transforming the realvalued features to the complex domain to exploit the orthogonal decision boundaries of complex-valued neural networks for solving real-valued classification problems.

This proposed methodology achieves a maximum efficiency of 100% in detection of microcalcification. Next important contribution in this research is the automatic characterization of the detected microcalcification regions into benign and malignant using Wave Atom transform and Circular Complex Valued-Extreme Learning Machine (CC-ELM). The proposed method was evaluated using 400 ROIs of Digital Database for Screening Mammography. The performance of the proposed method was about 96.19% accurate, which is significantly higher than the existing methods. It is also inferred that the results of proposed algorithms produce better accuracy and it provides radiologists a second opinion to easily detect breast cancer at an early stage. The performances of proposed algorithms are validated by comparing its Receiver Operating Characteristics with other existing methods