CHAPTER 9
CONCLUSIONS AND FUTURE SCOPE

9.1 INTRODUCTION

The overall view of this study is presented in this chapter. It includes the conclusions drawn from the results of the proposed mammogram classification system and various opportunities for further study.

9.2 SUMMARY OF THE THESIS

This research work presents the design of an automated breast cancer diagnosis system by analyzing digital mammogram images in order to provide a second opinion to the radiologists. The proposed system for mammogram classification utilizes DTMBWT for feature extraction and SVM classifier for the mammogram classification. This work uses MIAS database digital mammogram images for the evaluation of the proposed system in terms of sensitivity, specificity and classification accuracy in percentage. The outputs of the proposed mammogram classification system are clearly shown with figures and graphs. The performance measures used in the proposed system are percentage of classification accuracy, sensitivity, specificity, and confusion matrix. The performance measures are calculated and tabulated.

9.3 CONCLUSIONS

In this study, an efficient approach for building a computerized system for mammogram classification system was proposed, discussed and tested. The multi scale analysis named DTMBWT was investigated for feature extraction and SVM algorithm was used for classification purpose and the classification was done by a decision surface induced from the training features. It has been shown that the proposed method is very effective for the automatic classification of mammogram image for early breast cancer diagnosis. The evaluation of the system was carried out using MIAS database images and the proposed system could achieve very promising results.

The one question that arises when decomposing the given mammogram image by DTMBWT is: Which decomposition level would give the highest classification accuracy 100%
To investigate this, DTMBWT was applied up to the 6th level of decomposition. Also, to investigate the classifier performance all kernels such as linear, polynomial, quadratic, RBF, and MLP were exploited and their performances were evaluated. The statistical features such as mean or energy and variance were extracted from the given mammogram image by applying DTMBWT at a predefined level of decomposition. Then k-fold cross-validation was used for separating training and testing data. The extracted features from the training images were used for training the SVM classifier and tested.

The proposed system could achieve maximum average accuracy of 93.88% for normal/abnormal classification, 95.58% for mass/MCs classification, and 96.94% for mass severity classification and 100% for MCs classification using feature fusion approach with DTMBWT energy and variance features. Two statistical features; namely energy and variance derived from DTMBWT decomposition of mammograms were also analyzed independently and the results showed that the feature fusion approach gave higher classification accuracy than their individual performances. The performance of the proposed mammogram classification system was degraded at high level DTMBWT decomposition and highest average classification accuracy was achieved in the lowest level of decomposition. It might be perhaps, due to the redundant information produced at higher level of decomposition. The use of DTMBWT to classify the given mammogram image was tested and it was found that the DTMBWT could indeed be used for this purpose.

The objectives of this research were all met.

- The mammogram classification system using digital mammograms was effectively implemented and high classification accuracy was achieved.

- A three stage classification system was developed using SVM classifier. The developed mammogram classification system was able to classify the given mammogram into normal or abnormal, mass or MCs and then benign or malignant.

- The experimental results supported the use of the statistical features of DTMBWT coefficients to correctly classify the digital mammogram images.
Also, it was observed that the proposed automated mammogram classification system based on DTMBWT and SVM could give reliable and satisfactory results.

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The proposed system could achieve maximum average accuracy of 93.88% for normal or abnormal classification, 95.58% for mass or MCs classification, and 96.94% for mass severity classification and 100% for MCs classification using feature fusion approach with DTMBWT energy and variance features.

9.4 FUTURE WORK

Work can be done on the following to enhance the accuracy in classifying the digital mammograms:

- Along with statistical properties of DTMBWT coefficients, other textural features can be used to improve the results in the classification of digital mammogram images.
- Other frequency domain transforms such as Curvelet transform, Contourlet transform, Ridgelet transform can be hybridized with DTMBWT for feature extraction.
- Using different feature extraction methods may be better than the proposed DTMBWT features.
- Hybrid classifier or ensemble based classification can be used for further improvement.
- Other imaging modalities such as MRI, CT, and Ultra sound images can be used for future work.