CHAPTER 7

CONCLUSION AND SCOPE FOR FUTURE ENHANCEMENTS

7.1 INTRODUCTION

Computer Tomography (CT) is considered as the most sensitive imaging technique for early detection of lung cancer. On the other hand, there is a requirement for automated or semi automated methodology in order to make use of large amount of data obtained CT images and more accurately understanding of individual images. Computer Aided Diagnosis (CAD) can be used efficiently for early detection of cancer in all human organs such as lungs. Computer Aided Diagnosis (CAD) has been playing a significant role in cancer detection for the past two decades. The usage of existing CAD system for early detection of lung cancer with the help of CT images has been unsatisfactory because of its low sensitivity and high False Positive Rates (FPR).

Early detection of lung cancer is the only way by which the death rate can be reduced. But there is lot of difficulty in the early detection of lung cancer nodules. This research work mainly focused on the early detection of lung cancer. This research provides a computer aided diagnosis system for early detection of lung cancer.

Three proposed approaches are presented in this research work for the detection of lung cancer. The proposed approaches are:
- Segmentation of Lung Region using Fuzzy Possibilistic C-Means (FPCM)
- Segmentation of Lung Region using Modified Fuzzy Possibilistic C-Means (MFPCM)
- Classification of Nodules employing Support Vector Machine (SVM)
- Classification of Nodules extending Extreme Learning Machine

Each proposed scheme consists of five phases. They are:

**Phase 1:** Extraction of Lung Region from Chest Computer Tomography Images

**Phase 2:** Segmentation of Lung Region

**Phase 3:** Feature Extraction from the Segmented Region

**Phase 4:** Formation of Diagnostic rules from the extracted features

**Phase 5:** Classification of malignant and benign nodules.

The experiments were conducted for the proposed approaches with the real time lung images. The proposed approaches were evaluated by various performance factors like true and false positive detection, accuracy and classification time, along with sensitivity factor.
7.2 PERFORMANCE RANKING

7.2.1 Ranking based on different parameters

The proposed approaches were evaluated based on the true and false positive detection result. From the experimental observation, it is very clear that the proposed CAD system using ELM ranks first. For instance, the sensitivity and specificity of ELM was better (Refer Table 6.6). Similarly, the False Positive Rate and False Negative Rate (Refer Table 6.9) of the two approaches are tabulated and the results are promising for ELM. The Accuracy (Refer Table 6.7), PPV and NPV (Refer Table 6.10) of ELM and SVM were tabulated and the results favor ELM.

Table 7.1 Performance Ranking based on different parameters

<table>
<thead>
<tr>
<th>Proposed Approaches</th>
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<tr>
<td>ELM</td>
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</tr>
<tr>
<td>SVM</td>
<td>2</td>
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</table>

Table 7.1 shows the performance ranking of the proposed approaches based on sensitivity, specificity, FPV and NPV.

7.2.2 Ranking based on Classification Time

The classification time taken by SVM and ELM approaches were evaluated and tabulated (Refer Table 6.8). From the experimental observation, it is clearly observed that the classification time taken by SVM is very higher compared to ELM.
Table 7.2 Performance Ranking based on Classification Time

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Table 7.2 shows the performance ranking of the proposed approaches based on the classification time. Based on this, the CAD system with ELM is ranked first among the proposed approaches.

7.2.3 Overall Performance Ranking of the Proposed Approaches

From the experimental results, it is clearly observed that proposed CAD system using the ELM approach provides significant performance. The comparison of performance parameters of the proposed approaches can be obtained from the results of the True and False Positives, Accuracy, Sensitivity, Specificity and Classification Time (Refer Table 6.11). Table 7.3 shows the overall performance ranking of the proposed approaches.

Table 7.3 Overall Performance Ranking

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7.3 SCOPE FOR FUTURE ENHANCEMENTS

This research mainly deals with Computer Aided Diagnosis System (CAD) for early detection of lung cancer nodules from the Chest Computer Tomography (CT) image using FPCM, MFPCM and SVM and MFPCM and ELM approaches. These techniques are very much useful for the detection of
lung cancer. The proposed CAD system with the ELM approach provides the best result among the three proposed techniques. In order to improve the performance of the proposed approaches, some future enhancements would be necessary in the present research work. The main aim of the future enhancements would be to increase the sensitivity and specificity of the system.

The future option for this research is to use Enhanced Extreme Learning Machine in the CAD system. The use of Enhanced ELM (Guang-Bin Huang et al 2008) would provide even better results. Moreover the training time and the accuracy of the system would also be better by using Enhanced ELM.

The second future enhancement of this research would be to use the new clustering algorithm which can provide better results than the proposed clustering algorithms.

The other future enhancements would be to incorporate latest technologies like nanotechnology (Medley et al 2008), genetic algorithm (Serhat 2007) etc., into the CAD system for the better performance of the system.