8 CHAPTER

CONCLUSIONS AND FUTURE SCOPE

Objectives of the Chapter

- *To discuss the conclusions*
- *Suggestions regarding future work*

The thesis has extensively reviewed the existing de-noising, enhancement and segmentation approach in chapter 2. The proposed de-noising method used to remove the Rician noise of simulated and real MRI data has been suggested in chapter 3. The DSR based enhancement algorithms for different sequences and pathologies of MRI have been formulated in chapters 4 and 5. Further, chapter 6 demonstrated the intensity inhomogeneity correction of diffusion-weighted MRI whereas chapter 7 proposed the multi-objective FCM algorithm for the automatic segmentation of MRI data.

8.1 Conclusions

Very first, an adaptive noise estimation technique based on the minimization of noise and maximization of the structural information has been proposed. This noise estimation approach has been followed by (i) LMMSE filter and (ii) proposed a non-local Kalman filter for the de-noising of MRI data. The proposed approach has been found highly valuable for

recursive filters at the same time performed well for non-recursive filters. The results have shown that the proposed de-noising algorithms performed better in terms of visual image quality, which further helped in better segmentation accuracy.

For enhancement of MRI data, this work has proposed the novel optimized DSR techniques. The present study has implemented different optimization techniques in combination with different DSR models such as quartic bistable model, neuron model, and multi-stable model. In best of the my knowledge, till date, the bistable neuron model of DSR and multi-stable model of DSR have been first time used for the enhancement of MRI data. The proposed contrast enhancement algorithms based on quartic bistable model and neuron model have been found valuable and assisted the radiologist in the diagnosis of different pathological brain MRI data such as lacunar infarct, mesial temporal sclerosis, cortical dysplasia, and multiple sclerosis. In case of multi-stable model of DSR, the output results obtained in terms of enhancement achieved for ROI and mean intensity based dynamic curves were helpful in diagnosis of microadenoma with increased level of confidence. The comparison of optimization techniques on simulated MRI data has been demonstrated, where Ant-lion optimization has shown its advantages over the other optimization techniques i.e., PSO, Bat, NSGA II.

Further, a new algorithm based on DSR has been developed to address the intensity inhomogeneity artifact in the diffusion-weighted sequence of MRI data. The algorithm has also been tested on simulated MRI data. The obtained results confirmed that the algorithm is capable to remove inhomogeneity without loss of information and enhances the image features.

At a later stage of the thesis, automatic segmentation algorithm based on multi-objective FCM has been proposed. This algorithm has considered cluster compactness and fuzzy hypervolume as the fitness functions. The proposed segmentation algorithm has shown its effectiveness with highest mean accuracy 97.86%, 98.90%, 98.99% respectively in terms of JS, DC, SA on synthetic images, whereas 90.45%, 94.96%, 95.13% respectively in terms of JS, DC, SA on simulated MRI images. Further, this work has proposed a new cluster validity index based on multiple cluster qualities. This cluster validity index has provided a priori knowledge of the number of clusters in the MRI data, which helped proposed FCM algorithm to make it entirely automatic. This index has been extensively compared with Xie-Beni, FHV and PE indexes, where it has delivered comparatively better performance with the highest accuracy of 83.87%.

8.2 Future directions

In the near future, the algorithms proposed in the present work can further be extended. The direction of work may be as follows:

1. The proposed algorithms are based on iterative optimization, hence requires relatively more computation cost. In future, this limitation can be overcome while implementation of these algorithms under the concept of parallel computing.
2. The accuracy of present image optimization work largely depends on the choice of fitness functions. In the case of real MRI data, ground truth data is not available. Hence, the algorithm requires non-referential quality indexes. In this view, the effectiveness of proposed algorithms can be further improved while the formulation of new non-referential indexes. These indexes should be responsible for multiple image qualities accurately.