Alzheimer’s disease is a fatal and progressive neurological disorder that results in dementia, learning disabilities, gait inconsistency and confusion. The definite means of diagnosing AD is by performing post-mortem examination of brain. It is reported that, the manifestation of AD takes place due to the deposition of neurofibrillary tangles and amyloid plaques in the CSF. MCI is considered to be a transitional stage in the spectrum of AD. The prospective identification of MCI is highly essential as it presents a conversion rate of nearly 15% every year. Consequently, the early detection of MCI is important so as to slow down the disease progression.

In this work, an attempt is made to analyse the shape changes of ventricle and CC using LB eigen values in Alzheimer’s MR brain images. The images considered for this analysis are obtained from OASIS database. The ventricles and CC are segmented using RD level set method. Different edge maps obtained using Gaussian filtering, anisotropic diffusion filtering, Tukeys biweight error norm estimator, coherence enhancing diffusion filtering and phase congruency are attempted. The performance of all the algorithms is evaluated using validation measures. The performance of RD level set using phase congruency edge map is also compared with the other level set methods such as DRLSE, MDRLSE, IMPDRLSE and p-Laplace level set methods.
The segmented ventricle and CC are subjected to feature extraction using horn ratios, shape based geometric features, distance transform and LB eigen values. The significant features are subjected to linear SVM classifier. The performance of classification is evaluated using accuracy, sensitivity and specificity measures. Further, the shape analysis of ventricles and CC are analysed using shape DNA distance measure and CVR for normal versus MCI, MCI versus AD and normal versus AD subjects.

The results show that the use of PC edge map in the RD level set method facilitates accurate segmentation of ventricle and CC compared to other edge enhancement methods. Similarly, the performance of phase based RD is found to be high compared to other level set methods. The PCC and the similarity measures show that there exists high correlation between the segmented and the ground truth images.

The extracted shape based features such as horn ratios, geometric features and distance transform show large overlap in the feature space of normal, MCI and AD subjects. Conversely, the LB eigen value features are extracted from the segmented ventricles and CC to analyse the shape changes. The eigen values $\lambda_1$ to $\lambda_5$ extracted from the segmented ventricles are found to be statistically highly significant. Similarly, $\lambda_2$ and $\lambda_3$ are found to be statistically highly significant for CC. This demonstrates the ability of LB spectrum in elucidating the shape changes of dilated ventricles and callosal atrophy in MCI subjects.

The LB eigen values achieved high classification accuracy for normal versus MCI subjects. Similar trend is observed for other measures such as specificity and sensitivity. Further the shape DNA distance measure calculated using $\lambda_2$ of ventricles and CC is found to have high discrimination of MCI from normal and AD subjects. This shows that, the shape DNA distance measure could reflect the intrinsic geometric variations in the
morphometry of enlarged ventricles as well as in the CC. Similarly, the formulated CVR values of $\lambda_2$ are able to differentiate the MCI from normal and AD subjects. This ratio also attempts to explain the phenomenon of atrophy of CC caused by the enlargement of ventricles in the normal, MCI and AD subjects. This is considered to be significant in the disease diagnosis as it considers both CC and ventricle in the shape analysis.

The major contributions of this work include the following: RD level set method integrated with phase congruency edge map has been used to segment ventricle and CC in normal, MCI and AD subjects. The shape based LB eigen values are extracted from the ventricles and CC to quantify the structural alterations. The LB eigen value features in the MCI identification using linear SVM exhibited high accuracy, specificity and sensitivity values. Shape DNA distance measure has been applied for the first time to analyse the morphometric variations due to AD. CVR has been formulated for the first time to quantify the micro structural variations of CC due to ventricle enlargement. Thus, this analysis could be used for the early identification of MCI subjects from the healthy normal and AD subjects.

5.1 SCOPE FOR FUTURE WORK

The pipeline of process adopted in this study can be extended to other imaging modalities for the early identification of MCI subjects. Many shape based ratio metrics can be formulated to numerically quantify the micro-structural alterations of brain structures in the MCI subjects. This might aid in the development of commercially viable automated computer aided disease diagnosis environment for the mass screening of MCI subjects.