CHAPTER 8

CONCLUSION AND FUTURE ENHANCEMENT

8.1 Conclusion

The goal of this work was to improve the AD stage-wise classification performance, which helps medical professionals use computational methods to analyze medical image data and identify neurological conditions like AD and dementia. Every year, the number of people suffering from dementia rises worldwide. AD is currently the second leading cause of death globally and is the primary cause of dementia in older persons. Cognitive functioning issues in older adults are affected by AD. The person's ability is affected which is a challenging to perform the daily routine tasks. There is a lack of awareness related to cognitive damage and dementia precaution. AD can cause destructive impact on social and economic status. Early diagnosis of AD can result in a happy life with good mental health. Brain MRI is used for screening patients with dementia and AD diseases. To categorize the stages of AD, a novel method is therefore needed. Medical professionals can distinguish between normal and abnormal brain images with the use of brain MRI.

This research emphasis on early detection and stage wise classification of AD in older adults which aids to increase the patient maintenance and their life time. Advanced medical imaging practices, particularly in the brain neuron images, support the neurologist in choosing suitable treatment plan, discovering anomalies present in the human brain. In this study, an innovative and computationally progressive methods are proposed for brain neuron image analysis. The metrics are used to evaluate the method's performance. The following stages of AD are taken into consideration: non-dementia, very mild dementia, mild dementia, and moderate dementia. Hence, it is essential for an automated system to categorize AD to assist medical experts in decision making.

Initially, pre-processing methods were created to improve the image dissimilarity and denoise the brain cell images. The pre-processing techniques minimizes the noise present in MRIs. This process serves as a vital groundwork for consequent classification processes. In this study, preprocessing framework is achieved in two stages that includes de-noising and segmentation. The brain MRI datasets are subjected to image de-noising techniques such as the wiener, weighted median, adaptive, hampel, and AFHI (proposed approach). Another pre-processing technique is the segmentation which is performed on the AFHI filtered brain neuron image for effective skull stripping operation. Segmentation includes region growing, histogram based discrete wavelet transform, fuzzy set theory (FCM) and TDWT-FST (proposed technique), are applied. Before the categorization procedure, a variety of pre-processing techniques are essential for the brain MRI. The performance of the AFHI de-noising approach is evaluated in this study using three performance metrics: RMSE, PSNR, and SSIM. The performance of region growing, histogram-based DWT, FCM, and TDWT-FST segmentation techniques is evaluated in this work using three performance metrics: RMSE, PSNR, and MAE.

Experimental results and the performance analysis of the pre-processing techniques are performed. The test results show that the values produced by the AFHI method overtakes the other filtering methods. The AFHI approach is assessed in this study using performance metrics such as RMSE, PSNR, and SSIM. Techniques for segmenting images, including region growth, histogram-based thresholding, and the suggested TDWT-FST methods, are used. The TDWT-FST segmentation method outperforms the other segmentation techniques in the test results. The segmentation techniques are evaluated on both datasets using performance metrics like RMSE, PSNR, and MAE. In this study, the proposed AFHI and TDWT-FST methods efficiently preprocesses the images on ADNI and OASIS datasets.

In order to improve the classification process, feature extraction techniques are then applied to the pre-processed image in this study. Conventional ML techniques for feature extraction process on MRIs is complicated and it requires the involvement of an expert user. So, DL techniques are implemented to automatic the feature extraction process. In this study, traditional ML based feature extraction techniques are applied to extract texture-based information, which includes GLCM, GLRLM, and GLDM. It is expected that it aids in the extracted spatial domain to produce results in a more effective classification-based union feature set. Also, a DL technique which is based on CNN model is applied for feature extraction. Using MRI, an AlexNet automatically extracts features to diagnose AD. Several metrics are used to assess the CNN model's performance.

Lastly, two classifier types, BAGGING_SVM and BAGGING_NEAT, are proposed to improve AD stage classification performance. The usefulness of the bagging and SVM ensemble used in this study to identify AD is shown by enhancing classification accuracy, avoiding overfitting, and bolstering the solidity of the proposed model. A CNN model is employed for feature extraction in order to improve the performance of AD stage classification. For comparison, conventional feature extraction techniques such the GLCM, GLDM, and GLRLM are employed. The performance metrics of the BAGGING_SVM classifier are used to evaluate.

ADNI and OASIS datasets are used to conduct performance analysis and experimental outcomes for the BAGGING_SVM method. The classification accuracy of method which involves GLCM, GLDM and GLRLM with BAGGING_SVM obtained an accuracy of 90.8% and the classification accuracy of method which involves the pre-trained AlexNet with BAGGING_SVM obtained an accuracy of 91.6% respectively. The accuracy percentage obtained by the pre-trained AlexNet with BAGGING_SVM method is slightly more compared to the accuracy percentage obtained by GLCM, GLDM and GLRLM with BAGGING_SVM method. This demonstrates the effectiveness of the AlexNet model using BAGGING_SVM on ADNI dataset brain neuron images. The classification accuracy of the method which involves GLCM, GLDM and GLRLM with BAGGING_SVM obtained an accuracy of 87.51% and the classification accuracy of the method which involves the pre-trained AlexNet with BAGGING_SVM obtained accuracy of 89.2% respectively. The accuracy percentage obtained by the pre-trained AlexNet with BAGGING_SVM method is maximum compared to the accuracy percentage obtained by GLCM, GLDM and GLRLM with BAGGING_SVM method. This shows the efficiency of the pre-trained AlexNet model with BAGGING_SVM on brain neuron images on OASIS dataset. The findings of the experiment are verified and examined using performance metrics, and the evaluation and outcome analysis of the proposed approach are contrasted with previous research. Thus, the accuracy of 91.6% and 89.2% is achieved in the AlexNet with BAGGING_SVM method on ADNI and OASIS dataset, respectively. The ADNI dataset outperforms the OASIS dataset in terms of performance.

In this study, an ensemble of bagging and NEAT is proposed to classify AD into different stages. The objective of this classifier is to concurrently inspire diverse viewpoints and individual accuracy. A CNN model is employed for feature extraction in order to improve the performance of AD stage classification. For comparison, conventional feature extraction techniques such the GLCM, GLDM, and GLRLM are employed. The measures are used to analyze the performance of the BAGGING_NEAT classifier.

ADNI and OASIS datasets are used to conduct performance analysis and experimental outcomes for the BAGGING_NEAT method. The classification accuracy of the method which involves GLCM, GLDM and GLRLM with BAGGING_NEAT obtained accuracy of 95.8%, recall of 96.3%, specificity of 98.5, 95.6% precision and 95.6% F1-score during k=5 fold cross-validation. The classification accuracy of the method which involves GLCM, GLDM and GLRLM with BAGGING_NEAT obtained accuracy of 90.5%, recall of 94.7%, specificity of 96.9, precision of 94% and F1-Score of 94.1% when k=10-fold cross-validation. The proposed method successfully outperforms current algorithms across all performance parameters in k=5 fold cross-validation, demonstrating its effectiveness in handling fused features.

The classification accuracy of method which involves the pre-trained AlexNet with BAGGING_NEAT obtained accuracy of 97.5% respectively. The accuracy percentage received by the pre-trained AlexNet with BAGGING_NEAT method is more compared to the accuracy percentage obtained by GLCM, GLDM and GLRLM with BAGGING_NEAT method when k=5 fold cross-validation. This demonstrates how well the pre-trained AlexNet model with BAGGING_NEAT performs on images of brain neurons from ADNI dataset.

For the OASIS dataset, the proposed GLCM, GLDM, and GLRLM with BAGGING_NEAT method maintains a good level of performance over both k=5 and k=10-fold cross-validation. It has a k=5 accuracy of 94.6% and a k=10 accuracy of 87.9%. The classification accuracy of the method which involves GLCM, GLDM and GLRLM with BAGGING_NEAT obtained an accuracy of 87.9%, recall of 86.9%, specificity of 88.7%, the precision of 89%, and F1-Score of 87.4% when k=10 fold cross-validation. Overall, in k=5 fold cross-validation, the proposed method consistently outperforms existing algorithms across all performance parameters, proving its efficacy in dealing with fused features. The classification accuracy of method which involves GLCM, GLDM and GLRLM with BAGGING_NEAT obtained accuracy of 94.6% when k=5 fold cross-validation. The classification accuracy of the method which involves the pre-trained AlexNet with BAGGING_NEAT obtained accuracy of 95.8% respectively. The accuracy percentage obtained by the pre-trained AlexNet with BAGGING_NEAT method is more compared to the accuracy percentage obtained by GLCM, GLDM and GLRLM with BAGGING_NEAT method when k=5 fold cross-validation. This demonstrates how well the pre-trained AlexNet model with BAGGING_NEAT performs on images of brain neurons from the OASIS dataset. The ADNI dataset outperforms the OASIS dataset in terms of performance.

In the end, all of the proposed methods' performances were evaluated and contrasted using the metrics that were taken into consideration. The proposed AlexNet with BAGGING_NEAT method is found to be optimal on ADNI and OASIS dataset. The limitations of this study are given below:

- The study was conducted only on ADNI and OASIS datasets with three levels.
- A single modality of brain images that is MRI is used for classification.

However, the primary objectives of this study has been successfully achieved by enhancing the performance of AD stage classification using an ensemble based classification technique. The secondary objectives such as noise lessening, segmentation are also achieved. Thus, the primary and secondary objectives are achieved successfully.

8.2 Future enhancement

The study can be extended to include the following:

- An automated model for the feature extraction as well as multilevel classification using DL concepts can be considered to classify AD.
- The cloud architecture can be considered for proposing DL models.
- The hyper-parameters in the CNN model can be tuned by introducing hybrid optimization algorithms.
- Deep neural network architectures with hybrid combinations can be explored like Multilayer Perceptrons (MLPs), Deep belief networks, AE and Restricted Boltzmann Machines (RBMs).
- Further, studies using various kinds of image modalities such as CT and PET scans can be considered for constricting a model for AD classification.