SHAPE ANALYSIS OF CORPUS CALLOSUM IN ALZHEIMER'S CONDITION USING LEGENDRE AND UNITED MOMENT SHAPE FEATURES

Ravi Dadsena[1], K. R. Anandh[1,2] and S. Ramakrishnan[1]

[1]Department of Applied Mechanics, Indian Institute of Technology Madras, Chennai, India

[2]Neuroimaging Analysis Lab, Epilepsy Division, Department of Neurology, University of Alabama at Birmingham, Alabama, United States

ABSTRACT

Corpus Callosum (CC) is the largest white matter structure which connects cortical regions of both hemispheres inside the human brain. Alterations in the morphometry of CC is considered as an important imaging biomarker for the discrimination of Control, Mild Cognitive Impairment (MCI) and Alzheimer's Disease (AD) conditions. The aim of this work is to identify the shape changes of CC among Control, MCI and AD subjects using moment based shape features and classifiers. Phase based level set segmentation method is used for delineating CC from the whole brain volume and results are validated against Ground Truth (GT). Legendre and United moment shape features are extracted from the delineated MR images. Further, these moments are statistically analyzed using Statistical Package for Social Science (SPSS). The performance of moment based features in characterizing CC morphometry is analyzed using machine learning algorithms. Results demonstrate that, phase based level set method is able to delineate CC and the results are found to have high correlation with GT. The Area Under Curve (AUC) was found to be significantly high in Legendre moment (Control versus MCI=0.81, MCI versus AD=0.74, Control versus AD=0.93) as compared to the United moment features (Control versus MCI=0.60, MCI versus AD=0.49, Control versus AD=0.59). The statistically significant moments are used for the classification of Control, MCI and AD subjects using Naïve Bayes (NB), Multilayer Perceptron (MLP) and Linear Support Vector Machine (SVM) classifiers. Results show that, the combination of Legendre moments with linear SVM classifier could provide high classification accuracy of 88.34% for Control versus AD subjects. As the shape based Legendre moments could classify Control from AD subjects, the study seems to be clinically useful in the mass screening of population.

Keywords: Legendre moment feature, Phase based level set, Corpus Callosum, Classifiers

INTRODUCTION

Alzheimer's disease (AD) is a most fatal progressive neurodegenerative syndrome, resulting in the degeneration of cognitive activities which in turn can influence delayed memory, attention and movement abilities. The diagnosis of AD is based on the pathological findings from an invasive autopsy which might not be available, hence the non-invasive and accurate diagnosis of AD is highly significant [1].

Corpus Callosum (CC) is the largest white matter tract which connects two cerebral hemispheres inside the human brain. The pathology in different cortical areas may lead to variations in the area of CC. Atrophy of CC has been reported to be the anatomical correlate of Wallerian nerve fiber degeneration which leads to death of projecting pyramidal cells in neocortex layer III and reflect the pattern of neocortical degeneration and cognitive dysfunction [2, 3]. In previous studies, CC atrophy is related to the degree of cognitive loss and hence it is considered as the neuroanatomical basis for memory disintegration in AD. Magnetic Resonance Imaging (MRI) allows one to assess numerous structural properties of CC, including its size, shape and microstructure area. Hence CC area is readily visualized by MR images,