

SEGMENTATION OF BRAIN STRUCTURES IN ALZHEIMER MR IMAGES USING SPATIAL FUZZY CLUSTERING LEVEL SET

Sreelakshmi Shaji and Ramakrishnan Swaminathan

Non-Invasive Imaging and Diagnostics Laboratory, Biomedical Engineering Group, Department of Applied Mechanics, Indian Institute of Technology, Madras, Chennai, India - 600036

Corresponding Author: Sreelakshmi Shaji
Non-Invasive Imaging and Diagnostics Laboratory, Biomedical Engineering Group, Department of Applied Mechanics, Indian Institute of Technology Madras, India 600036
Tel: +91 9400787072
Email: lakshminair.here@gmail.com
https://doi.org/10.34107/BiomedSciInstrum.57.04234

ABSTRACT

Alzheimer's Disease (AD) is an irreversible neurodegenerative disorder that affects brain structures. Corpus Callosum (CC) atrophy and Lateral ventricle (LV) enlargement are useful structural biomarkers in distinguishing the preclinical stages of AD. The shape of CC appears to be homogeneous from normal controls to AD images and LV shows shape dissimilarity across subjects. Therefore, effective methods to segment CC and LV are essential to characterize the magnitude of morphometric changes. In this study, an attempt has been made to segment CC and LV from MR brain images using the Spatial Fuzzy Clustering based Level Set (SFC-LS) method. For this, T1-weighted MR images of AD, Mild Cognitive Impairment (MCI), and normal controls are obtained from a public database. Spatial fuzzy clustering forms the initial contour for the level set and regularizes the evolution of curve. The segmented images are validated against ground truth using standard measures. Results indicate that SFC-LS is able to segment CC and LV with automated contour initialization. The final contours obtained are sharp and distinct with a high validation performance of accuracy and specificity greater than 97% for normal controls, MCI, and AD. A dice score of 83% and 84% is achieved in segmenting CC and LV respectively. As structural changes in CC and LV have the potential to predict the early stages of AD, the proposed approach seems to be clinically significant.

Keywords: Alzheimer's Disease; Mild Cognitive Impairment; Magnetic Resonance Imaging; Corpus Callosum; Lateral Ventricles; Spatial Fuzzy Clustering Level Set

INTRODUCTION

Alzheimer's Disease (AD) is the most common type of dementia among the elderly population resulting in progressive and irreversible loss of cognitive functions. It is estimated that by 2050, about 100 million populations worldwide will suffer from AD [1]. Due to the increasing prevalence, accurate diagnosis of the prodromal stage of AD, Mild Cognitive Impairment (MCI), is essential for the possible delaying of progression of the disease [2].

The brain atrophy associated with AD is considered to be an important biomarker in characterizing the disease stages. Studies reveal that the atrophy of the Corpus Callosum (CC) which is the largest white matter tract connecting the two brain hemispheres, is closely associated with AD progression [3], [4]. The atrophy of white and gray matter structures results in the enlargement of Lateral Ventricles (LV) which are located in the center of the brain [2], [5].

Neuroimaging techniques play a vital role in AD diagnosis due to their ability to assess brain tissue changes. Structural Magnetic Resonance Imaging (sMRI) is widely used due to its non-invasive nature