

LATERAL VENTRICLE TEXTURE ANALYSIS IN ALZHEIMER BRAIN MR IMAGES USING KERNEL DENSITY ESTIMATION

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ABSTRACT

Alzheimer's Disease (AD) is an irreversible, progressive neurodegenerative disorder affecting a large population worldwide. Automated diagnosis of AD using Magnetic Resonance (MR) imaging-based biomarkers plays a crucial role in disease management. Compositional changes in cerebrospinal fluid due to AD might induce textural variations in Lateral Ventricles (LV) of the brain. In this work, an attempt has been made to differentiate Alzheimer's condition by quantifying the textural changes in LV using Kernel Density Estimation (KDE) technique. Reaction-Diffusion level set method is used to segment the LV from T1-weighted trans-axial brain MR images obtained from a publically available database. Spatial KDE is used to analyze the local intensity variations within the segmented LV. The optimal kernel function and bandwidth are selected for KDE. The statistical features such as mean, median, standard deviation, variance, kurtosis, skewness and entropy, representing the distribution of KDE values within LV, are evaluated. The extracted KDE-based statistical features show significant discrimination between normal and AD subjects ($p<0.01$). An accuracy of 86.20% and sensitivity of 96% are obtained using SVM classifier. The results indicate that KDE seems to be a potential tool for analyzing the textural changes in brain, and thus can be clinically relevant for diagnosis of AD.

Keywords: Alzheimer's disease, Kernel Density Estimation, Magnetic Resonance Imaging, Texture analysis, Lateral ventricles, Classification

INTRODUCTION

Alzheimer's disease (AD) is the most common form of dementia currently affecting over 47 million people worldwide, and the number is estimated to increase to 130 million by 2030 [1]. This chronic and progressive neurodegenerative disorder induces deterioration in cognitive functions and nerve cell degeneration within the brain tissues of the affected individuals. The changes are irreversible and severely affect their daily functionalities. Clinical confirmation of AD is based on testing the presence of abnormal quantities of Aβ proteins and tau tangles in the cerebrospinal fluid (CSF) and psychological measurement scales such as Clinical Dementia Rating for evaluating the cognitive functionalities [2].

Use of various neuroimaging techniques to identify these changes in the brain can aid in the non-invasive and automated diagnosis of the disease. Magnetic Resonance Imaging (MRI) has been most extensively employed in AD diagnosis as it provides high tissue contrast, spatial resolution and also captures subtle changes in the brain [3].

Textural changes in brain tissues due to AD are reflected as spatial variations in pixel intensities which are primarily caused by the accumulated effects of physiological changes in the tissues. Studies