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REVIEW PAPERS

Alzheimer's disease diagnosis using deep learning techniques: datasets, challenges, research gaps and future directions

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Abstract
Alzheimer's disease (AD) is a condition characterized by the degeneration of brain cells, leading to the development of dementia. Symptoms of dementia include memory loss, communication difficulties, impaired reasoning, and personality changes, often deteriorating as the disease advances. As per the statistics, around 6.9 million individuals in the United States are diagnosed with AD. Approximately two-thirds of Americans with Alzheimer's are female. Of the total population affected, 4.2 million are women, while 2.7 million are men aged 65 and older in the U.S., constituting 11% of women and 9% of men within this age group. While treatment options for AD are available, they primarily aim to address symptoms rather than providing a cure or slowing down the progression of the disease. Several neural network scans play crucial roles in medical diagnostics, including "Magnetic Resonance Imaging (MRI)" and "Positron Emission Tomography (PET)". However, these techniques often involve manual examination, resulting in drawbacks such as slow processing and the risk of human error. This study aims to demonstrate how Artificial Intelligence (AI) techniques, including computer vision, Machine Learning (ML), and Deep Learning (DL), can precisely diagnose the early stages of AD, potentially delaying or preventing disease progression. DL algorithms, known for their ability to handle vast amounts of data and extract relevant features, allow the detection of treatable symptoms of the disease before it reaches irreversible stages. The study begins with an overview of AD and the prevailing methodologies utilized for its early detection. It delves into examining diverse DL techniques in scrutinizing clinical data to identify the disease in its early stages. Further, the study explores various publicly accessible datasets, addressing associated challenges and proposing potential future research directions. A significant contribution of this research lies in introducing holography microscopic medical imaging as a novel approach to AD diagnosis, an area previously unexplored by researchers. The discussion section thoroughly explores different interpretations and implications arising from the conducted study. The second last section addresses ongoing research obstacles and looks at potential avenues for future studies. Ultimately, the study concludes by presenting its findings and considering their implications.

Keywords Alzheimer's disease (AD) · Deep learning (DL) · Early diagnosis · Convolutional neural networks (CNNs) · Recurrent neural networks (RNNs)

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1 Introduction

Alzheimer's disease (AD) is a progressive neurological disease characterized by the gradual degeneration of nerve cells. Its hallmark features include the presence of neuritic plaques [1] and neurofibrillary tangles [2], which result from the accumulation of Amyloid-Beta peptides (Aβ), primarily in the medial temporal lobe and neocortical structures, ultimately leading to cell death [3]. The term "AD" was coined by Emil Kraepelin in the eighth edition of his psychiatry handbook, marking its official recognition as a

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