Chapter 7
Advancements in Medical Imaging:
A Transition From Machine Learning to Deep Learning

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ABSTRACT

Medical imaging holds a pivotal role in modern healthcare, facilitating early disease identification, treatment planning, and patient progress monitoring. The integration of machine learning (ML) has significantly transformed medical imaging, offering automated analysis, pattern recognition, and diagnostic support. However, a notable paradigm shift has emerged in recent times, highlighting the ascendancy of deep learning (DL) techniques, heralding a new era in this field. This exploration scrutinizes the dynamic evolution within medical imaging, accentuating the departure from conventional machine learning methods toward the more advanced domain of deep learning. It scrutinizes the foundational principles of machine learning as applied in medical imaging, shedding light on the constraints that prompted the adoption of deep learning methodologies. Furthermore, the chapter explores the efficacy of deep learning models across diverse medical imaging modalities encompassing MRI, CT scans, X-rays, and ultrasound.

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INTRODUCTION

Medical imaging refers to the methods and procedures employed to produce visual depictions of the internal structures of the body for clinical examination and medical interventions. These visual representations are typically generated using diverse modalities like X-rays, computed tomography (CT), magnetic resonance imaging (MRI), ultrasound, and nuclear medicine. The role of medical imaging is pivotal in diagnosing illnesses, formulating treatment plans, and tracking patient recovery progress. Medical imaging plays a crucial role in modern healthcare by aiding in disease diagnosis, treatment planning, and monitoring patient outcomes (Najjar, 2023). The infusion of technology, particularly machine learning (ML), has reshaped the landscape of medical imaging, facilitating more precise and efficient analysis of complex imaging data.

Machine learning (ML) in medical imaging encompasses the utilization of algorithms and statistical models to automatically analyze and interpret medical images. ML algorithms are trained on extensive datasets of annotated medical images to identify patterns, classify abnormalities, and aid radiologists in diagnosis. ML algorithms can assist in tasks like image segmentation, feature extraction, and image classification, thereby enhancing the efficiency and precision of medical image analysis.

The evolution of machine learning within medical imaging has been impactful, revolutionizing how healthcare professionals interpret and utilize diagnostic images. Conventional ML algorithms laid the groundwork for automating analysis, recognizing features, and creating predictive models, substantially enhancing diagnostic capabilities across diverse imaging methods (Bera et al., 2019; Mahmood et al., 2021).

However, as medical imaging progresses, a noticeable transition has emerged – a shift from traditional machine learning methodologies to the era of deep learning. Deep learning (DL) represents a subset of machine learning that employs artificial neural networks with multiple layers (known as deep neural networks) to learn intricate patterns and representations directly from data. In medical imaging, deep learning algorithms excel in extracting complex features from images, enabling highly accurate and automated analysis. Deep learning models can acquire hierarchical representations of medical images, leading to cutting-edge results in tasks such as tumor detection, organ segmentation, and disease prognosis.

Deep learning techniques, particularly neural networks like recurrent neural networks (RNNs) and convolutional neural networks (CNNs), have emerged as powerful tools for identifying intricate patterns, reconstructing images, performing segmentation, and achieving exceptional accuracy in image-based diagnoses (Bhattacharya et al., 2021; Panayides et al., 2020).