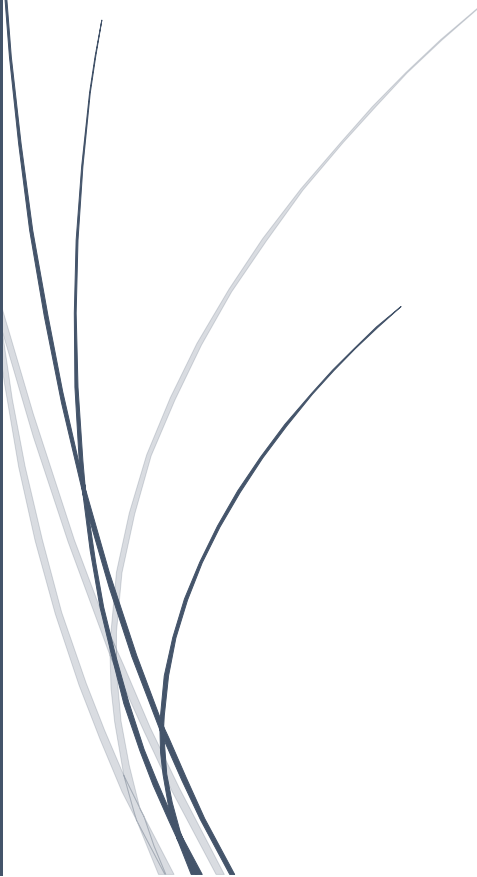


The logo for RADemics, featuring a dark blue vertical bar on the left and a blue arrow pointing right with the text "RADemics" inside.

RADemics

AI Driven Medical Imaging and Computer Vision Techniques for Enhanced Disease Diagnosis and Treatment Planning

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AI Driven Medical Imaging and Computer Vision Techniques for Enhanced Disease Diagnosis and Treatment Planning

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Abstract

Advancements in artificial intelligence (AI) and computer vision have significantly transformed medical imaging, offering innovative tools for early disease detection, accurate diagnosis, and effective treatment planning. The integration of AI models with multi-modal imaging techniques has enabled the automated extraction, interpretation, and fusion of complex biomedical data, surpassing the limitations of conventional diagnostic workflows. This chapter explores the evolving role of AI-driven computer vision technologies in enhancing clinical decision-making by leveraging deep learning architectures, multi-scale feature representation, and real-time analytics. Particular focus is given to the fusion of imaging data with clinical and genomic information, facilitating personalized healthcare through precise risk stratification and targeted therapy recommendations, it addresses the challenges in data harmonization, model interpretability, and deployment across diverse clinical environments. The potential of multimodal digital twins, graph neural networks, and hybrid fusion architectures is examined as future directions for achieving predictive and patient-specific care. Through a comprehensive analysis of methodologies, applications, and benchmarking strategies, this chapter underscores the transformative impact of AI and computer vision in modern medical imaging systems. Emphasis is placed on the need for standardized datasets, transparent evaluation metrics, and collaborative research efforts to drive the next generation of intelligent healthcare technologies.

Keywords: Artificial Intelligence, Computer Vision, Medical Imaging, Multi-modal Data Fusion, Personalized Diagnosis, Clinical Decision Support

Introduction

The rapid evolution of artificial intelligence (AI) and computer vision has significantly advanced the field of medical imaging, enabling healthcare systems to move beyond conventional diagnostic techniques [1]. Medical imaging, long reliant on the expertise of radiologists for interpretation, is now being augmented by machine learning models capable of identifying complex patterns, anomalies, and correlations across vast datasets [2]. This paradigm shift stems from the increasing availability of digital imaging repositories, advancements in computing power,

and the development of sophisticated algorithms capable of learning from annotated clinical data [3]. As a result, diagnostic processes have become faster, more consistent, and scalable across various healthcare environments [4]. These developments are particularly valuable in settings where access to specialized clinicians is limited, offering an opportunity to bridge healthcare disparities through intelligent automation [5].

AI-driven models in imaging utilize deep learning, especially convolutional neural networks (CNNs), to perform tasks such as lesion detection, organ segmentation, and image classification with high levels of accuracy [6]. These models have demonstrated expert-level performance in identifying diseases like pneumonia, brain tumors, diabetic retinopathy, and cancers across multiple organ systems [7]. Computer vision plays a central role in extracting spatial and structural information from imaging modalities such as MRI, CT, ultrasound, and PET [8]. This enables the quantification of pathological features and supports evidence-based decisions in diagnosis and treatment [9]. As these systems continue to be trained on increasingly diverse datasets, their generalization capabilities improve, enhancing their reliability across different demographic populations and clinical institutions [10].