



# Deep learning in medicine: advancing healthcare with intelligent solutions and the future of holography imaging in early diagnosis

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## Abstract

Deep Learning (DL) is currently transforming health services by significantly improving early cancer diagnosis, drug discovery, protein–protein interaction analysis, and gene editing. The main purpose of this review study is to explore how the integration of the analytical capabilities of DL with medical datasets contributes to advancements in healthcare services. The scope of this study revolves around emphasizing the impact of DL strategies in contributing to healthcare services. It underscores how DL algorithms significantly improve accuracy in medical data analysis, helping diagnosis and treatment planning. It also highlights how integrating Artificial Intelligence (AI) with medical datasets can profoundly impact robotic surgery. The primary findings of the study involve exploring emerging ideas within this integrative field, particularly focusing on the roles of holography microscopic medical imaging and attention models in early disease identification. Also, the study examines Federated Learning (FL) concepts, with the primary focus on addressing the ethical implications of medical-related datasets. The authors further examine how Explainable AI (XAI) techniques such as Gradient-weighted Class Activation Mapping (Grad CAM), assist medical professionals in understanding the decision-making processes of AI algorithms promoting transparency and informed decision-making. After conducting an extensive review of DL in medicine, the authors have identified the challenges associated with this integrative journey and suggested emerging future research directions for researchers interested in this field.

**Keywords** Artificial Intelligence (AI) · Deep Learning (DL) · Neural Networks · Early diagnosis · Image Processing · Explainable AI (XAI) · Holography microscopic medical imaging

## 1 Introduction

Artificial Intelligence (AI) has significantly advanced the field of medicine through its contributions to diagnostics and disease prediction, thereby enhancing patient well-being [1]. The progress in AI technology has facilitated the practical analysis of volumetric and diverse patient datasets, including medical images, genetic information, and Electronic