

Applications of Artificial Intelligence in Medical Image Analysis

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1. Introduction

Artificial Intelligence (AI) is a transformative technology producing fundamental changes in many fields. In medical imaging, AI is having a significant effect on how medical images are acquired, processed, interpreted, and utilized in clinical practice [1]. Recent advances in machine learning, deep learning, transformer architectures, and foundation models have enabled remarkable progress across a broad range of applications, including disease classification, image segmentation, image reconstruction, and computer-aided diagnosis. At the same time, the increasing availability of multimodal imaging data and large-scale medical datasets has further accelerated innovation in AI-driven medical image analysis.

In response to these developments, this Special Issue, “Applications of Artificial Intelligence in Medical Image Analysis”, was launched to provide an interdisciplinary platform for presenting recent advances in AI methodologies and their applications to medical imaging. The scope intentionally encompassed a wide spectrum of topics, including deep learning and machine learning, image segmentation and reconstruction, multimodal image analysis, radiomics, real-world data (RWD), explainable AI, validation, standardization, and clinical implementation. By bringing together researchers from engineering, computer science, and clinical medicine, the Special Issue aims to encourage interdisciplinary collaboration and to bridge the gap between methodological innovation and practical healthcare applications.

This Editorial provides an overview of the contributions published, and discusses the current trends revealed by these articles. In addition to summarizing the individual articles, we highlight emerging directions in AI-based medical image analysis and consider the remaining challenges toward clinical translation and real-world implementation. Together, these studies demonstrate not only the rapid evolution of AI technologies but also the increasing convergence of engineering, computer science, and clinical medicine in addressing real-world challenges in medical imaging.

2. Overview of the Published Papers

This Special Issue includes eleven original research articles and one systematic review covering a broad spectrum of AI applications. Table 1 summarizes the characteristics of the original articles, including their clinical targets, imaging modalities, AI methodologies, input data types, and dataset sources. These articles collectively demonstrate the diversity of current AI research, encompassing a wide range of clinical applications, imaging modalities, computational approaches, and data resources.



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Table 1. Overview of the original research articles published in this Special Issue.

Ref	Target	Modality	Input	AI Task	AI Method	Dataset
[2]	Acute coronary syndrome	ECG	Image	Generation	Generative AI	Institutional
[3]	Alzheimer’s disease	MRI	Image	Classification	Hybrid DL–ML	Public
[4]	Breast cancer	FNA-derived features	Table	Classification	ML	Public
[5]	Fundus disease	FFA	Image	Classification	CNN	Public
[6]	Melanoma	Histopathological images	Image	Classification	Hybrid DL–ML	Single-center
[7]	Skin cancer and brain tumor	MRI and skin photography	Image	Classification	CNN	Public
[8]	Colorectal cancer	MSI	Spectral	Classification	Foundation model	Single-center
[9]	Kidney disease	CT	Image	Classification	Hybrid DL–ML	Public
[10]	Oral cancer	Histopathological images	Image	Classification	Transformer	Public
[11]	Prostate	MRI	Image	Segmentation	CNN	Public
[12]	Glaucoma	Fundus photography	Image	Classification	CNN	Public

Abbreviations: AI, artificial intelligence; ECG, electrocardiography; MRI, magnetic resonance imaging; DL, deep learning; ML, machine learning; FNA, fine needle aspiration; FFA, fluorescein fundus angiography; CNN, convolutional neural network; MSI, mass spectrometry imaging; CT, computed tomography.

Among the published studies, image classification was the predominant AI task, accounting for nine of the eleven original articles [3–10,12]. These studies addressed a wide variety of clinical problems across neurodegenerative, oncological, ophthalmological, and renal diseases. In addition to classification, one study focused on image segmentation [11], while another explored the application of generative AI for cardiovascular medical education [2].

From a methodological perspective, this Special Issue reflects the ongoing diversification of AI technologies in medical imaging. Although convolutional neural network (CNN)-based approaches remained the most commonly adopted methodology [5,7,11,12], conventional machine learning [4] and hybrid deep learning–machine learning frameworks [3,6,9] also played important roles. Furthermore, transformer-based architectures [10], foundation models [8], and generative AI [2] were represented, illustrating the increasing diversity of AI methodologies applied to medical imaging. Collectively, these contributions highlight the rapid evolution of AI methodologies beyond conventional CNNs.

Regarding the datasets used, six studies utilized publicly available datasets [3–5,7,9–12], whereas only three studies employed institutional or single-center clinical datasets [2,6,8]. This distribution indicates that publicly available benchmark datasets continue to serve as the primary resource for developing and evaluating AI models in medical imaging. This balance between benchmark datasets and institutional clinical data provides useful insight into the current landscape of AI research in medical imaging.

3. Emerging Trends Revealed by This Special Issue

The articles published in this Special Issue collectively demonstrate the rapid diversification of AI methodologies. While CNNs remain widely adopted, the inclusion of hybrid deep learning–machine learning frameworks, transformer-based architectures, foundation models, and generative AI reflects the expanding range of computational approaches available for medical image analysis. Rather than converging toward a single dominant methodology, AI research is evolving toward selecting the most appropriate techniques according to specific clinical tasks and data characteristics. The accompanying systematic

review further reinforces this trend by demonstrating that recent AI research is extending beyond the development of novel model architectures toward practical considerations for clinical deployment [13]. In particular, the increasing attention to neural network quantization reflects growing recognition that model efficiency, computational cost, and hardware compatibility are becoming as important as predictive performance. These findings suggest that future advances in medical AI will be driven not only by methodological innovation but also by technologies that facilitate robust and scalable implementation in real-world clinical environments.

4. Challenges Toward Clinical Translation

Despite the remarkable progress of AI technologies, successful clinical translation requires more than improvements in algorithmic performance. A joint multi-society statement published by leading radiological organizations emphasized that AI should be regarded as a human-centered technology designed to support, rather than replace, clinical decision-making. The statement further highlighted that responsibility and accountability for AI-assisted decisions remain with human designers and healthcare professionals, underscoring the importance of transparency, reliability, and ethical implementation in clinical practice [14]. These principles remain highly relevant today. As highlighted in a recent systematic review of continual learning in medical image analysis [15], maintaining AI performance in real-world clinical environments requires continuous validation against evolving data distributions, accumulation of clinical evidence, and adaptation to new clinical scenarios. Rather than developing algorithms that perform well only in controlled research settings, future AI systems should be designed to support sustainable deployment through real-world validation and continuous performance improvement. Continual learning represents one promising approach toward achieving this goal by enabling AI systems to evolve alongside clinical practice while preserving previously acquired knowledge. Despite the fact that many controversies remain regarding the objectivity and overuse of such systems [16], their clinical deployment is accelerating.

As AI methodologies continue to diversify and mature, future efforts should prioritize clinically meaningful system integration rather than technology-driven development alone.

5. Conclusions

Although remarkable progress has been achieved in AI algorithm development, translating these advances into robust and clinically deployable systems remains one of the most important challenges in medical imaging. The studies included in this Special Issue provide valuable insights into both the current achievements and the future direction of AI toward routine clinical practice.

Building upon these advances, a second edition of this Special Issue, “AI in Medical Imaging: From Algorithms to Clinical Practice”, has been launched to further explore the translation of AI technologies into real-world healthcare [17]. We hope that this new edition will continue to promote interdisciplinary collaboration among clinicians, engineers, computer scientists, and industry partners, ultimately accelerating the development of trustworthy, clinically relevant, and deployable AI systems for medical imaging.

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