SCMPCR
South Asia Centre for Medical Physics and Cancer Research
SCMPCR Newsletter
A sister organization of Alo-BT
February 2026 / Volume 8 / Issue 1
QUALITY EDUCATION AND HEALTH SCIENCE FOR PATIENT BENEFIT

General Article

Beyond the Algorithm: The Multidisciplinary Role of AI Researchers in Medical Physics

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Introduction: We are currently witnessing a paradigm shift in healthcare often described as the "Golden Age" of Artificial Intelligence (AI). For decades, medical physics has relied on computational modeling to understand radiation interactions and imaging mechanics. However, the role of the AI researcher in this field has evolved from simple automation to becoming a critical partner in clinical decision-making. Today, AI researchers are not merely writing code; they are solving the "last mile" problems in radiation oncology and diagnostic imaging, translating complex deep learning theories into life-saving clinical tools.

Contribution of Human Element: A multidisciplinary approach to successful AI implementation is never the work of a single profession; it requires a robust ecosystem of human resources. The "AI Researcher" acts as the architect, designing models (such as U-Nets or GANs) that can interpret complex medical data. However, this work is impossible without a multidisciplinary team:

- **Medical Physicists:** They act as the bridge between code and clinic, performing rigorous Quality Assurance (QA) to ensure the AI's output is physically possible and safe for patient use.
- **Radiation Oncologists & Radiologists:** These specialists provide the "Ground Truth" the expert-labeled data required to train algorithms. Without their high-quality inputs, even the most advanced model will fail ("Garbage In, Garbage Out").
- **Radiation Therapists (RTTs):** As the frontline users, they validate whether an AI tool (like auto-contouring) actually saves time in a real-world workflow or merely adds complexity.
- **IT & PACS Specialists:** They ensure the seamless flow of data between the AI server and the hospital's image database, a critical often-overlooked role.

Transforming Radiation Therapy: The most immediate contribution of AI researchers lies in radiation therapy planning. Historically, contouring Organs at Risk (OAR) and tumor targets was a labor-intensive manual process. Recent advancements in Deep Learning, specifically convolutional neural networks (CNNs), have enabled the automation of this task with sub-millimeter accuracy. Current research in 2025 is moving beyond simple segmentation. AI researchers are now developing generative models, such as Generative

Adversarial Networks (GANs), to create "synthetic CT" scans from MRI data. This innovation allows patients to receive radiation plans based on MRI soft-tissue contrast without requiring the additional radiation dose of a planning CT scan. Furthermore, Reinforcement Learning (RL) agents are being deployed to optimize dose distribution, effectively "playing" the treatment planning game to maximize tumor control while sparing healthy tissue.

Revolutionizing Diagnostic Imaging: In diagnostic physics, the focus has shifted toward image reconstruction and quality assurance (QA). AI researchers are developing algorithms that can reconstruct high-fidelity images from sparse data, enabling faster MRI scans and lower-dose CT protocols without compromising diagnostic quality.
A critical area of contribution is "predictive maintenance." By analyzing the vast streams of log data from linacs and scanners, AI models can now predict equipment failures before they occur, ensuring that treatment schedules remain uninterrupted. This shift from reactive to proactive QA is a direct result of collaboration between computer scientists and clinical physicists.

The Generative Frontier: The newest frontier for AI researchers is Generative AI and Large Language Models (LLMs). Beyond pixels, these models are now being adapted to handle multimodal data combining images, patient history, and genomic data into a single diagnostic reasoning engine. Researchers are exploring how these models can draft medical notes, summarize complex patient histories for tumor boards, and even simulate patient physiology as "Digital Twins" to test treatment outcomes virtually before physical application.

Conclusion: The integration of AI into medical physics is no longer a futuristic concept; it is a clinical reality. However, this power comes with responsibility. The primary role of the AI researcher today is to ensure these systems are safe, explainable, and equitable. By collaborating closely with medical physicists, AI researchers can ensure that the algorithms of tomorrow do not just process data, but truly care for patients.

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