Mini Review
Volume 10:3, 2023

Journal of Biomedical Systems & Emerging Technologies

ISSN: 2952-8526 Open Access

Emerging Applications of Artificial Intelligence in Biomedical Imaging: Challenges and Opportunities

Mohamed Akram*

Department of Science, University of Chittagong, Chittagong, Bangladesh

Abstract

Artificial Intelligence (AI) has emerged as a transformative technology in various industries and its impact on biomedical imaging is no exception. In recent years, AI has shown great promise in revolutionizing the field of medical imaging, enabling more accurate diagnoses, personalized treatments and improved patient outcomes. This review explores the emerging applications of AI in biomedical imaging, delving into the challenges and opportunities it presents for the future of healthcare.

Keywords: Artificial intelligence • Healthcare • Biomedical imaging

Introduction

Biomedical imaging plays a pivotal role in modern medicine, enabling clinicians to visualize and analyze internal structures and processes non-invasively. From X-rays and Computed Tomography (CT) scans to Magnetic Resonance Imaging (MRI) and positron emission tomography (PET), medical imaging technologies provide valuable insights into the human body's intricacies [1]. However, the analysis of medical images can be time-consuming and subject to human error, leading to challenges in clinical decision-making. This is where AI steps in to revolutionize the field.

Literature Review

Emerging applications of AI in biomedical imaging

Image reconstruction and enhancement: AI algorithms, particularly those based on deep learning techniques, have shown remarkable results in image reconstruction and enhancement. These techniques can reconstruct high-quality images from limited or noisy data, enabling faster and lower-dose scans in various imaging modalities. AI-based image denoising, artifact correction and resolution enhancement have the potential to improve image quality, thus aiding radiologists and clinicians in making more accurate diagnoses.

Image segmentation and annotation

Segmentation and annotation of medical images are essential for identifying and delineating specific anatomical structures or regions of interest. AI-powered segmentation algorithms can automatically delineate organs, tumors and lesions, reducing the manual effort required by radiologists and improving the consistency and reproducibility of results [2]. This capability is particularly crucial in radiation therapy planning, surgical navigation and longitudinal disease monitoring.

***Address for Correspondence:** Mohamed Akram, Department of Science, University of Chittagong, Chittagong, Bangladesh, E-mail: akram0914@cu.ac.bd*

Received: 01 May, 2023, Manuscript No. bset-23-108815; **Editor assigned:** 02 May, 2023, PreQC No. P-108815; **Reviewed:** 08 June, 2023, QC No. Q-108815, **Revised:** 16 June, 2023, Manuscript No. R-108815; **Published:** 23 June, 2023, DOI: 10.37421/2952-8526.2023.10.171

Computer-aided detection and diagnosis

AI has demonstrated impressive capabilities in computer-aided detection (CAD) and diagnosis, where algorithms can identify and flag abnormalities in medical images. For instance, AI-driven CAD systems can assist in the early detection of cancerous lesions, such as breast masses or lung nodules, leading to timely interventions and improved patient outcomes. Furthermore, AI-based diagnostic tools can aid in differentiating between benign and malignant conditions, helping clinicians in treatment planning and decision-making.

Radiomics and predictive modeling

Radiomics is an emerging field that involves the extraction of a large number of quantitative features from medical images, which can then be correlated with clinical outcomes and treatment responses. AI-driven predictive modeling techniques can analyze these radiomic features to predict disease progression, therapeutic responses and overall patient prognosis [3]. Such predictive models hold great potential for personalized medicine, allowing clinicians to tailor treatment plans based on an individual's unique characteristics and predicted outcomes.

Image registration and fusion

AI-based image registration and fusion techniques aim to combine information from multiple imaging modalities or timepoints, providing a more comprehensive view of the patient's condition. These techniques can aid in the integration of data from various imaging modalities, such as MRI and PET, for better disease characterization and treatment planning. Additionally, image fusion can enable the comparison of pre- and post-treatment images, facilitating the assessment of treatment efficacy and disease progression.

Challenges in the application of ai in biomedical imaging

Data quality and quantity: The success of AI algorithms heavily relies on the availability of high-quality and diverse training data. In biomedical imaging, obtaining annotated datasets can be challenging due to privacy concerns, data sharing limitations and the need for expert annotations. Additionally, certain medical conditions might have limited data availability, leading to potential biases and generalization issues in AI models. Efforts to curate large and diverse datasets, while ensuring data privacy and security, are essential to overcome these challenges.

Interpretability and explainability

AI models, particularly deep learning-based approaches, are often considered black boxes, as they lack transparency in their decision-making processes. In critical medical applications, interpretability and explainability are vital to gain the trust of clinicians and patients [4]. Understanding how AI models arrive at their conclusions and identifying the key features driving their decisions is crucial for the adoption of AI in clinical practice. Research into explainable AI methods is an ongoing area of exploration in biomedical imaging.

Validation and clinical integration

Validating AI algorithms for clinical use is a complex process, involving rigorous evaluation against gold-standard diagnostic criteria and comparison with expert radiologists' performance. Regulatory approvals and standards for AI-based medical devices pose additional challenges, as they require robust evidence of safety, efficacy and clinical utility. Collaborative efforts between AI developers, clinical researchers and regulatory authorities are necessary to establish the clinical validity and effectiveness of AI in biomedical imaging.

Ethical and legal concerns

The use of AI in medical imaging raises ethical and legal considerations, particularly regarding patient privacy, data ownership and liability. Ensuring data privacy and security while using AI models in real-world clinical settings is of utmost importance to protect patient information [5,6]. Additionally, issues related to bias and fairness in AI algorithms must be addressed to prevent disparities in healthcare outcomes based on demographic factors. Ethical frameworks and guidelines for AI applications in medicine should be developed and adhered to by all stakeholders.

Discussion

Multimodal imaging and integrative AI

The integration of AI with multimodal imaging techniques holds significant promise for comprehensive disease assessment. Combining information from different imaging modalities, genomics and clinical data can provide a holistic view of the patient's condition and treatment response. Integrative AI models that analyze data from diverse sources can potentially enhance diagnostic accuracy, identify novel biomarkers and facilitate precision medicine approaches.

Real-time image analysis and clinical decision support

AI-driven real-time image analysis can empower clinicians with immediate insights during procedures and interventions. For instance, AI-based image analysis during surgery or interventional procedures can assist in real-time decision-making, enabling more precise and targeted interventions. Additionally, AI-powered clinical decision support systems can provide evidence-based recommendations to guide treatment planning and patient management, improving clinical outcomes and reducing medical errors.

AI in remote and resource-limited settings

AI has the potential to bridge the gap in healthcare access between urban centers and remote or resource-limited regions. Portable and cloud-based AI solutions can be deployed in telemedicine and mobile health applications, enabling access to expert diagnostic support and personalized treatment recommendations. In regions with limited access to radiologists and specialized imaging facilities, AI can serve as a valuable tool to augment local healthcare capacities.

Longitudinal monitoring and predictive analytics

AI-based predictive models, combined with longitudinal imaging data, can support proactive patient management and disease monitoring. By analyzing patterns in longitudinal imaging data, AI can identify subtle changes indicative of disease progression or treatment response. These insights can aid in early intervention and personalized treatment adjustments, ultimately leading to improved patient outcomes.

AI for drug discovery and therapeutics

Beyond imaging, AI can play a crucial role in drug discovery and therapeutics. AI algorithms can analyze vast amounts of biomedical data, such as genomic profiles and drug-target interactions, to identify potential drug candidates and personalized treatment regimens. By combining imaging data with other patient-specific information, AI can facilitate the development of targeted therapies and precision medicine approaches.

Conclusion

AI's emerging applications in biomedical imaging present a transformative opportunity to enhance healthcare delivery, improve patient outcomes and advance medical research. From image reconstruction and segmentation to computer-aided diagnosis and predictive modeling, AI holds the potential to revolutionize clinical practice and usher in a new era of personalized medicine. However, several challenges, such as data quality, interpretability, validation and ethical concerns, must be addressed to unlock the full potential of AI in healthcare. Collaborative efforts between researchers, clinicians, industry stakeholders and regulatory authorities are essential to overcome these challenges and harness the full benefits of AI in biomedical imaging. As AI continues to evolve, it is imperative to maintain a patient-centric approach, ensuring that AI technologies are safe, effective and ethically deployed to improve global health outcomes.

Acknowledgement

None.

Conflict of Interest

None.

References

1. Nahavandi, Darius, Roohallah Alizadehsani, Abbas Khosravi and U. Rajendra Acharya. "Application of artificial intelligence in wearable devices: Opportunities and challenges." *Comput Methods Programs Biomed* 213 (2022): 106541.

2. Zhang, Jing and Dacheng Tao. "Empowering things with intelligence: A survey of the progress, challenges and opportunities in artificial intelligence of things." *IEEE Internet Things J* 8 (2020): 7789-7817.

3. Christou, Chrysanthos D. and Georgios Tsoulfas. "Challenges and opportunities in the application of artificial intelligence in gastroenterology and hepatology." *World J Gastroenterol* 27 (2021): 6191.

4. Rahmim, Arman, Tyler J. Bradshaw, Irène Buvat and Joyita Dutta, et al. "Issues and Challenges in Applications of Artificial Intelligence to Nuclear Medicine--The Bethesda Report (AI Summit 2022)." *arXiv preprint arXiv:2211.03783* (2022).

5. Petersen, Steffen E., Musa Abdulkareem and Tim Leiner. "Artificial intelligence will transform cardiac imaging—opportunities and challenges." *Front Cardiovasc Med* 6 (2019): 133.

6. Manickam, Pandiaraj, Siva Ananth Mariappan, Sindhu Monica Murugesan and Shekhar Hansda, et al. "Artificial Intelligence (AI) and Internet of Medical Things (IoMT) assisted biomedical systems for intelligent healthcare." *Biosensors* 12 (2022): 562.

How to cite this article: Akram, Mohamed. “Emerging Applications of Artificial Intelligence in Biomedical Imaging: Challenges and Opportunities.” *J Biomed Syst Emerg Technol* 10 (2023): 171.