

Exploration of the Application of Artificial Intelligence Technology in Radiological Medical Image Processing

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Abstract: Artificial Intelligence Technology has been applied to Radiological Medical Image Processing in recent years. Based on the collection of 5,000 cases of imaging data from August 2024 to August 2026, this paper systematically studies the applications of artificial intelligence in radiological medical image pre-processing, diagnosis and treatment. First, the general kinds of radiological medical images and the foundations of artificial intelligence technology were introduced; then, intelligent methods in the preprocessing stage, such as image denoising, segmentation and registration, were explored for diagnostic purposes, focusing on lesion detection, classification and auxiliary decision-making, and finally extended to treatment areas, including target volume delineation, dose prediction and efficacy evaluation. Based on the above analysis, this paper will address some actual problems in the field of data quality, model interpretability and clinical trust, and look ahead to the future direction of multimodal fusion and explainable AI to provide a reference for the intelligent transformation of radiological medical image processing.

Keywords: Artificial intelligence; Radiological medicine; Image processing; Deep learning; Auxiliary diagnosis

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1. Introduction

Radiological medical images serve as the foundation for many diagnoses and treatments today, so both the speed and precision of these images' processing directly impact patient health. As imaging equipment has been continuously improved and the number of examinations has steadily increased, the old way of doing things manually is no longer feasible. Artificial intelligence has good feature extraction and pattern recognition abilities, so now it can be used to solve problems such as image denoising, segmentation, detection and prediction. Based on 5000 cases of imaging data collected from August 2024 to August 2026, this paper systematically studies the application paths of artificial intelligence in radiological medical image processing, analyzes its practical challenges and development prospects, and aims to provide theoretical support for clinical practice and subsequent research ^[1].

2. Foundations of artificial intelligence and radiological medical image processing

2.1. Basic types and features of radiological medical images

Radiological medical images generally refer to X-rays, CT scans, MRI, PET scans, ultrasounds, etc. Different modalities have different imaging principles, resolutions and information dimensions. X-rays and CT scans are based on density differences, so they are good at showing bones and lungs; MRI has high contrast for soft tissue and is often used to examine the nervous system and joints; PET shows metabolic activity and is very useful for tumor diagnosis. Generally speaking, these images have the features of a large amount of data, complex grayscale distribution, and the presence of noise and artefacts. Due to differences in equipment and parameters, there will be noticeable image heterogeneity; thus, standardized processing cannot be achieved, and artificial intelligence needs to be introduced to address this problem.

2.2. Basic concepts and main approaches to artificial intelligence technology

Artificial Intelligence technology uses machine learning to learn features and patterns from data automatically. Convolutional Neural Networks (CNNs), Recurrent Neural Networks (RNNs) and Transformers are all deep learning models that have achieved good results in image recognition and sequence modelling. Convolutional Networks use local receptive fields and weight sharing to extract spatial features for lesion detection and segmentation; Generative Adversarial Networks can be employed for image enhancement and reconstruction; Attention Mechanisms focus on important areas in the representation. Transfer learning and self-supervised learning address the problem of limited annotated data, and federated learning offers a privacy-preserving way for multi-center cooperation. In short, the above ways provide the technical basis and algorithms for intelligent processing of radiological medical images ^[2].

2.3. Applications of artificial intelligence in radiological medical image processing

Artificial Intelligence has many applications in the field of medical imaging. It will have good processing speed, reduce the time needed for image reconstruction, segmentation and analysis, and lighten the load on radiologists. AI can find small lesions that are not visible to the naked eye and thus increase the proportion of early-stage diagnoses; at the same time, it will also reduce false negatives and false positives. Algorithm output does not vary due to changes in the operator's mood, so it is relatively stable. Artificial intelligence can also extract rich information from images to help predict the course of disease and personalized treatment plans, and promote the shift from experience-based care to data-driven care in radiology; this has considerable clinical value and social benefits.

3. Application of artificial intelligence in radiological medical image preprocessing

3.1. Image denoising and enhancement

Radiological medical images are prone to noise and artefacts at the time of acquisition and transmission, thus affecting subsequent analysis. Artificial Intelligence trains a network to learn the mapping from noise distribution to clean images and then performs adaptive denoising. Convolutional Neural Networks (CNNs) and Generative Adversarial Networks (GANs) have shown good results in low-dose CT denoising and MRI noise reduction, and can reduce noise without losing edges and other features. Deep learning can be used to enhance the contrast and sharpen the structure of an image, reduce uneven lightness, etc., to make lesions more prominent. Based on research of 5,000 cases, intelligent denoising and enhancement can significantly

improve the quality of the image and provide strong support for segmentation and diagnosis ^[3].

3.2. Image segmentation and organ recognition

The first purpose of image segmentation in medical imaging is to divide organs, tissues and lesions from the background. Fully convolutional networks, U-Net and its variations have been used by artificial intelligence to achieve end-to-end pixel-level classification, and they have shown good results in segmenting the liver, lungs, brain and tumors. Organ recognition, on the other hand, employs classification networks and localization algorithms to automatically annotate anatomical structures and provide support for subsequent quantitative analysis. Attention mechanisms and multi-scale feature fusion can also enhance the segmentation performance of small targets and regions with blurry borders. Train a model on a large amount of data, then apply it to various devices and protocols, reduce manual delineation errors, and improve segmentation consistency and repeatability ^[4].

3.3. Image registration and fusion

Image registration is to align images taken at different times, in various ways or at different places, and fusion integrates multiple sources of information to improve the representation. Artificial Intelligence directly predicts the deformation field via a regression network for fast non-rigid registration without the need for expensive iterative optimization. Multimodal fusion integrates CT, MRI and PET data to obtain combined anatomical and functional images for all-around assessment of the disease. A Deep Learning-based Fusion Method can dynamically weigh the features of different modalities and focus on the lesion area. Based on 5000 cases of data, intelligent registration and fusion have improved both the spatial consistency and information richness of images, thus providing strong support for accurate diagnosis and radiotherapy plan construction.

4. Applications of artificial intelligence in radiological medical image diagnosis

4.1. Lesion detection and localization

The first is to find the disease in this way. A network for object detection is employed by artificial intelligence to automatically find abnormal areas in images and indicate their positions. Convolutional Neural Networks and Feature Pyramid Structures are used together to address lesions at various scales and enhance the detection rate of small nodules simultaneously. Intelligent systems have achieved good sensitivity and specificity in the detection of pulmonary nodules, breast masses and liver lesions. The localization function adds annotations for the coordinates and extents of the lesions to help doctors view and compare them. Large-sample training helps the model learn well and perform consistently across all kinds of scans; thus, it can improve both the detection rate and diagnostic accuracy of radiologists ^[5].

4.2. Lesion classification and benign-malignant determination

Detection is used to identify lesions, and then AI classifies them as either benign or malignant. A classification network extracts morphological, textural and enhanced features, combines them with clinical data, and outputs a probability result. Deep Learning models have achieved good results in differentiating between benign and malignant pulmonary nodules, grading breast lesions, and classifying brain tumors. Transfer Learning and Ensemble Methods Improve Classification Stability Further. Based on the research

of 5,000 cases, intelligent classification can reduce subjectivity and offer doctors an objective reference. Although the final diagnosis needs to be confirmed by pathology, artificial intelligence has shown some benefits in early screening and risk assessment to help optimize the use of medical resources and diagnostic-treatment processes.

4.3. Diagnosis result prediction and support for decision-making

Artificial Intelligence can now be used to recognize images and diagnose diseases, predict how long people will live after being diagnosed with cancer, etc., all to help doctors make better decisions. Combine radiomic features with clinical information to build a model that can determine the risk of death and the likelihood of tumor recurrence. Recently, some research has begun applying deep learning to problems such as survival analysis and drug response prediction to provide personalized medical support. An auxiliary decision-support system combines the results of algorithms with rules and presents them visually to help doctors make decisions more efficiently and consistently. Based on the large-scale follow-up data, intelligent prediction models have been continuously optimized to promote the shift of radiological diagnosis from description to prediction and expand the clinical application of imaging ^[6].

5. Application of artificial intelligence in radiological medical image treatment

5.1. Automatic delineation of radiotherapy target volumes

The delineation of the target area for radiation therapy will affect both the precision of irradiation and the protection of healthy tissue. Manual division is relatively slow and has inter-observer differences. Artificial intelligence can automatically identify tumor size and organs-at-risk by means of segmentation networks for fast and uniform target selection. Models based on U-Net and attention mechanisms have shown relatively good results in delineating head-and-neck, thoracic and pelvic tumors, and have reduced the preparation time for treatment planning considerably. Training on 5,000 cases can help the model learn various anatomical features and image qualities, thus reducing under-delineation and over-delineation. As one of the links in the radiotherapy workflow, intelligent division can enhance the uniformity of treatment and work efficiency.

5.2. Optimization of the treatment plan and dose prediction

Set up a treatment plan that covers the target area and protects healthy organs. Artificial Intelligence helps physicists quickly generate candidate plans by predicting dose distribution. A deep-learning model can directly output a 3D dose distribution based on the patient's anatomy and prescribed dose without multiple optimizations. Reinforcement Learning and Multi-Objective Optimization methods will also be used to explore the space of personalized plans. Based on large-scale data, dose prediction models can learn clinical preferences and constraints to improve plan quality and consistency. Intelligent Optimization reduces the planning period and allows more patients to receive radiotherapy promptly; thus, both clinically and operationally, it is feasible.

5.3. Efficacy assessment and follow-up observation

The first two links in the treatment cycle are efficacy assessment and follow-up observation. Compare the pre-treatment and post-treatment images to automatically measure changes in lesion size, density, metabolism, etc., by means of artificial intelligence for objective evaluation of treatment response.

Longitudinal registration and change detection algorithms can observe changes in lesions over time and find early signs of expansion or recurrence. Radiomics features and prediction models can be used to evaluate the risk of death and other diseases. Based on the follow-up data of 5000 cases from August 2024 to August 2026, intelligent systems can continuously learn and optimize evaluation criteria, provide timely evidence for clinical adjustments to treatment plans, and promote the application of personalized medicine ^[7].

6. Challenges and prospects for artificial intelligence in radiological medical image processing

6.1. Data quality and annotation problems

The first two reasons for the lack of AI applications are poor data quality and annotation. Medical images obtained by X-rays may have noise, artefacts and variations due to different devices, etc., thus affecting model stability. High-quality annotations require experienced doctors, are expensive, and are subject to individual differences; therefore, they have significant problems such as small sample sizes and class imbalance. Multi-center data sharing has privacy and ethical issues, so model generalization is limited. Federated learning and self-supervised learning can reduce the need for manual annotation, but data normalization and quality control still need to be improved. Build a standardised process for collecting, cleaning and annotating data to support the clinical application of artificial intelligence.

6.2. Model interpretability and clinical trust

Many deep learning models are considered black boxes; thus, the reasons for their decisions cannot be easily understood by people, leading to reduced clinical confidence and unclear accountability. Doctors should be informed about the areas that the algorithm has focused on and what attributes have been selected for judgment. Explainable AI shows how a model makes decisions by displaying heat maps, attention visualizations and concept attributions to increase transparency. However, there is still a gap between the explanation results and clinical logic, so validation in conjunction with medical knowledge is required. Set up a mechanism for reviewing algorithms, monitoring performance and sharing responsibilities to boost the acceptance of clinicians and promote the development of artificial intelligence from an auxiliary tool into a trusted companion.

6.3. Technology integration and future development directions

In the future, artificial intelligence in radiological medical image processing will move towards multi-technology integration. Multimodal large models can combine images, text and genomics to gain a deeper understanding of the disease. Edge computing and cloud computing work together to provide real-time processing and remote cooperation. Generative artificial intelligence can be applied to image reconstruction, data augmentation and simulation training to address the problem of data scarcity. Federated Learning and Privacy-Preserving Computation Promote Multi-Center Cooperation and Improve Model Generalization Ability. With the strengthening of regulatory systems and the deepening of clinical trials, artificial intelligence is expected to cover all links in the process of screening, diagnosis, treatment and follow-up, thereby advancing radiology towards intelligence, precision and personalization.

7. Conclusion

Artificial Intelligence technology has many applications in radiological medical image processing at present. Based on 5000 cases of data collected from August 2024 to August 2026, this paper systematically studies the methods and values of artificial intelligence in preprocessing, diagnosis and treatment, and analyzes problems such as data quality, interpretability and technological integration. Artificial intelligence can enhance the speed and accuracy of image processing and optimize radiotherapy workflow and efficacy assessment; however, there are still problems of standardization, trust and regulation in its clinical application. In the future, with the progress of multimodal fusion and explainable AI, artificial intelligence will be applied more broadly in radiology to assist doctors in making precise diagnoses and treatments for patients.

Disclosure statement

The author declares no conflict of interest.

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