Applications of Artificial Intelligence in Nuclear Medicine Image Generation

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As we all know nuclear medicine is a crucial part of the modern health care system. It has significantly improved the disease diagnosis.

In this term paper I will give you a conceptual classification and a brief summary of the technical fundamentals of Artificial intelligence, Possible applications are discussed on the basis of a typical work flow in medical imaging, grouped by planning, scanning, interpretation, and reporting.Then turn the main limitations of current AI techniques, such as issues with interpretability or the need for large amounts of annotated data, are briefly addressed.

This paper focused on four aspects

- Impact of AI on the nuclear medicine.
- The associated challenges.
- The opportunities.
- Including imaging physics.
- Image reconstruction.
- Image postprocessing.
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Discuss about the application of artificial intelligence (AI) in medical imaging (including nuclear medicine imaging) has rapidly developed. most AI applications in nuclear medicine imaging have focused on the diagnosis, treatment monitoring, also be used for image generation to shorten the time of image acquisition, reduce the dose of injected tracer, and enhance image quality.

The application of AI in image generation for single-photon emission computed tomography (SPECT) and positron emission tomography (PET) either without or with anatomical information (CT or magnetic resonance imaging (MRI)).

After that generating attenuation map, estimating scatter events, boosting image quality, and predicting internal dose map is summarized and discussion then review problems, advantages, disadvantages, challenges and advancement of AI in nuclear Medicine.

1 Abstract

The application of artificial intelligence (AI) in medical imaging (including nuclear medicine imaging) has rapidly developed. Most AI applications in nuclear medicine imaging have focused on the diagnosis, treatment monitoring, and correlation analyses with pathology or specific gene mutation. It can also be used for image generation to shorten the time of image acquisition, reduce the dose of injected tracer, and enhance image quality.

This work provides an overview of the application of AI in image generation for single-photon emission computed tomography (SPECT) and positron emission tomography (PET) either without or with anatomical information [CT or magnetic resonance imaging (MRI)]. This paper focused on four aspects, including imaging physics, image reconstruction, image postprocessing, and internal dosimetry. AI application in generating attenuation map, estimating scatter events, boosting image quality, and predicting internal dose map is summarized and discussed.

2 Imaging physics

As the two most widely used nuclear medicine imaging technologies, both PET and SPECT quantify radionuclides' distribution in a recipient by measuring the gamma photons emitted from that recipient. In practice, gamma photons are attenuated due to tissue absorption in the recipient. The attenuation effect causes the number of photons to be less than expected and results in nonuniform deviations in the radioactive distribution due to the different attenuation paths from the tracer to the detector. Another factor affecting image quality is scattered photons. Scattering events will cause severe artifacts and quantitative errors. The emergence of AI technology is not a complete replacement of traditional methods but rather an auxiliary means to find function mapping relationships and largely depends on the model structure, data range, and training process.

3 Application in nuclear medicine

The rise of AI in medicine is often associated with "superhuman" abilities and precision medicine. At the same time, often overlooked are the facts that large parts of physicians' everyday work consist of routine tasks and that the delegation of those tasks to AI would give the human workforce more time for

higher-value activities (8) that typically require human attributes such as creativity, cognitive insight, meaning, or empathy. The day-to-day work of medical imaging involves a multitude of activities, including the planning of examinations, the detection of pathologies and their quantification, and manual research for additional information in medical records and textbooks—which often tend to bore and demand too little intellectually from the experienced physician but, with continuously rising workloads, tend to overwhelm the beginner. Without diminishing the prospects of "superdiagnostics" and precision medicine, seemingly more easily achievable goals of AI in medicine should not be forgotten because they might relieve people who are highly educated and have specialized skills of repetitive routine tasks.