Generative models improve radiomics

Impact Paragraph

CT radiomics has the potential to provide clinical decision support in oncology due to the wide us of CT scanning in clinical practive. [1] Due to the long-term risk posed by ionizing radiation exposure, low dose CTs have become more popular (according to the As Low As Reasonably Achievable (ALARA) principle [2]) in clinical practice, especially for screening and monitoring of populations at risk. Radiomics from low dose CT might be an effective tool for quicker and more reliable screening. [3] However, as a consequence of the low radiation exposure in low dose CT imaging, noise in such images is more pronounced and this noise decreases the reliability and performance of radiomics. Improving the reproducibility of radiomics and its performance in clinical applications from low dose CTs is therefore a timely and potentially impactful research topic.

One potential solution worth exploring for improving the reproducibility and performance of radiomics based on low dose CT is denoising the images before extracting radiomic features. As the state of art low dose CT denoising method, generative models are used as denoisers in this thesis to improve low dose CT radiomics reproducibility and performance. These studies may bring certain scientific and social impacts.

Scientific impacts

1. All our studies are published in international peer-reviewed journals (such as: Computer Methods in Biomechanics and Biomedical Engineering: Imaging & Visualization, Physics in Medicine & Biology, Medical Physics, Medica Physica, Journal of Applied Clinical Medical Physics).

2. All our studies are available as open access publications.

3. **Chapter 2** investigates the beneficials of shortcuts in encoder-decoder network for CT denoising, results provided guidelines for network designing in denoising task.

4. **Chapter 3** is the first effort to improve the reproducibility of radiomic features calculated on low dose CT scans by applying generative models.

5. **Chapter 4** introduces a new lung cancer diagnosis method; this method achieves a good performance in classification with a higher interpretability.

6. **Chapter 5** is the first effort to improve the performance of radiomics-based models from features extracted from low dose CT scans.

7. **Chapter 6** assess the potential of using cycle GAN to denoise low dose CTs and improve radiomics reproducibility and performance.

Social impacts

1. Codes and important pre-trained generative models of this thesis are available for public use as open source; we hope that these can help medical physicists and other care professionals to remove barriers for applying generative models for low dose CT radiomics.

2. Our proposed lung cancer diagnosis solution can improve the detection and management of early lung cancer, and we hope our method can reduce the mortality of lung cancer for patients.

3. Improving low dose CT radiomics performance may reduce ionizing radiation exposure for patients and therefore reduce the number of cancers and other diseases caused by this exposure.

References:

[1] Ibrahim, Abdalla, et al. "Radiomics analysis for clinical decision support in nuclear medicine." *Seminars in nuclear medicine*. Vol. 49. No. 5. WB Saunders, 2019.

[2] Musolino, Stephen V., Joseph DeFranco, and Richard Schlueck. "The ALARA principle in the context of a radiological or nuclear emergency." *Health physics* 94.2 (2008): 109-111.

[3] Homayounieh, Fatemeh, et al. "Prediction of coronary calcification and stenosis: role of radiomics from Low-Dose CT." *Academic Radiology* 28.7 (2021): 972-979.