Master internship 2024 in Lyon, France

Simulated database of SPECT images for AI-based partial volume effect correction for Lu-177 PSMA treatment

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This work is a collaboration between CREATIS lab, Léon Bérard cancer center (CLB, Lyon, France), IP2I (CNRS) and Spectrum Dynamics cie.

There is a high probability that this master's thesis project will be continued as a PhD project with the company.

Medical and whole project context.
Lutetium-177 (Lu-177) PSMA therapy is a novel theranostic approach for the treatment of advanced metastatic prostate cancer. It combines the use of a radiopharmaceutical agent, Lu-177 vipivotide tetraxetan (Pluvicto), which specifically targets prostate cancer cells that express the prostate-specific membrane antigen (PSMA), with single-photon emission computed tomography (SPECT) imaging to monitor the distribution of the radiopharmaceutical and guide treatment. Partial volume correction (PVC) is a technique used to improve the accuracy of SPECT images by accounting for the limited resolution of the imaging system. This is especially important in Lu-177 PSMA therapy to improve the quantification of radiopharmaceutical uptake in organs at risk and in tumor lesions. The Veriton system is a state-of-the-art SPECT camera composed of 12 CZT detector allowing high sensitivity and decreased acquisition time compared to conventional system.

However, Partial Volume Effect PVE is still present and impairs image quantification. Currently in the team, a deep learning method is being developed to correct PVE. This algorithm relies on a large database of simulated images.

Scientific context of the internship.
The goal of this master thesis project is to develop and implement a simulation workflow that will generate a database of SPECT images. This database will be used for training a neural network correcting for PVE. Simulation will be based on 1) the new version of GATE Monte Carlo toolkit with advanced AI-based acceleration methods, and 2) the RTK reconstruction toolkit. This will help to improve the accuracy of SPECT images and provide clinicians with more reliable information to guide treatment planning and delivery.
The successful development and implementation of a PVC algorithm for the Veriton system will have a significant impact on the clinical management of patients with advanced metastatic prostate cancer undergoing Lu-177 PSMA therapy. By improving the accuracy of SPECT images, PVC can help to improve the targeting of tumor tissue and reduce the risk of side effects. This will lead to better patient outcomes and improved quality of life.

First tasks of the master internship.
1. Perform bibliographic review on SPECT simulation techniques

2. Develop a simulation model for the Veriton SPECT imaging system
3. Investigate acceleration methods to decrease computation time
4. Participate in the development of the deep learning model in collaboration with a PhD student

Environment. The recruited person will work in a multidisciplinary team composed of medical physicists, researchers and computer scientists of CREATIS laboratory and Leon-Bérard Cancer Center (Lyon).

Expected skills and other information

- Expected skills: medical physics, Monte Carlo, computer sciences, AI
- Technical skills: Python (required), Gate
- English and French
- Expected start: early 2024
- Duration: 6 months
- Location: Lyon, Léon Bérard Cancer Center, France
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