MSc project in Medical Physics

Deep Learning for Respiratory Phase Estimation in Cone-Beam CT Projections

@ Medical University of Vienna / AKH Wien

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The Department of Radiation Oncology at the Medical University of Vienna offers a master project in the field of medical physics starting from July 2026.

Motivation:

Breathing motion during irradiation is a challenge in radiation oncology, impeding precise dose deposition to tumours near the diaphragm. Possible solutions are online tumor tracking or gating. The basis for these active approaches is real-time tumour motion monitoring. Modern treatment devices are already equipped with imaging devices such as optical surface scanner or x-ray based options. Gantry-mounted x-ray devices allow for the acquisition of a so called “cone-beam” computed tomography offering the reconstruction of 3D images in the treatment position. However, the temporal information from the x-ray projection images is lost after 3D reconstruction.

Work description:

The goal of this MSc project is to investigate self-supervised machine learning approaches for estimating the breathing phase from cone-beam CT (CBCT) projection images of lung cancer patients. Instead of directly predicting the breathing phase, a neural network (NNW) will be trained to learn a motion-aware embedding of projection images that captures respiratory motion patterns. Using a dataset containing CBCT projections and corresponding breathing motion signals from the surface scanner as ground truth, the learned representation will be used to derive respiratory phase information and compared with existing image-based approaches. The main tasks of this project are:

- Analysis and preparation of CBCT projection data and corresponding respiratory motion signals
- Development and implementation of a self-supervised neural network to learn motion-related embeddings from projection images (based on existing deep learning libraries)
- Development of a method to derive respiratory phase information from the learned embedding space
- Validation and comparison of the proposed approach with conventional image-based breathing phase estimation methods

Qualifications:

- Student of computer science, physics, biomedical engineering or similar technical studies
- Fluent in English (oral and written)
- Analytical skills and ability to work independently on a project basis
- Programming experience in Python
- Experience with machine learning libraries

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