Master's Thesis at the Pattern Recognition Lab Nr.:

Patient-Specific Quality Assurance of Synthetic CT for MR-Only Radiotherapy

Patientenindividuelle Qualitätssicherung synthetischer CT-Bilder für die MR-Only-Strahlentherapie

Modern radiotherapy workflows are increasingly using an MR-only approach: a synthetic computed tomography (sCT) is generated directly from the planning magnetic resonance imaging (MRI) [1]. This avoids CT/MR registration errors, simplifies and shortens the overall workflow, and reduces additional imaging, as well as the applied imaging dose [2,3]. Vendor algorithms, for example available as optional functionality within syngo.via RT Image Suite (Siemens Healthineers, Germany), can produce sCTs 'out of the box' and have already been clinically introduced in several indications [4-7]. However, because the technology is relatively new, a standardized patient-specific quality assurance (PSQA) strategy for sCT has not yet been established [8]. The aim of this thesis is therefore to design and validate a fast, fully automated QA pipeline that flags sCTs with relevant dose-impacting deviations, such as Hounsfield unit/ electron density errors or geometric artifacts, before dose calculation, thus closing the safety gap between algorithm development and robust daily clinical use.

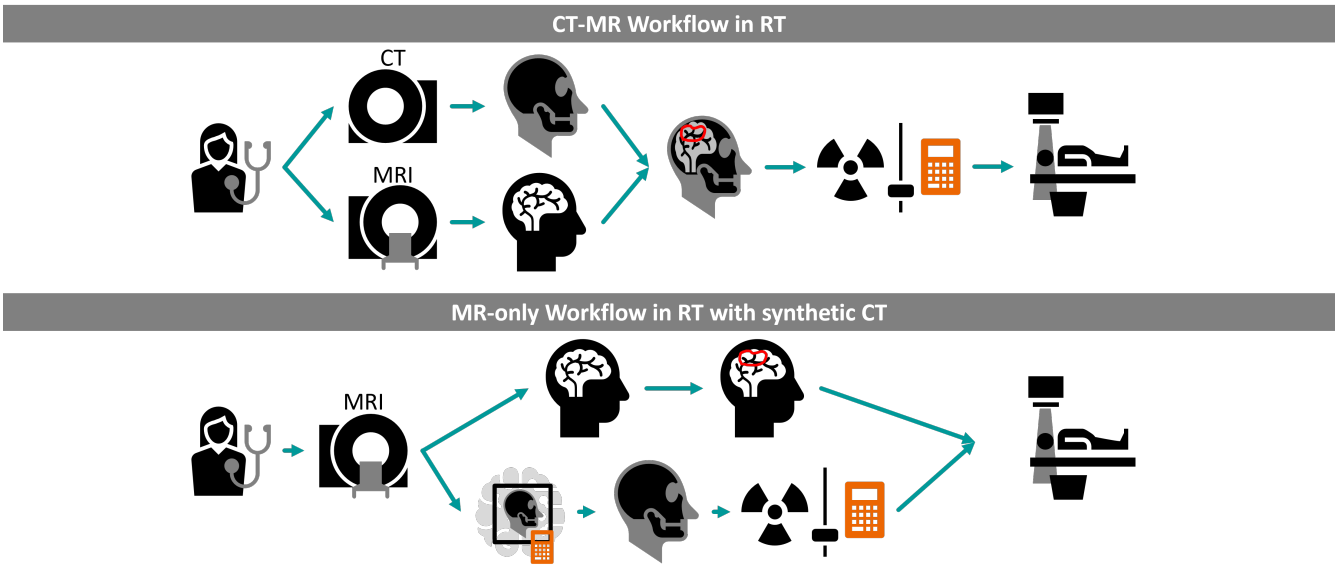

Figure 1: Comparison of a conventional CT/MR planning workflow with an MR-only workflow in radiotherapy, where a synthetic CT is generated from the planning MRI

Topic & Objectives:

- **Focus:** Develop and validate a PSQA framework using existing datasets. The framework will define and tune decision criteria (e.g. thresholds or composite metrics) on healthy volunteers and patients data and demonstrate feasibility in a retrospective cohort of patients.
- **No experimental work required:** This is a data-focused thesis, no new measurements or prospective data collection are needed. All analyses will be performed on the available datasets.
- **Clinical exposure:** If desired, clinical insight can be gained into radiotherapy workflows.

Data & Environment:

- Available MR/CT and sCT volunteer datasets; additional retrospective patient datasets for validation.
- You will be working at the Department of Radiation Oncology (UK Erlangen) in close collaboration with Siemens Healthineers.

Outcomes & Deliverables:

- Documented development and validation of a patient-specific QA framework, including clearly described decision logic and derivation.
- Concise evaluation report and draft guidelines for clinical use (proof-of-concept).
- Master's thesis (English) and presentation to an interdisciplinary audience.
- A joint peer-reviewed publication is intended.

Candidate profile:

- Experience in data analysis and medical image processing
- Enthusiasm for interdisciplinary collaboration and clinical context
- Basic understanding of radiotherapy is helpful

If you are interested in the thesis project, please send your application (CV, letter of motivation, current transcript of records) with subject 'sCT PSQA - Thesis' to: bernd-niklas.axer@extern.uk-erlangen.de

Academic advisors: Bernd -Niklas Axer M. Eng., Dr. rer. biol. hum. Juliane Szkitsak,
Annette Schwarz M. Sc., PD Dr. med. habil. Florian Putz, Prof. Dr. rer. nat. Christoph Bert,
Prof. Dr. Ing. habil. Andreas Maier
Begin: November/ December 2025

Literature:

[1] Fusella M., et al. Results of 2023 survey on the use of synthetic computed tomography for magnetic resonance imaging-only radiotherapy: Current status and future steps. Physics and Imaging in Radiation Oncology. 2024;32:100652.

[2] Villegas F., et al. Challenges and opportunities in the development and clinical implementation of artificial intelligence-based synthetic computed tomography for magnetic resonance-only radiotherapy. Radiotherapy and Oncology. 2024;198:110387.

[3] Masitho S., et al. Accuracy of MRI–CT registration in brain stereotactic radiotherapy: Impact of MRI acquisition setup and registration method. Zeitschrift für Medizinische Physik. 2022;32(4):477–487.

[4] Grigo J., et al. "sCT-Feasibility" - a feasibility study for deep learning-based MRI-only brain radiotherapy. Radiation Oncology. 2024;19(1):33.

[5] Deng J., et al. Development and clinical implementation of an MRI-only planning workflow featuring deep learning-based synthetic CT for prostate cancer external beam radiotherapy. Journal of Applied Clinical Medical Physics. 2025;26(9):e70228.

[6] Lerner M., et al. Clinical validation of a commercially available deep learning software for synthetic CT generation for brain. Radiation Oncology. 2021;16(1):66.

[7] Yip T.T.Y., Li Z., Li T. Clinical validation of MR-generated synthetic CT by MRCAT for brain tumor radiotherapy. Journal of Applied Clinical Medical Physics. 2025;26(1):e14494.

[8] Dal Bello R., et al. Patient-specific quality assurance strategies for synthetic computed tomography in magnetic resonance-only radiotherapy of the abdomen. Physics and Imaging in Radiation Oncology. 2023;27:100464.