MSC PROJECT: PREDICTING THE RADIOTHERAPY DOSE BASED ON MR IMAGES

Supervisors:
David Tilly, Medical Physics, Akademiska Sjukhuset
Robin Strand, Professor in Computerized Image Analysis

1. BACKGROUND

Approximately 50% of all cancer patients receives radiotherapy (RT) as part of their treatment. The most common form of RT is External Beam where a linear accelerator (Linac) aims high-energy photons at the tumour. A cross-fire technique is used to concentrate the radiation dose to the tumour and spare the surrounding healthy tissue. A treatment course is divided into a number of treatment sessions (fractions) often given once a day where the same treatment plan is executed for all sessions. Patient organ motion between and during fractions are handled by expanding the treated volume with safety margins at the cost of increased dose to the healthy tissue.

Integrated imaging devices (x-ray) is used to aim the radiation at the target. Conventional RT utilizes x-ray imaging with limited soft tissue contrast resulting in larger safety margins that can cause radiation induced treatment side effects. The latest generation treatment machine, in operation at Akademiska since 2019, integrates an MR with the Linac (MR-Linac) which utilises the superior contrast for aiming at the soft tissue tumour.

An adaptive workflow is employed where a treatment plan is tailored to the anatomy of the day. The goal is to increase the accuracy of the treatment and thereby reduce the safety margins thus sparing the healthy tissue. The adaptive workflow entails image acquisition, organ delineation, plan creation and delivery – all in one session. This procedure currently takes 45-60 min with four persons staffing the machine which is at least twice as long with twice as many in the staff. If the patient anatomy is very similar to the reference plan, then it might not be necessary go through the entire complex workflow and thus spare the patient, often in pain, a long session as well as save personnel resources.

A decision support tool, e.g. utilising machine learning algorithms, that can predict if the full workflow is needed, and if so the gain in relevant dosimetric evaluation criteria, would thus enable optimization of resources and make the most sophisticated RT available to more patients. The current project will address the component of predicting the 3D dose distribution, which is then input to a decision-making component as seen in Figure 1.

Dose prediction using deep learning models has recently been proposed, e.g. [1–4] and for MR-Linac in the abdomen [5]. This project will choose a suitable network architecture from the literature and apply to dose prediction for prostate treatments on the MR-Linac.

2. AIM

- Choose a DL network architecture based on a literature study
- Given a set of MR images with delineation test how accurate a deep learning algorithm can predict the 3D dose.
3. DATA

Patent data from 10 patients each with 7 fractions (so in total 70 datasets) all with delineations and dose distributions. The algorithm will the images and/or delineations as input and is trained to produce the dose distributions during supervised learning.

![Diagram](image)

*Figure 1. Calculation pipeline for decision support for adaptive radiotherapy.*

4. REFERENCES


