ANTONI VAN LEEUWENHOEK
NEDERLANDS KANKER INSTITUUT

M.Sc. projects in Medical Physics
At the department of radiotherapy,
Netherlands Cancer Institute / Antoni van Leeuwenhoek

The department
Radiotherapy uses ionizing radiation to irradiate tumour tissue to a high dose while sparing the surrounding normal healthy tissue as much as possible. The cluster radiotherapy of the Antoni van Leeuwenhoek hospital uses the most modern techniques to irradiate its patients. Due to the synergy between clinic implementation groups and medical physics research, we are able to quickly implement state of the art techniques in daily clinical practice. Because of this, the Antoni van Leeuwenhoek hospital belongs to the (inter)-national forefront of clinical radiotherapy.

The medical physics department consists of 11 qualified medical physicists, 3 medical physics trainees as well as a group of PostDocs, PhDs and physics support staff. When you decide to do your master thesis at the Antoni van Leeuwenhoek, you will have an excellent opportunity to experience daily practice at a medical physics department with a strong focus on research and innovation. Below we provide the summary of three possible projects that are currently available. If, however, you have specific ideas for a different project, you can always contact us to discuss the possibilities.

For further information or if you wish to apply for any of the projects, please contact dr. Tomas Janssen, Medical physicist, +31 (0)20 512 2164, t.janssen@nki.nl

Project 1: Use of Bayesian networks in quality control of radiotherapy treatment
To ensure the safe delivery of the radiation, various checks are routinely performed. On technical parameters (radiation energy, radiation dose, scale of beam modulation, etc.) that characterizes a radiotherapy treatment. This control automatically classifies each treatment according to disease site and treatment technique and next, for each classification, thresholds are defined. If a particular treatment exceeds one of these thresholds, extra safety checks are automatically initiated.

One of the main drawbacks of the current implementation is that the classification rules and thresholds have to be set by hand. In order to resolve this issue, we wish to develop a control system based on a Bayesian network for error detection. By populating the network with the same technical parameters we currently use, we should be able to classify outliers based upon the probability of that particular combination of parameters.

In this project, you will first design and develop the Bayesian network. Next, you will study the applicability to use this approach as a means of quality control in our department.

Project 2: Exploring artefacts in 4D-CT acquisition

Prior to the delivery of radiation dose, treatments are simulated on a CT scan of the patient. At this stage, the treatment of the tumour while sparing the surrounding tissues is optimized. For lung cancer patients, in order to take into account motion due to breathing, respiration-correlated 4D-CT scanning is applied. By simultaneously acquiring overlapping images of the patient and registering the breathing signal of the patient, a movie of the breathing patient can be reconstructed. This 4D-CT scan is then post-processed to calculate the time-averaged position of the tumour. At the Antoni van Leeuwenhoek we have about 10 years of experience with this technique which was partially developed in-house.

Irregularities in the breathing pattern can lead to non-trivial artefacts in such a 4D-CT. For example, a patient holding its breath slightly longer in between two breaths might lead to a misalignment of the images in the breathing-cycle. Artefacts like this introduce an uncertainty in the exact tumour position and thus lead to a less precise treatment.

The aim of this project is to properly understand several types of artefacts that can occur and understand their impact on treatment. To achieve this, we shall simulate, based upon a simple geometrical model the effect of different breathing irregularities on 4D-CT scans. Based upon these simulations and experiments, guidelines will be developed to describe the change in accuracy of treatment if a certain artefact occurs.

In this project, you will design and develop simulations of 4D-CT-scanning of a simple geometric object and therewith study the effect of breathing irregularities. You will perform experiments on the CT scanner to verify the simulations.

Project 3: Correlation of anatomical changes during radiotherapy of head and neck cancer patients measured with cone-beam CT and EPID dosimetry

During a course of radiotherapy for head and neck (H&N) cancer anatomical changes due to changes in volume of the target or changes in neck diameter can occur. These changes can visually be observed on daily cone-beam CT (CBCT) and are scored digitally by radiotherapy therapists according to a traffic light protocol. During each irradiation the radiation dose delivered to the patient is measured using an electronic portal imaging device (EPID) positioned behind the patient, and analysed automatically using (another) traffic light protocol.

The CBCT data will give information about the magnitude of geometric changes during the 7 weeks of treatment. The EPID dosimetry results will indicate how much the dose delivered to a patient is deviating from the planned dose.

It is the purpose of this project to correlate the CBCT geometric data with the EPID dosimetry results using the two traffic light protocols. The resulting information will be used to assess the usefulness of EPID dosimetry in deciding in which cases anatomical changes during a course of treatment of H&N cancer do need a new plan.