Proposal for a Master Thesis in

Adaptive Radiotherapy of Lung Cancer

Project

To evaluate adaptive radiotherapy and develop methods to improve plan adaptation scenarios for lung cancer patients.

Background

Anatomical changes in non-small cell lung cancer (NSCLC) patients due to volumetric changes (e.g. tumour shrinkage, atelectasis or pleural effusion), or displacements of anatomical structures (e.g. a baseline shift of the tumour or a shift of the mediastinal structures) needing adaptations occur in approximately 12–27% of the patients during fractionated radiotherapy. As a result, the delivered dose to the tumour or organs at risk may deviate from the planned dose and become unacceptable. In these cases, adaptive radiotherapy (ART) is performed.

Patients eligible for ART are generally recognized during the review of cone-beam CT (CBCT) scans. However, the correct and timely offline or online review of CBCT scans is hampered by work load, time pressure, might be error prone and depend on human observations. Visual assessment of anatomical changes on the CBCT scan are currently used to guide the radiation therapy technologist and radiation oncologist in treatment adaptation. We would like to optimize this procedure to a make it an automated process and include the actual radiotherapy dose delivery in the process. For this we would like to investigate the use of advanced image processing techniques such as deformable image registration for contour propagation and quick assessment of the radiotherapy dose distribution to improve the radiotherapy treatment quality.

Project available: now

Supervisors

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Proposal for a Master Thesis in

Dual Energy Cone Beam CT

Project

To investigate the possibility to perform dual energy CT (DECT) imaging using a linear accelerator's on-board cone beam CT imaging system. The student gets the opportunity to work with one of the Varian TrueBeam linear accelerators that we use in our clinic. The project involves practical experiments, data analysis in MATLAB and reconstructing 3D (possibly 4D) cone beam CT images.

Background

The linear accelerator's on-board cone beam CT imaging system is used to detect changes in patient positioning and anatomy such as a translation or rotation of the patient, weight loss, tumor regression etc. It is important that these changes are detected as soon as possible, since they can cause discrepancies between the planned and the actually delivered radiation dose. For DECT imaging, two images are acquired with two different X-ray spectra. The resulting CT number images can be decomposed into effective atomic number images and relative electron density images. Performing DECT imaging using the linear accelerator's on-board cone beam CT imaging system could provide additional anatomical information that cannot be obtained with standard single energy cone beam CT imaging.

Project available: 2017

Supervisors

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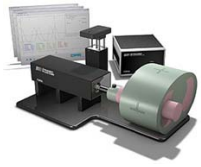

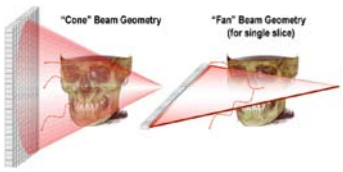

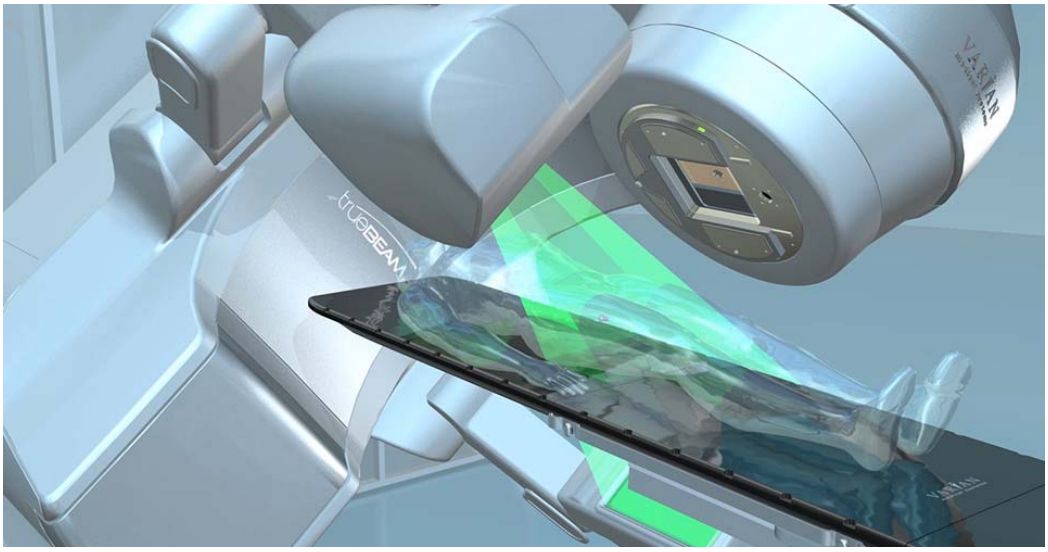
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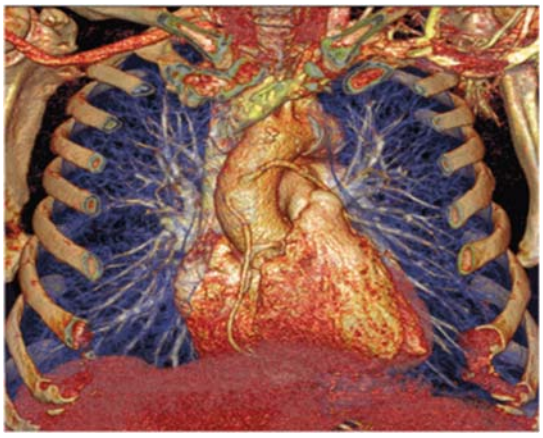
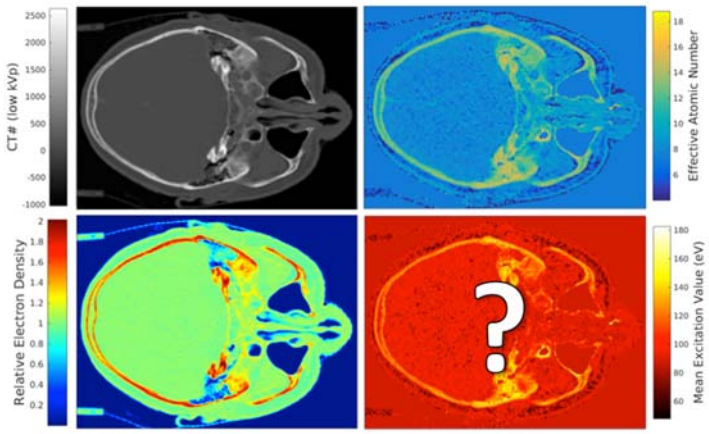


Proposal for a Master Thesis in

Dual- and Triple- energy CT for tissue characterization

Project

To perform tissue decomposition in elemental fractions using dual and triple- energy CT images. To extract the tissue's mean excitation energy from triple-energy CT.



Background

Radiotherapy dose calculations rely in using tabled values of elemental compositions for the human tissues, which are far from accurate. Using Imaging techniques to extract the tissues' compositions would reduce the uncertainty in all radiotherapy treatments.

Triple-energy CT (TECT) is a novel way of extracting tissue specific properties from three images of the same object. From dual-energy CT (DECT) is possible to extract the relative electron density and effective atomic number, from which the mean excitation value is derived. However a new method is needed to extract this tissue property that will reduce the uncertainty in proton therapy.

Project available: June 2017

Supervisors

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Proposal for a Master Thesis in CT imaging

Project

To validate image parameters of preclinical and clinical cone beam CT image reconstructions with a new cone beam CT simulation model which should be programmed in ImaSim.

Background

ImaSim is a (dual energy) CT simulation program, developed at Maastro Clinic, which allows fan beam (dual energy) CT simulations of voxelized geometries. ImaSim should be extended to cone beam (CB)CT simulations. After implementation, the CBCT algorithm has to be validated with preclinical scans obtained from our small animal radiotherapy device and with the CBCT panels of a linear accelerator.

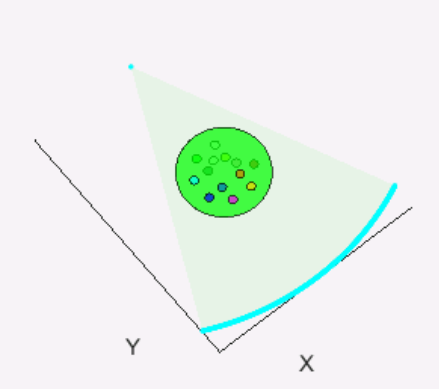

Figure 1. Fan beam CT simulation setup in ImaSim

Skills required: Matlab programming

Project available: June 2017

Supervisors

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Proposal for a Master Thesis in Proton Therapy

Project

To perform Monte Carlo dose calculations for proton treatment plans, based on phantom studies and patient data. Do commissioning studies on the differences in dose distribution based on Single-Energy and Dual-Energy CT imaging.

Background

Proton Therapy is a sort of radiotherapy, which uses proton beams to irradiate tumorous tissues. Proton beams have a characteristic energy distribution that can decrease the amount of dose delivered to healthy tissues.

MAASTRO Clinic recently initiated the construction of its own Proton Therapy Center (ZONPTC, www.zonptc.nl). The first patient treatment is planned for December 2018, whereas the commissioning stage will begin in December 2017.

Project available: June 2017

Supervisors

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Proposal for a Master Thesis in Quantitative Image Analysis

Project

To compare new tools for extracting quantitative tumour features from medical images (Radiomics) to build cancer therapy decision support systems

Background

Some cancers are known to show significant phenotypic differences that can be exploited noninvasively by medical imaging. Radiomics refers to computerized image analysis that extracts much more information about the tumour than can be obtained using human eyes only. Decision support systems (DSS) can be built by combining radiomics with machine learning on massive data sets. Such DSS may have immense clinical potential by providing unprecedented opportunities to deeply personalize cancer treatment at low cost.

In this project, the student shall gain a deeper understanding of the technologies required for machine learning and high-throughput image computations on “big data” in healthcare. Learning outcomes include experience using semantic web, familiarity with ontology mapping and experience with computerized medical image analysis (CT/MR/PET).

The student will carry out the activity within the Knowledge Engineering research group at MAASTRO clinic

Project available: June 2017

Supervisors

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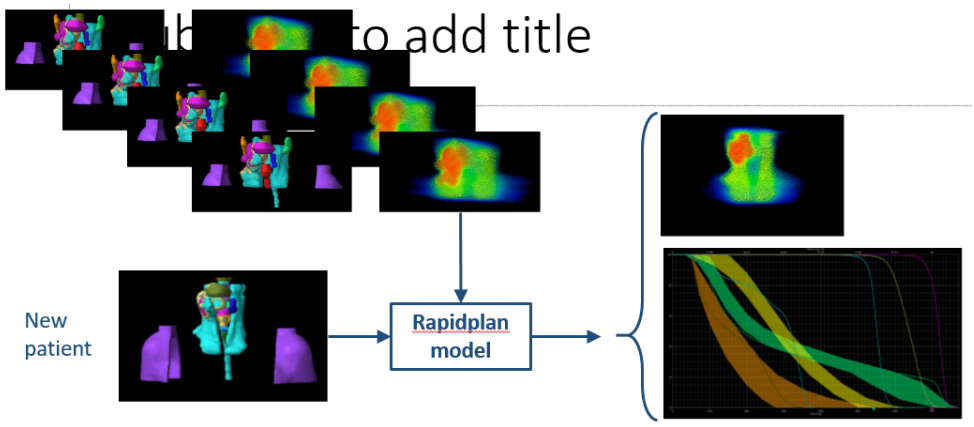
Proposal for a Master Thesis in Radiation Therapy

Project

Treatment planning, i.e. the process of beam setup and dose calculation to create an optimal dose distribution for radiation therapy treatment, is currently a time consuming process. Recently, automated methods have become available. In Maastro clinic, a knowledge based automatic planning system is currently being investigated for clinical use, which uses a library of previously delivered treatments to calculate the best possible dose distribution. In this thesis project you will investigate the effectiveness of automated planning for clinical use in head and neck cancer treatment and the robustness of a knowledge based technique for changes in treatment technique. We expect you to have affinity with the handling of DICOM data, data-analysis and the use of Matlab.



Background

MAASTRO Clinic is one of the leading radiation therapy centres in the Netherlands, treating 4000 patients each year in two locations in Maastricht and Venlo.

MAASTRO contributes to the fight against cancer in three ways:

- by administering radiation treatment according to the latest medical knowledge, in consultation with its patients and in the safest way possible;
- by conducting pioneering medical research whose results have a direct impact on the effectiveness of treatment;
- by offering training and educational programmes to ensure a steady supply of specialists now and in the future.

Project available: June 2017

Supervisors

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