University of Victoria | Graduate Studies

Notice of the Final Oral Examination
for the Degree of Master of Science

of

ANDREW COATHUP

BSc (University of Ottawa, 2014)

"Towards Personalized PTV Margins for External Beam Radiation Therapy of the Prostate "

Department of Physics and Astronomy

Tuesday, August 22, 2017
10:00 A.M.
Clearihue Building
Room B007

Supervisory Committee:
Dr. Parminder Basran, Department of Physics and Astronomy, University of Victoria (Co-Supervisor)
Dr. Magdelana Bazalova, Department of Physics and Astronomy, UVic (Co-Supervisor)
Dr. Will Ansbacher, Department of Physics and Astronomy, UVic (Member)

External Examiner:
Dr. Deidre Batchelar, Department of Medical Physics, UBC Okanagan

Chair of Oral Examination:
Dr. Stephanie Willerth, Department of Mechanical Engineering, UVic

Dr. David Capson, Dean, Faculty of Graduate Studies

Abstract

External Beam Radiation Therapy (EBRT) is a common treatment option for patients with prostate cancer. When treating the prostate with EBRT, an additional irradiated volume (PTV margin) is added around the prostate to account for uncertainties in treatment set-up and delivery. This ensures an accurate and uniform radiation dose to the prostate.

In principle, the PTV margin applied to the prostate accounts for all uncertainties in treatment set-up and delivery for the entire population of patients. However, it does not account for differences in the extent of these uncertainties that occur from patient to patient. The purpose of this thesis is to investigate the feasibility of personalized PTV margins for external beam radiation therapy of the prostate, with particular emphasis on regression-based predictive algorithms.

Predictive algorithms were benchmarked for application in predicting patient intrafraction motion. Clinically relevant motion data and PSFs were generated and used to evaluate the performance of several predictive algorithms, with additional emphasis on patient data requirements and the influence of input data noise. Evaluation was done by comparing the difference between the predicted motion and the actual motion.

Benchmarked algorithms were then applied to actual patient data. Motion data, rotation data, and patient-specific factors (PSFs) were collected for 21 prostate cancer patients and used to train and validate the performance of multiple algorithms. The best algorithm for this number of patients was the LASSO. It predicted both the mean and the standard deviation of a prostate cancer patient's intra-fraction motion to within a maximum of 0.8mm and 0.4mm mean absolute error, respectively, along all of the vertical, longitudinal, and lateral directions.

The motion predictions generated by the LASSO were incorporated, along with other center-specific uncertainties in radiation therapy planning, set-up, and delivery, to produce a personalized PTV margin.