Mobility grant report

EPID dosimetry and adaptive radiotherapy with artificial intelligence

Dates: *10-14 June, 2019*
Institute and country visited: *Centre Hospitalier Universitaire (CHU) de Québec/Université Laval, Québec, Canada*

Report:

The clinic where I work, Maastro in Maastricht, The Netherlands, has a longstanding record of research in dose-guided radiotherapy using the electronic portal imaging device (EPID) for dosimetry. In this process, the exit radiation during treatment is acquired by the EPID, these portal images are converted to 2D, 3D and even 4D doses, and these are compared with a predicted dose distribution to detect delivery errors. Recently, we have started working with artificial intelligence (AI) in this field. EPID dosimetry is an area in which AI is potentially very applicable, as large amounts of EPID dosimetry data are generated during treatment, which are difficult for human observers to interpret. The main goal of using AI with EPID dosimetry is to be able to classify patients in need of treatment adaptation, based on EPID images and/or gamma analysis of these images. The institute that I visited, CHU de Québec/Université Laval, has been active in this field [1, 2], and the aims of the visit were: to learn about the adaptive radiotherapy process with EPID dosimetry that is in use at this institute; to learn about the AI methods used there; and to start a collaboration between Maastro and CHU de Québec/Université Laval in which knowledge and data could be shared for mutual improvement of the clinics' use of AI for EPID dosimetry.

During the one-week visit, several aspects of the radiotherapy procedures at CHU de Québec were studied. First, insight was gained regarding the clinical adaptive radiotherapy process. I was able to attend several patient treatments during which the EPID was used. These patients were specifically selected for close monitoring as they were expected to undergo large anatomical changes over the course of their treatments, which were expected to be detected on EPID images. For one patient, differences in the EPID images were indeed visible, and use of a cone-beam CT image and dose recalculation enabled further evaluation of whether adaptation of the treatment plan was necessary. Observing this process gave me a good understanding of the adaptive radiotherapy process at CHU de Québec and the considerations that were made when deciding to create a new treatment plan.

Second, I was provided with a dataset of gamma analysis maps, used in previous work at CHU de Québec/Université Laval [1, 2]. While working with this data, I was able to better understand and to learn more about the AI methods described in their publications. Evaluation of the CHU data also allowed me to compare them with the data we have at Maastro, and to assess the similarities and differences. Furthermore, I was introduced to their current work, which is focusing on extension of the previous models to include more detailed information, e.g. spatial features, as well as analysis of different tumour sites.

The visit was very interesting and fruitful, and led to challenges that both institutes are eager to investigate further. We are planning to collaborate further in the coming months, test models on different datasets, and evaluate the results together. The knowledge gained from this visit will help to continue the AI for EPID dosimetry project at Maastro as well as at CHU de Québec/Université Laval. I would like to express my gratitude to ESTRO for the opportunity to realize this visit.

The research institute of CHU de Québec/Université Laval where my visit took place.

View of the old city of Québec. In this picture CHU de Québec is located on the left; it is the building with the green roof and the surrounding buildings.

References

1. Piron, O., Varfalvy, N., and Archambault, L. *Establishing action threshold for change in patient anatomy using EPID gamma analysis and PTV coverage for head and neck radiotherapy treatment.* Medical Physics, 2018. **45**(8): p. 3534-3545.
2. Varfalvy, N., et al. *Classification of changes occurring in lung patient during radiotherapy using relative γ analysis and hidden Markov models.* Medical Physics, 2017. **44**(10): p. 5043-5050.

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