DELIVERY VERIFICATION AND DOSE RECONSTRUCTION IN TOMOTHERAPY

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It has long been a desire in photon-beam radiation therapy to make use of the significant fraction of the beam exiting the patient to infer how much of the beam energy was actually deposited in the patient. With a linear accelerator and corresponding exit detector mounted on the same ring gantry, tomotherapy provides a unique opportunity to accomplish this.

Dose reconstruction describes the process in which the full three-dimensional dose actually deposited in a patient is computed. Dose reconstruction requires two inputs: an image of the patient at the time of treatment and the actual energy fluence delivered. Dose is reconstructed by computing the dose in the CT with the verified energy fluence using any model-based algorithm such as convolution/superposition or Monte Carlo. In tomotherapy, the CT at the time of treatment is obtained by megavoltage CT, the merits of which have been studied and proven. The actual energy fluence delivered to the patient is computed in a process called delivery verification.

Methods for delivery verification and dose reconstruction in tomotherapy were investigated in this work. It is shown that delivery verification can be realized by a linear model of the tomotherapy system. However, due to the measurements required with this initial approach, clinical implementation would be difficult. Therefore, a clinically viable method for delivery verification was established, the details of which are discussed. With the verified energy fluence from delivery verification, an assessment of the accuracy and usefulness of dose reconstruction is performed. The latter two topics are presented in the context of a generalized dose comparison tool developed for intensity modulated radiation therapy. Finally, the importance of having a CT from the time of treatment for reconstructing the dose is shown. This is currently a point of contention in modern clinical radiotherapy and it is proven that using the incorrect CT for dose reconstruction can lead to misleading conclusions regarding a treatment. With the correct CT, dose reconstruction may allow for adaptive radiotherapy, in which errors in previous fraction(s) are remedied in subsequent fraction(s), and improved outcomes.