PhD Thesis title: 'New Methods for Motion Management During Radiation Therapy'

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Graduation Date: 10 July 2013
Available on line: http://archiv.ub.uni-heidelberg.de/volltextserver/15272/

ABSTRACT:
In this thesis, a number of new image-based techniques for the management of intra-fractional motion during radiation therapy are presented. Intra-fractional motion describes all kinds of anatomy changes - most prominently respiration - that occur during a single treatment session. Spatially confining the radiation dose to the tumour tissue and thus sparing surrounding healthy tissue is assumed to be crucial for a successful treatment with limited side effects. Unfortunately, the delivery of dose distributions that are sharply confined to the tumour is greatly complicated by patient motion. If not accounted for, this motion will lead to a smearing out of the original dose distribution and will facilitate the redistribution of dose from tumour to healthy tissue. Possible technical solutions for this issue include the interruption of the radiation delivery if the tumour leaves a predefined spatial 'window', and the reshaping of the treatment field 'on-the-fly' to follow the tumour. Regardless of delivery techniques selected, patient motion needs to be reliably detected in real-time to allow for an adaptation of the treatment delivery. First, the author presents experimental results for a novel x-ray imaging system that is attached to the treatment delivery device and enables him to continuously monitor tumour motion during treatment delivery with sub-mm accuracy, a latency better than 90 ms, and a 7 Hz update rate [1]. Second, the author presents a Monte Carlo simulation for an improved amorphous-silicon flat-panel detector that reduces treatment beam filtration by 60% and long-range MV-scatter by 80% [2]. The author concludes his thesis by presenting results of an experimental demonstration of a novel dose-saving actively-triggered 4d cone-beam computed tomography device [3].

References to author publications that relate specifically to the dissertation:

[1] M.F. Fast, A. Krauss, U. Oelfke, and S. Nill, "Position detection accuracy of a novel linac-mounted intrafractional x-ray imaging system," Medical Physics, vol. 39, Jan. 2012, pp. 109-18.

[2] M.F. Fast, A. Teymurazyan, G. Pang, U. Oelfke, and J.A. Rowlands, "Finding an improved amorphous-silicon x-ray flat-panel detector configuration for the in-line geometry," Physics in Medicine and Biology, vol. 58, April 2013, pp. 2305-24.

[3] M.F. Fast, E. Wisotzky, U. Oelfke, and S. Nill, "Actively triggered 4d cone-beam CT acquisition," Medical Physics, vol. 40, Sep. 2013, pp. 091909.