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Multi-leaf Collimator (MLC) Edge Reconstruction for Radiotherapy Using Large Area CMOS Image Sensor

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In this paper we present a novel approach which employs a thin large area CMOS image sensor to implement an upstream in-vivo dosimeter for intensity-modulated radiotherapy (IMRT).
Cancer treatments such as IMRT or volumetric modulated arc therapy (VMAT) require increasingly complex methods to verify the accuracy and precision of the treatment delivery. In vivo dosimetry based on measurements made in an electronic portal imaging device (EPID) are affected by the distorting effect of the patient anatomy on the beam intensity. Alternatively, upstream detectors scatter and attenuate the beam. In the proposed solution the signal attenuation due to the CMOS sensor is minimal. The device combines low attenuation with high resolution, high stability and is fully suitable for VMAT. It can also be left in position while the patient is treated, eliminating the need for pre-treatment verification.
The paper presents the challenges of designing a large image sensor (61mm by 63mm). Particular attention has been paid to yield, signal distribution, radiation hardness and readout speed.
Multi-leaf collimator (MLC) edge reconstructions using a commercially available EPID and the designed large area CMOS sensor have been compared. The results show that the proposed CMOS-based solution achieves a precision 3.5 times better compared to EPID. The natural next step is to perform real time tests with a IMRT plan before moving towards larger sensors.
To fully exploit the potential of the proposed solution, in fact, larger, faster and buttable sensors will be needed in the future.

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