Purpose: To implement a quality assurance (QA) system for the treatment delivery of online adaptive radiation therapy utilizing Dynamic Machine Information (DMI).

Materials and Methods: DMI provides the expected/actual MLC leaf-positions, delivered MU, and beam-on status every 50ms during delivery. In this study a stream of DMI inputs is simulated by playing back Dynalog information recorded while delivering a test fluence map (FM). Based on these DMI inputs, the QA system performs three levels of monitoring/verification on the plan delivery process:

(1) Following each input, actual and expected FMs delivered up to the current MLC position is dynamically updated using corresponding MLC positions in the DMI. The magnitude and frequency of pixel-by-pixel fluence differences between these two FMs are calculated and visualized in histograms.

(2) At each control point, actual MLC positions are verified against the treatment plan for potential errors in data transfer between the treatment planning system (TPS) and the MLC controller.

(3) Both (1) and (2) can signal beam-hold with a user-specified error tolerance.

(4) After treatment, delivered dose is reconstructed in TPS based on DMI data during delivery, and compared to planned dose.

Results: (1) Efficiency: Average latency from DMI input to the completion of fluence difference calculation is <1ms.

(2) Efficacy: For test FM, transient error in leaf positions is (-0.07±0.28)mm; cumulative errors in delivered fluence is (0.003±0.183)% of the maximal fluence. The system can also identify
data transfer errors between TPS and MLC controller. Off-line dose reconstruction and evaluation show <0.5% dosimetric discrepancy from planned dose distribution for the test FM.

Conclusion: This QA system is capable of identifying MLC position/fluence errors in near real-time, and assessing dosimetric impact of the treatment delivery process. It is thus a valuable tool for clinical implementation of online adaptive radiation therapy.

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