Purpose: Develop a prototype real-time adaptive therapy system integrating automatic soft tissue tumor localization (STTL) with dynamic multileaf collimator (DMLC) adaptation of the treatment aperture. The system maintains a dynamic treatment aperture centered on the current tumor location during the entire breathing cycle. The STTL component utilizes portal images and operates without the need for fiducial markers. The proposed system has the potential to improve treatment accuracy, dose conformity and sparing of healthy tissue.

Methods: A prototype system was developed. The tumor is located automatically and in real-time on continuously acquired portal images and the tumor position is forwarded to the DMLC component to adapt the treatment aperture. The functionality is demonstrated with a preliminary setup: portal images are acquired by the treatment control system with a frame rate of 2 fps. The STTL algorithm continuously reads images, locates the target position and forwards it to the DMLC component which moves the treatment field aperture to that location. The preliminary setup was tested with a dynamic chest phantom driving a 1D sinusoidal motion in superior-inferior direction parallel to the MLC leafs.

Results: The individual geometric errors of the STTL algorithm and the DMLC are each smaller than 1mm in this configuration. The latency of the preliminary setup was less than 100 ms for the tracking of 15 landmarks with additional latencies coming from image acquisition, network transfers and DMLC component. The overall latency in the final setup is expected to be better than 550 ms.

Conclusions: We have developed a prototype real-time adaptive therapy system integrating automatic soft tissue tumor localization with DMLC adaptation of the treatment aperture. The functionality of the combined system was successfully tested in a preliminary setup. The overall geometric accuracy is expected to be better than 2 mm for 1D motion.

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