Abstract ID: 15691 Title: A nonparametric Bayesian approach to real-time 3D tumor localization via monoscopic xray imaging during treatment delivery

Purpose:Monoscopic x-ray imaging with on-board kV devices is an attractive approach for real-time image guidance in modern radiation therapy, but it falls short in providing reliable information along the direction of imaging x-ray. By effectively taking consideration of projection data at prior times and/or angles through a Bayesian formalism, we develop a nonparametric algorithm for real-time and full 3D tumor localization with a single x-ray imager during treatment delivery.

Methods:First, we construct the a priori probability density function using the 2D tumor locations on the projection images acquired during patient setup. Whenever an x-ray image is acquired during the treatment delivery, the corresponding 2D tumor location on the imager is used to update the likelihood function. The unresolved third dimension is obtained by maximizing the posterior probability distribution. The algorithm does not involve optimization of any model parameter and therefore can be used in a 'plug-and-play' fashion. We validated the algorithm using the 3D tumor motion trajectories of a lung and a pancreas patient reproduced by a physical phantom. Continuous kV images were acquired over a full gantry rotation with the TrueBeam on-board imaging system. Three scenarios were considered: fluoroscopic setup, cone beam CT setup, and retrospective analysis.

Results:The 3D localization error is < 1 mm on average and < 1.5 mm at 95 percentile in the lung and pancreas cases for all three scenarios. The difference in 3D localization error for different scenarios is small and is not statistically significant.

Conclusions:The proposed algorithm eliminates the need for any population based model parameters in monoscopic image guided RT and allows accurate and real-time 3D tumor localization on current standard Linacs with a single x-ray imager.