Purpose: A growing class of complex X-ray fluoroscopy guided procedures, particularly in interventional cardiology, neuroradiology, and in real-time tumor-tracking radiotherapy and radiosurgery involve long treatment durations. There is increasing concern regarding the amount of imaging dose delivered to the patient in these procedures. Recently, a method has been proposed for modulating imaging parameters using feedback of tracking precision. We evaluate such a method on respiratory motion data in the context of tracking a fiducial under X-ray fluoroscopy and present an online framework for modulating exposure to reduce imaging dose.

Methods: A Teflon sphere (1.5mm in diameter, 1000HU) was imaged at tube currents ranging from 0.5 mA to 0.9mA at a fixed energy of 100 kVp. The images were acquired on a Varian Paxscan 4030A (2048x1536) under the kV imaging geometry typically found on kV enabled medical linear accelerator systems (1000 mm source to axis distance, 1550 mm source to detector distance). This set of images was then used to generate motion sequences using published respiratory motion data, which were then composited to include a regions of high and low noise. The sphere was then tracked in these images using a particle filter. Tracking uncertainty from the particle filter was used to modulate the tube current such that the desired operating tracking precision was maintained while minimizing the imaging dose used. Performance was assessed using entrance surface exposure and mean squared error as metrics. An online framework for tracking objects of interested is developed that modulates the tube current in near real time.

Results: Comparison of the exposure modulation framework with a similar system employing fixed exposure reveals a dose savings of up to 27.4% when using an operating uncertainty of 0.2 mm.

Conclusions:This work presents a near real-time framework with a potential for dose reduction in X-ray fluoroscopic tracking procedures.