AbstractID: 13398 Title: Tracking 3D trajectory of internal markers using radiographic sequential stereo imaging: estimation of breathing motion

Purpose: To show that Sequential Stereo Algorithm can track internal markers that move with respiration using a single imager and to determine the accuracy and required number of images (dose) for typical breathing trajectories.

Method and Materials: The Sequential Stereo Algorithm, developed at Varian Medical Systems, Palo Alto, CA (patent pending) uses images acquired at different times and from different directions to track point targets moving in 3D. It performs best for trajectories that are *approximately* repeating in space, but not necessarily periodic; no prior knowledge or additional surrogate signal is needed. One application is to track radio opaque markers moving by respiration in the lung or liver, using kV images acquired on a gantry-based onboard imager while the gantry is rotating. We evaluated the algorithm using three different studies: 1) The Tracking concept was proven with projections from clinical CBCT scans (used retrospectively) exhibiting respiration motion. 2) Tracking accuracy was measured in a phantom experiment by kV imaging of a marker that moved on a known trajectory using a computer controlled 3-axis stage. 3) The sensitivity of accuracy to imaging frequency was determined by simulation study involving a virtual moving marker. Actual patient trajectories that included irregular breathing were driving both the stage and the simulated virtual point.

Results: Using 3.5fps imaging over 30 Sec and 180° gantry rotation the 3D tracking error at measurement points was 0.65mm RMS (1.83mm max) for the phantom imaging study, and 0.75mm RMS (1.64mm max) for the simulation. For an irregular breathing interval the error was 1.01mm RMS (3.64mm max). Simulation showed that error remains consistently under 1mm for imaging frequency greater than 3fps.

Conclusion: Sequential Stereo can accurately track internal markers that move with respiration in 3D, and may potentially be useful in real-time adaptive radiotherapy techniques.