

FIDUCIAL-BASED RESPIRATORY TRACKING VERIFICATION USING A HIGH-RESOLUTION PORTABLE FLAT-PANEL DETECTOR

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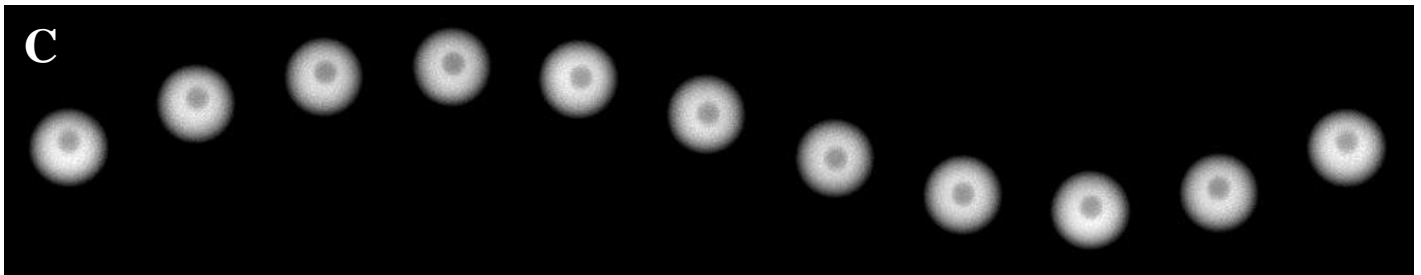
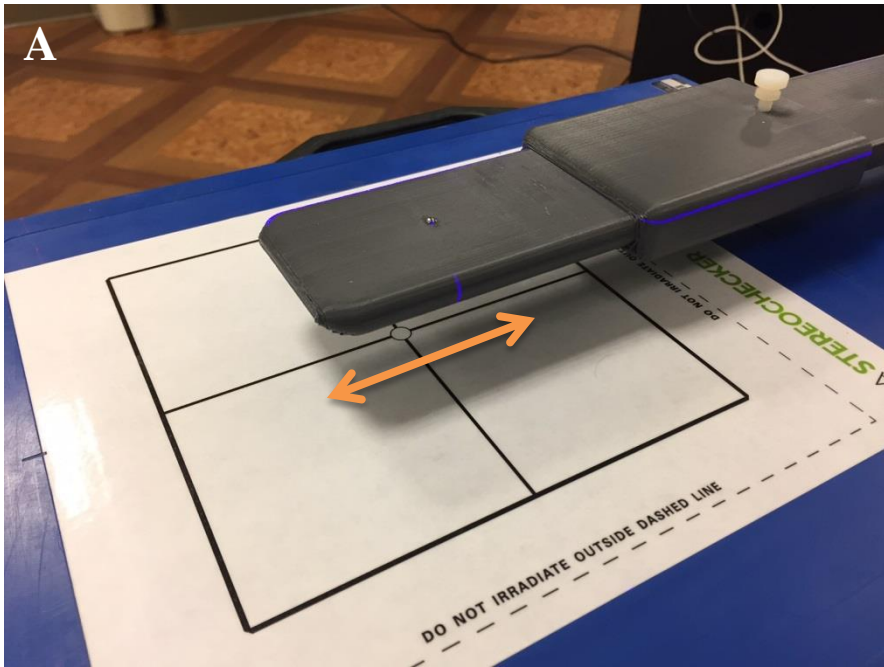
Purpose: The CyberKnife tracks lung lesions using the Synchrony system, where the motion of high-density fiducial markers serves as a surrogate for tumor motion. The authors present a filmless technique aimed at increasing precision and efficiency in the performance of Synchrony QA. Using the QA StereoChecker (QASC, Standard Imaging, Inc., Middleton, WI), a high-resolution portable flat-panel detector, the targeting accuracy of an M6 CyberKnife was determined during the delivery of a Synchrony plan. This study also investigated the variability in targeting accuracy as a function of the speed of a target.

Methods: A 3mm tungsten BB was affixed to a respiratory phantom (CIRS, Norfolk, VA) providing +/- 5mm motion in the superior/inferior direction in a plane parallel to the QASC. The speed of the BB varied between 0.0mm/s and 20mm/s. A single 10mm diameter beam was centered on the BB and perpendicular to the QASC, during which cine images were acquired. Delivery accuracy of the system was quantified by evaluating the variability of the difference between the centers of the radiation field and BB (which appeared as a shadow in the field).

Results: Across all measured speeds, targeting variation followed a normal distribution about the mean. At zero velocity, 95.45% of values fell within 0.10mm of the mean targeting variation value. Targeting variation increased with increasing speed, with measured values of 0.27mm, 0.31mm, 0.43mm, 0.58mm, 0.67mm, 0.65mm, and 0.65mm for 2.5mm/s, 5.0mm/s, 10.0mm/s, 12.5mm/s, 15.0mm/s, 17.5mm/s, and 20.0mm/s, respectively.

Conclusion: Used in conjunction with a motion phantom, the QA StereoChecker can adequately and precisely evaluate the performance of the Synchrony System. At speeds up to 20mm/s, Synchrony was shown to maintain variability of target accuracy with 95.45% of the measured values falling within 0.65mm from the mean. Clinically, this provides useful guidance in defining margins around lung lesions.

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Above. A. A 3mm Tungsten BB is coupled to a CIRS Respiratory Motion Phantom, and moves in a Sup/Inf motion atop a QAStereoChecker Portable Flat-Panel Imager (Standard Imaging Inc, Middleton, WI). **B.** A CyberKnife plan is delivered using the Synchrony Respiratory tracking system, targeting and tracking the BB. Using a 10mm fixed collimator, a beam is delivered orthogonal to the detector (and plane of BB motion). **C.** A time-lapse image of the motion of the BB, shown as a shadow within the larger field. The centers of the BB's shadow and the beam are calculated using automated Hough transform-based imaged analysis.

Right. Targeting variability is quantified as twice the standard deviation of the absolute difference between the center of the BB and the center of the field. Targeting variability is represented in this plot as a function of the speed of the target.

Targeting Variability - Variation with Speed

Error Bars Represent Standard Error

