

The Accuray CyberKnife incorporates a non-isocentric, robot-mounted linear accelerator which uses image guidance not only to detect the presence and determine the magnitude of target motion, but also to correct for real-time motion in 6 dimensions (x, y, and z translations, roll, pitch, and yaw angles). The ability to continuously correct for motion during treatment allows for sub-millimetric targeting accuracy for targets that do not move with respiration, and 1.5 mm (or less) accuracy for those that do. The stereotactic image guidance system uses two orthogonal, ceiling-mounted, kilo-voltage x-ray tubes and a pair of planar amorphous silicon imagers recessed in the floor. Five different tracking methods are employed, with the robot correcting the aim of the x-ray beam to account for target motion throughout treatment. Three tracking methods rely on anatomic density differences in the images (Skull Tracking, X-Sight Lung Tracking, and X-Sight Spine Tracking). Two rely on fiducial markers (Fiducial Tracking and Synchrony). Of these five methodologies, Synchrony and X-Sight Lung Tracking are designed to track and correct for motion of targets that move with respiration. The other three methods assume target motion is decoupled from respiratory motion. A recently developed refinement to X-Sight Lung tracking - called Lung Optimized Treatment - will be described briefly. The hardware and software used for each of the tracking methods will be discussed, along with examples of common treatment sites appropriate for each methodology. Finally, quality assurance techniques, along with results from system end-to-end tests, will be presented for each approach.