

AbstractID: 9623 Title: Calibration of Image-guided Robotic System for Prostate Brachytherapy

Purpose: To perform calibration and evaluation of an image-guided brachytherapy robotic system. **Method and Materials:** Brachytherapy robot calibration consists of three steps: mechanical robotic calibration, image calibration and overall system calibration. Mechanical calibration determines 1) system resolution, the smallest incremental movement that the robot can physically perform, 2) repeatability as a measure of the ability of the robot to move back to the same position and orientation and 3) accuracy, as the robot's ability to precisely move to a desired position in 3D space. Imaging calibration for our system is the procedure where distance from ultrasound images is transformed to the metric distance in robot absolute coordinates. Overall system calibration is to determine the exact position of image stacks, calculated in absolute robotic system coordinates. These steps were performed using high-resolution camera, specially designed phantom box for imaging calibration and CMM device for mechanical calibration. The system software allows mutual calibration between mechanical and imaging robotic modules. Mechanical calibration consists of DHV table definition for robotic system, matrix transformation, definition of composite matrices, direct kinematic solution, inverse kinematics solution, definition of robot initial position, calculation of positioner error, and error correction method. The robot errors gathered by position measurement are minimized by numerical optimization. **Results:** The calibrated precision of translation movements for the stylet and cannula are in the range of 0.03 - 0.08mm (depending on load); lateral and vertical movements for the gantry are 0.03mm; probe translation and rotation are 0.05mm and 0.03deg, respectively. The fiducial error for imaging is less than 0.1mm in x and y image coordinates. **Conclusion:** Overall robotic brachytherapy calibration plays a crucial role in accurate delivery. The calibrated precision of the image-guided brachytherapy robotic system are considered satisfactory for the given clinical application. **Acknowledgement:** Supported by NCI -R01-CA091763.