AbstractID: 7560 Title: Real-time Three-Dimensional Position and Orientation Data of a Brachytherapy Robot Using Magnetic Tracking

Purpose: To incorporate a magnetic tracking system with a brachytherapy robot to provide real-time information on position and orientation of anatomical structures.

Methods and Materials: A custom-built six-degree-of-freedom robot was engineered for highly accurate prostate brachytherapy implantations. The robot was tested and optimized in phantom to provide sub-millimeter error in seed placement. However, an implantation's accuracy may be limited by the ability to transfer 3-D anatomical data and convert it to the robot's coordinate frame. This transformation is difficult if the imager is not fixed, because the transformation from anatomical coordinates to robot coordinates changes dynamically. We tested the characteristics of a Minibird II tracking system (Ascension Technology, Burlington, VT) which consists of a transmitter that emits a magnetic field and a sensor to provide feedback of position and orientation. Multiple sensors can be added to determine the relationship between the robot and an ultrasound probe, for example. An analysis of the Minibird's accuracy in relationship to the highly precise movements of the robot in three dimensions was performed.

Results: The robot's movement compared to the magnetic tracker's positional information over 24 cm of travel was within 1.21%, 0.77% and 1.18% in the x, y, and z directions respectively.

Conclusion: Using magnetic tracking, a robot designed for brachytherapy implantation may use nearly any imaging modality to acquire anatomical data. A sensor may attach to a free-hand ultrasound probe or fluoroscopy machine, for example. This opens the possibility of using the robot for needle insertions other than prostate LDR procedures with a rectal probe. The robot can be modified easily for accurate needle targeting of many soft tissue structures. Lastly, the cost of magnetic tracking is small (in equipment and upkeep cost) when compared to 3-D infrared tracking, while also eliminating the "line-of-sight" issues that may occur with those systems.