

## AbstractID: 5394 Title: A robotic platform for image-guided brachytherapy (IGBT)

**Purpose:** In image-guided brachytherapy (IGBT), accurate placement of needles and radiation sources is a major challenge. In traditional prostate brachytherapy, for example, needles are introduced through fixed, parallel holes of a template where the maneuverability of the needle is extremely limited. The accuracy of needle placement and seed delivery is subject to variation with clinician technique, such as deflection force and needle rotation. We present a robotic platform for IGBT, a semi-automated 14 degree-of-freedom (DOF) robotic system, designed and fabricated for performing prostate brachytherapy with radioactive seeds.

**Method and Materials:** The IGBT system consists of two main modules: (1) a 7 DOF positioning module, and (2) a 7 DOF surgery module. The positioning module has a 2 DOF cart and a 5 DOF platform. The surgery module includes a 2 DOF ultrasound probe driver, a 3 DOF gantry robot, a 2 DOF needle inserter and a seed pusher. All motions of the surgery module are motorized. This system incorporated numerous important data and methods garnered from *in-vivo* measurements during actual brachytherapy procedures. Various techniques to enhance precision of needle insertion and seed delivery have been implemented into the system, after extensive verification via phantom experiments. Three force-torque sensors were incorporated for tracking the forces on the needle to detect pubic arch interference and to improve robot control. Rigidity and factor of safety of the mechanical structures have been analyzed using finite element method. The system has provisions for feedback of various states (position, velocity and force), which will be useful to improve needle insertion and seed delivery accuracy, consistency and efficiency.

**Results and Conclusion:** Preliminary experimental results demonstrate highly accurate (sub-millimeter) and consistent placement of brachytherapy needle. Extensive experiments have been conducted to evaluate performance of this prototype system for IGBT.

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