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Development of a novel robot for prostate focal therapy and brachytherapy

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Purpose: To report on the initial experience with a new 3D ultrasound robotic system for prostate brachytherapy assistance and focal therapy. MRI-TRUS fusion as well as its ability to track prostate motion intra-operatively allows it to manage motions and guide needles to MRI enhanced tumor foci.
Materials & Methods: A robotic system for TRUS-guided needle implantation combined with intraoperative prostate tracking was created. Experiments were conducted on 90 targets embedded in 9 mobile and deformable synthetic prostate phantoms. A preliminary feasibility study on 2 cadavers was also carried out. The experiments involved trying to insert glass beads as close as possible to targets in multimodal imaging phantoms and in cadaver prostates. The results were measured by segmenting the inserted beads in CT scan volumes of the phantoms and of the cadaver's radical prostatectomy specimens.
Results: The robot was able to reach the chosen targets in phantoms with a median accuracy of 2.73 mm, with a median prostate motion of 5.46 mm. Accuracy was better in apex than in base (2.28 vs 3.83 mm, $p<0.001$) and was similar for horizontal and angled needle inclinations (2.7 vs 2.82 mm, $p=0.18$). Cadaver tests showed the feasibility of the robot's ergonomics in the operating room but further in vivo assessments are needed.
Conclusion: This robot for prostate focal therapy and brachytherapy is the first system using intraoperative prostate motion tracking to guide needles into the prostate. The preliminary experiments described show its ability to reach targets in spite of the motion of the prostate.