

AbstractID: 12757 Title: An innovative needle tip detection method for TRUS-guided prostate HDR brachytherapy

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**Purpose:** In the TRUS-guided prostate HDR brachytherapy, the needle tip defines the distal end of possible dwells. Needle tip detection plays a critical role in the distance accuracy of dwell positions and hence has a significant impact on dosimetry. However, directly finding the needle tip on the ultrasound images is nothing but an uncertain art. Therefore, the current study was conducted to design and evaluate a novel method to turn this uncertain art into an accurate measurement-based detection.

**Method and Materials:** Our method used real-time-measured residual needle length and offline-established coordinates to calculate the needle tip position on the TRUS images. Coordinates were established and populated to a lookup table through measurements at possible template-to-probe configurations. With the known full length of a needle, the tip position can be calculated using an online-measured residual length and this lookup table. To evaluate our method, we conducted an experiment in water. The needle tip positions were detected by (1) x-ray radiographs which we use as the gold-standards; (2) our measurement-based method; and (3) direct detection on ultrasound images. 5 different template-to-probe configurations were tested, and at each configuration the equipments were assembled for 3 times to assess the assembling reproducibility.

**Results:** With the 5 tested configurations, the reproducibility was found based on the gold-standard radiographs to be within 0.2 mm. Relative errors using our method and the direct detection method were from 0.6 to 0.8 mm and from 0.9 to 2.3 mm, respectively.

**Conclusion:** A simple and effective method to accurately detect the needle tip on the TRUS images for HDR prostate brachytherapy was developed based on physical-measurement-defined coordinate systems. The validity and accuracy of the method was tested and established. The easy-to-implement method is clinical-ready.