ABSTRACTS

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MR-TRUS Registration Accuracy for Targeted Biopsy of the Prostate

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Introduction: Image-guided prostate biopsy through fusion of multi-parametric MRI with real-time transrectal ultrasound (TRUS) offers the promise of improved cancer diagnosis. Accurate image registration of MR and TRUS is necessary to reliably target areas of suspected cancer. We performed preliminary clinical validation of the MR-TRUS registration accuracy in a 3D imaging and biopsy-tracking device (Artemis, Eigen). Prior validation of MR-TRUS registration has been performed only on phantoms.

Methods: Five patients with internal gold bead fiducials (3 per patient), previously inserted to guide radiation therapy, were imaged using multi-parametric MRI and 3D transrectal ultrasound. The fiducial locations were identified by a uro-radiologist and imaging scientists on MRI and TRUS. Prostates were then outlined using a semi-automatic segmentation method in both modalities. For each case, three users (SN, RN, DK) performed manual alignment and automatic registration independently. Segmentations in TRUS and MRI were kept constant across users per study. Registration was performed on both segmented surfaces with a user defined rigid alignment followed by an automatic non-rigid surface registration of corresponding segmentations from MR and TRUS followed by elastic interpolation. Target registration error (TRE), i.e. the distance between corresponding points on MR and TRUS, was averaged across users and fiducials in a study. The error associated with selecting a fiducial, or fiducial localization error (FLE), was normalized across users, and calculated as the mean norm of the resulting error vectors.

Results: 10 of the 15 fiducials were found with certainty on both modalities. We found an average target registration error (TRE) of 3.23 mm, with a fiducial localization error (FLE) of 0.53 mm in TRUS and 0.44 mm in MRI. When all observers agreed upon an alignment for registration, a TRE of 3.08 mm was found.

Conclusion: Registration accuracies in men agreed with values previously obtained in phantoms (Narayanan *et al*, IEEE Biomed Imag, 2009). FLE contributions to TRE were minimal. Increases in both the dataset size and TRUS scan quality are necessary for improved estimation of error. Segmentation variability in TRUS and MR and its contribution to TRE are also necessary for an accurate measure of error sources. These preliminary data indicate that MR-TRUS fusion, for the purpose of targeted prostate biopsy, may be performed with accuracy.

Case	# of Fiducials	Segmented TRUS Vol. (mL)	Segmented MR Vol. (mL)	Difference in Vol. (%)	Max Fiducial Distance(mm)	Target Registration Error (mm)
1	2	20.25	24.85	+20.40	27.67	4.91
2	2	25.83	28.00	+8.06	27.20	4.15
3	2	39.67	41.16	+3.69	15.65	2.17
4	1	45.98	55.74	+19.19	-	2.30
5	3	134.70	107.43	-22.53	45.05	3.01
TRUS Fiducial Localization Error (FLE)			0.53 mm			
MR Fiducial Localization Error (FLE)			0.44 mm			
Average Target Registration Error (TRE)			3.23 mm			