Rigid and non-rigid registration of prostate B-mode and ARFI images to MR and whole-mount histology

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Acoustic Radiation Force Impulse (ARFI) imaging is being developed to guide needle biopsies and focal therapies in the prostate using an ER7B endorectal ultrasound probe on a Siemens ACUSON SC2000Ô ultrasound scanner. B-mode ultrasound (US) images suffer from poor prostate structure visualization, but i*n vivo* ARFI images delineate internal structures in the prostate with higher contrast. Magentic resonance (MR) imaging is also emerging as a useful imaging modality in delineating and characterizing regions of disease. We are developing image registration techniques that facilitate correlation of *in vivo* ARFI, B-mode US, and MR images obtained prior to radical prostatectomy with whole mount histology data. Pathology and internal prostate structures were identified and segmented and used to form 3D mesh models of the prostate. Non-rigid registration of the different models was performed and the registered images were evaluated for co-localization of confirmed pathology. The methodology was validated using simulated prostate anatomy and finite-element techniques and found to improve the accuracy of the average displacement of registration markers by 76% in the MR simulation and 58% in the US simulation. When implemented on the patient data, the registration methodology was found to simplify multi-modality image comparison and analysis. Confirmed pathology was found to align with similarly suspicious regions in both ARFI and MR images. With its improved anatomical visualization over traditional B-mode imaging, ARFI holds promise for providing targeted image guidance of prostate focal therapy and needle biopsy.