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Towards Open Source Infrastructure for Joint MRI/TRUS Guided Prostate Interventions

A. Fedorov¹, A. Lasso², M. Moradi³, E. Neubauer Sugar¹, S.-E. Song¹, R. Owen⁴, T. Kapur¹, W.M. Wells¹, P. Nguyen¹, G. Fichtinger², C. Tempany¹
¹Brigham and Women’s Hospital, Boston, MA ²Queens University, Kingston, ON ³University of British Columbia, Vancouver, BC ⁴BK Medical, Peabody, MA

Purpose Transrectal Ultrasound (TRUS) and Magnetic Resonance Imaging (MRI) are complementary imaging modalities in visualizing anatomy of the prostate and characterizing the tissue for cancer presence. Our goal is to develop a free open-source infrastructure to facilitate image acquisition, visualization, analysis, and joint guidance for prostate interventions using these two modalities. Towards this goal, our initial step was to establish the feasibility and technical setup for research data acquisition of TRUS and TRUS/MRI registration.

Methods Clinical Setup TRUS image acquisition was performed during brachytherapy prostate volume studies. Per standard clinical setup, TRUS probe (BK 8848) was attached to a motorized mover (Nucletron EndoCavity Rotational Mover (ECRM)) and mounted on a stepper (Nucletron OncoSelect). Imaging was performed using the sagittal array of the probe rotated by ECRM. Research setup Camera link and OEM research interfaces of the BK ProFocus US scanner (BK Medical) were used to collect radiofrequency (RF) TRUS concurrently with the clinical image acquisition. Spatial sensor (Phidget Spatial) was attached to the handle of the probe to track sagittal array orientation during motorized sweep. Synchronous collection of the RF and tracking data was performed using Public Library for UltraSound research (PLUS)¹ on a workstation equipped with a camera link interface (Dalsa X64 CL Express). Post-processing We used PLUS for brightness and scan conversion, and 3D reconstruction from the tracked data. Reconstructed volumes were aligned with the T2-weighted MRI images, and the prostate gland was contoured in both volumes using 3D Slicer (http://slicer.org). Distance transform was applied to the gland contours. The distance maps were registered non-rigidly using BRAINS module of 3D Slicer. The resulting transforms were applied to the MRI dataset.

Results The described approach was applied in an cohort of clinical patients (n=10). Our setup was compatible with the clinical workflow and did not introduce delays or complications during the procedure. Based on the initial analysis (n=2), deformable registration was feasible and qualitative assessment deemed the results satisfactory.

Conclusions We demonstrated the feasibility of tracked acquisition of TRUS RF data during conventional prostate volume study procedures, and established the post-processing workflow for joint visualization of TRUS and MR imaging data. Our approach requires availability of US research interface, but otherwise relies on publicly available software and tracking components.

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¹Public Library for UltraSound research (PLUS): http://www.plustoolkit.org/