Registration of ultrasound and histology data for validation of emerging prostate cancer imaging techniques

REGISTRATION OF ULTRASOUND AND HISTOLOGY DATA FOR VALIDATION OF EMERGING PROSTATE CANCER IMAGING TECHNIQUES

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Introduction: Several ultrasound (US) methods are emerging for prostate cancer imaging, aiming at enabling targeted biopsies as well as focal-therapy guidance. However, any of these methods, such as elastography and contrast-enhanced US, requires accurate validation prior to introduction in clinical practice. As the gold standard reference for prostate cancer detection remains histological Gleason scoring after radical prostatectomy, validation requires accurate mapping of the histology results on the imaging results. This task is complicated by misalignment between histology slices and US imaging planes, and by prostate deformations in the ultrasound image, due to insertion of the transrectal US (TRUS) probe, as well as in the histology, due to fixation processes. In addition, except for the prostate contour, US images do not provide reliable landmarks for accurate mapping. This abstract proposes a solution to these problems by a dedicated 3D elastic registration method.

Methods: A 3D US image of the prostate is reconstructed based on two 2D TRUS imaging sweeps, longitudinal and lateral. Also a 3D reconstruction of the histology results, including cancer location, is realized by integration and interpolation of 4-mm prostate slices. Two 3D triangulated meshes of the prostate surface are then realized on the reconstructed US and histology volumes. A combination of rigid and elastic registration is applied for 3D mapping of the histology on the US surface. The deformation of the inner volume is estimated on the basis of the surface deformation, without need for additional landmarks.

Results: *In vitro* validation was performed by a prostate mimicking phantom with inserted elastic wires. The proposed registration method was applied to estimate the wire displacement due to an externally-applied pressure. The resulting accuracy was 2.2 mm, smaller than the histology resolution (4 mm). The method feasibility was tested in two patients referred for radical prostatectomy. Figure 1 shows two registered planes with the contours of the US image and the corresponding mapped histology. Cancerous tissue, according to the histology, is depicted in red.

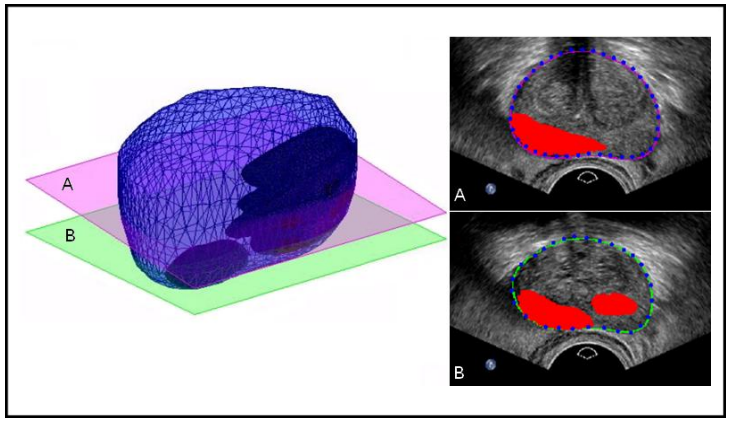

Figure: Mapping of two registered planes from histology to US.