

PP-12**Ultrasound-histology registration for validation of prostate cancer imaging techniques**S.G. Schalk¹, M. Mischi¹, T.A. Saidov¹, M. Smeenge², J.J.C.M.H. de la Rosette², H. Wijkstra^{1,2}¹ Department of Electrical Engineering, Eindhoven University of Technology, Eindhoven, The Netherlands² Department of Urology, AMC University Hospital, Amsterdam, The Netherlands

Introduction: With the aim to enable targeted biopsies and focal therapy for prostate cancer (PCa), several ultrasound(US)-based PCa localization methods are emerging. Accurate validation is an essential step towards clinical introduction for any of these methods. Typically, histopathologic analysis of the prostate after excision is used as a gold standard. To enable accurate validation, accurate histology-US registration is required. This registration method should compensate for misalignment between histology slices and US imaging planes, deformation of the prostate after excision, and local deformation at the posterior surface caused by the transrectal US probe. Registration is further complicated by the lack of natural landmarks which are visible in both modalities to assist the registration and the limited slicing resolution of the prostate during preparation for histology. This abstract proposes a 3-dimensional (3D), surface-based, elastic registration method to solve the aforementioned issues.

Material & Methods: A 3D prostate shape is reconstructed based on the prostate contours in a transversal US sweep video and a longitudinal image. Also, a shape model is constructed from the prostate contours of the histology slices, including cancerous areas. A rigid registration, followed by elastic registration, maps the histology results onto the ultrasound shape. This enables fusion of any US plane with the histology results for pixel-wise validation.

For quantitative validation of the proposed registration method, an *in-vitro* experiment was performed producing and using four prostate-mimicking phantoms, each containing eight fiducial markers. The models were deformed by local pressure, simulating the deformation caused by a transrectal probe during a prostate examination. Using a 3D US probe, the models were scanned in undeformed and deformed (twice) state. Subsequently, shape models were constructed and registered using the proposed method. The target registration error (TRE) was defined as the distance between a registered marker and its reference. The *in-vivo* feasibility of the method was also tested; histology results were successfully fused with B-mode prostate images in 12 patients.

Results: The *in-vitro* experiment resulted in a TRE of 2.2 ± 1.4 mm (mean \pm standard deviation), which is well below the histology slicing thickness (4 mm) and the diameter of clinically significant cancer (10 mm). No difficulties were encountered during the histology-US fusion of the 12 patients.

Conclusion: The proposed surface-based registration method proved to be accurate in an *in-vitro* experiment. Additionally, the feasibility to register *in-vivo* US prostate images and histopathological results was demonstrated. Being independent of the underlying imaging modality, future application to MR can also be envisaged.