A0133

Data processing pipeline and Artificial Intelligence (AI) for autonomous fusion in transperineal prostate biopsies

Eur Urol Suppl 2024;85 (S1): S858

Cianflone F.[1], Maris B.[2], Alessandro V.[1], Artoni F.[1], Montanaro F.[1], Pettenuzzo G.[1], Cerruto M.A.[1], Fiorini P.[2], Antonelli A.[1]

[1]University of Verona - Azienda Ospedaliera Universitaria Integrata, Dept. of Urology, Verona, Italy, [2]University of Verona, Dept. of Engineering for Innovation Medicine, Verona, Italy

Introduction & Objectives: The role of prostate segmentation through AI is to automatize fusion biopsies procedures. Real-time segmentation of the prostate could allow prostate tracking during the procedure, compensating both ultrasound (US) probe and patients movements. Here we present a data processing pipeline and AI for autonomous fusion during transperineal prostate biopsies.

Materials & Methods: 293 patients undergoing freehand US-guided transperineal prostate biopsies for prostate cancer suspicion at our center were enrolled from 04/21 to 07/22; 242 underwent fusion biopsies, with 153 of them having in-house mpMRI DICOM images. An Arietta V70 US machine with biplanar transrectal probe was employed. Before performing the biopsy, prostate sagittal and axial US (framerate ~20Hz) were recorded in DICOM format, gathering ~400 images for each patient. To obtain the ‘ground-truth', expert radiologists segmented the prostates on sagittal and axial scans with a semi-automatic interface in Mevislab (MeVis Medical Solutions AG, Germany). The US dataset was divided into test, validation and training with a ratio of 20%, 20% and 60% respectively. An AI algorithm was designed for this task: PROST-Net. A 60 patients validation cohort was enrolled from 02/23 to 06/23. Transrectal biplanar US (Esaote) was performed, with the same scan protocol. On this US data, the interface was integrated with the AI, giving an initial contouring of the prostate; 2 experturologists adjusted AI results, adding more immediate data to the ‘ground truth'. To train our algorithm for MRI segmentation, we used data from the Cancer Imaging Archive website (https://wiki.cancerimagingarchive.net/), and its accuracy was verified on patients' in house MRI data. The dataset contained T2 MRI scans, 3D reconstructed US and prostate and PIRADS≥3 lesions segmentation in both MRI and US. After automatic contouring of the prostate in both mpMRI and US, we designed a fusion algorithm that works in 3 steps: pre-alignment, rigid-alignment and elastic fusion. After fusion, distances between each lesion in MRI to the same lesion in US were assessed.

Results: On the US test data after “ground-truth”, the Dice coefficient of PROST-Net in prostate segmentation was 0.78. In the 2° US cohort after adding data, its accuracy was >0.80. After MRI algorithm training, the accuracy was 0.95 on in-house MRIs. Dice coefficient between MRI and US segmentation after rigid fusion was 0.75. Mean MRI-US lesion distance was 8mm after the rigid fusion and 4mm after elastic fusion.

Conclusions: We demonstrate an effective data processing pipeline and AI for the autonomous fusion during transperineal prostate biopsies. Further goal is to add data for AI algorithm to reach ≥0.90 fusion accuracy and ≤2mm MRI-US lesion distance, providing a sound basis for developing an autonomous robotic platform for transperineal prostate biopsies.