Detection of Prostate Cancer Using Temporal Sequences of Ultrasound Data: A Large Clinical Feasibility Study

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Introduction

Transrectal Ultrasound (TRUS) Systematic Biopsy MR/TRUS Fusion Biopsy

Objective: Improvement of TRUS-guided prostate biopsy by increasing its accuracy and reducing the high rate of unnecessarily biopsies using temporal enhanced ultrasound.

Temporal Enhanced Ultrasound

Temporal Enhanced Ultrasound: Temporal sequence of Radio Frequency (RF) ultrasound frames from a stationary tissue location.

Material and Methods

Figure 1. Test data are divided into three subgroups based on the distance of the target to prostate boundary and the axial and sagittal histopathologies.

Figure 2. An illustration of the proposed method. The DBN has one visible layer with 50 units and four hidden layers with 100, 50 and 6 hidden units, respectively. The latent features are the output of the last layer of DBN.

Results

Figure 3. Performance across: (Top) MR suspicion levels & datasets. (Bottom) Gleason scores (GS) for dataset D2-B.

Figure 4. Cancer probability maps overlaid on TRUS images. ROIs with cancer likelihood >70% are in red. Segmented prostate boundary from MRI is projected on TRUS coordinates.

Figure 5. Differences of distributions between cancerous and benign tissue back projected on the input. Frequencies between 0–2 Hz provide the most discriminative features.

Conclusion

- Using temporal enhanced US in a fusion prostate biopsy study an AUC of 0.80 for moderately scored mp-MRI targets is achieved.
- Temporal enhanced US combined with mp-MRI has the potential to reduce the number of unnecessary biopsies.
- Limitations: (i) Training DBN is computationally expensive; (ii) temporal enhanced ultrasound is only acquired from mp-MRI positive tumors.

References