Ultrasound-based Characterization of Prostate Cancer For Transrectal Biopsy Guidance

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Introduction: The Prostate Cancer (PCa) detection under transrectal ultrasound (TRUS) guidance is blind to intraprostatic pathology, and can miss clinically significant disease. Multi-parametric MRI (mp-MRI) and its fusion with TRUS show promising results to target potential cancer lesions. However, mp-MRI has a high false positive rate, and can miss smaller foci of high-grade disease. Our group has been investigating a new ultrasound-based paradigm for tissue characterization referred to as Temporal Enhanced Ultrasound (TeUS). TeUS is defined as the time-series of ultrasound radio frequency frames captured from insonification of a fixed tissue location over time.

Methods: Here, we use TeUS for detection and grading of PCa in a clinical study with 197 biopsy cores from 132 patients. Our method involves capturing high-level features of TeUS with a deep-learning approach followed by detection of aggressive cancer. Based on the evidence derived from the deep-learning model, and the structure of tissue from digital pathology, we also build a simulation framework for studying the physical phenomenon underlying TeUS [1, 2].

Results: We achieved an area under the curve (AUC) of 0.80 to 0.93 for detection of PCa for targets with different suspicious levels in mp-MRI. Deep-learning based feature visualization pointed to dominant frequencies in the data that were in the range of heart beat. Simulation results exciting prostate tissue in this frequency range produced outcomes that corroborated with in vivo observations [3].

Conclusion: In a retrospective study, our deep-learning solution based on TeUS can complement mp-MRI-based fusion biopsy. Future study will be to evaluate this technology prospectively.

References

