Joint learning of ultrasonic backscattering statistical physics and signal confidence primal for characterizing atherosclerotic plaques using intravascular ultrasound.

Intravascular Ultrasound (IVUS) is a predominant imaging modality in interventional cardiology. It provides real-time cross-sectional images of arteries and assists clinicians to infer about atherosclerotic plaques composition. These plaques are heterogeneous in nature and constitute fibrous tissue, lipid deposits and calcifications. Each of these tissues backscatter ultrasonic pulses and are associated with a characteristic intensity in B-mode IVUS image. However, clinicians are challenged when colocated heterogeneous tissue backscatter mixed signals appearing as non-unique intensity patterns in B-mode IVUS image. Tissue characterization algorithms have been developed to assist clinicians to identify such heterogeneous tissues and assess plaque vulnerability. In this paper, we propose a novel technique coined as Stochastic Driven Histology (SDH) that is able to provide information about co-located heterogeneous tissues. It employs learning of tissue specific ultrasonic backscattering statistical physics and signal confidence primal from labeled data for predicting heterogeneous tissue composition in plaques. We employ a random forest for the purpose of learning such a
primal using sparsely labeled and noisy samples. In clinical deployment, the posterior prediction of
different lesions constituting the plaque is estimated. Folded cross-validation experiments have been
performed with 53 plaques indicating high concurrence with traditional tissue histology. On the wider
horizon, this framework enables learning of tissue-energy interaction statistical physics and can be
leveraged for promising clinical applications requiring tissue characterization beyond the application
demonstrated in this paper.