Neural Network in Tissue Characterization of Optical Coherence Tomography Images for Smart Laser Surgery: A Preliminary Study

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The aim of this study is to develop an automatic tissue characterization system, based on Optical Coherence Tomography (OCT) images, for smart laser surgery. OCT is rapidly becoming the method of choice for investigating thin tissues or subsurface imaging. In smart laser surgery, OCT could be used to indicate which tissue is being irradiated, thereby preventing the laser from ablating critical tissue such as nerves and veins. Automatic tissue characterization based on the OCT images should be sufficient to give feedback to the laser control. In this study, two main neural networks were trained to classify texture and optical attenuation of three different tissues (bone, fat, and muscle). One neural network texture classifier was trained to differentiate between patterned and patternless images. The other neural network was trained to classify patternless images based on their attenuation profile. The two neural networks were stacked as a binary tree. The ability of this hybrid deep-learning approach to characterize tissue was evaluated for accuracy in classifying OCT images from these three different tissues. The overall (averaged) accuracy was 82.4% for the texture-based network and 98.0% for the attenuation-based (A-Scan) network. The fully connected layer of the neural network achieved 98.7% accuracy. This method shows the ability of the neural network to learn feature representation from OCT images and offers a feasible solution to the challenge of heuristic independent tissue characterization for histology and use in smart laser surgery.

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