Effective Medical Image Segmentation for Osteoarthritis Analysis.

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Abstract

Osteoarthritis (OA) is the most common degenerative joint disease worldwide, tending to occur in the joints of hip and knee. Effective medical image segmentation methods play important roles in the clinical analysis and diagnosis of the disease. In this dissertation, we first exploit a deep multi-task learning network for the shape-preserved segmentation of the proximal part of femur (i.e., femoral head and neck) in 2D magnetic resonance (MR) images. This method combines the tasks of region identification and boundary distance regression, and thus enables the task-specific feature learning for continuous segmented object with smooth boundary. This bone depiction can be further used for the alpha angle measurements to reflect the evolution of hip OA. Second, we propose the knee cartilages (i.e., femoral, tibial, and patellar cartilage) segmentation in large-sized and high-resolution 3D MR knee data and explore the defect/loss conditions in cartilages which are important factors of knee OA. The key contribution is an adversarial learning based collaborative multi-agent network. We use three parallel segmentation agents to label cartilages in their respective region of interest (ROI), and then fuse the three cartilages by a ROI-fusion layer and drive a collaborative learning by an adversarial sub-network. The ROI-fusion layer not only fuses the individual cartilages, but also backpropagates the training loss from the adversarial subnetwork to each agent to enable joint learning of shape and spatial constraints. In the last part of this dissertation, we investigate the muscular and adipose structure extraction in 3D MR thigh data via an integrated framework. Specically, deformable models and learning based techniques are integrated into the framework to enable robust tissue quantication for the large-scale analysis of OA-related thigh tissue changes.

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