Deterministic and probabilistic active contour models for medical image segmentation

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Abstract:

In clinical applications, automatic medical object extraction is often a necessary preprocessing step for organ reconstruction, quantitative analysis and computer aided diagnosis. Due to the wide variety of shapes, the complexity of the topology, the presence of noise in a complex background, and the specificities of imaging techniques, extracting medical objects automatically and accurately is a very difficult task. Active contour models are among the most successful methods for finding optimal outlines of objects and one of the issues of our research was the hypothesis that prior knowledge about the structures to be extracted could also play an important role in the segmentation procedure. In this work, we firstly present a general framework of prior knowledge based image segmentation. Then in such a framework, we proposed several deterministic and probabilistic active contour models in different medical applications: 1) the Region Competition based Active Contour (RCAC model) for medical objects in general, 2) the Vascular Active Contour model (VAC) for vessel tree segmentation, 3) prior shape constrained active contour models for the extraction of specific shapes, 4) a deformable model exploiting hierarchical and multi-level probabilistic prior knowledge for mitral annulus extraction and liver segmentation. As shown in our experiments in ultrasound, CT, and MRI images, these models are more accurate and robust than the classical active contour models and are therefore more suited for an automatic extraction procedure.