PhD Thesis

Sketch-Based Interactive Segmentation and Segmentation Editing for Oncological Therapy Monitoring

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Abstract

A tumor’s change in size is an important criterion for assessing its response to chemotherapy. The current gold standard for measuring the size of solid tumors and their progression over time is the maximum diameter. A diameter is not always appropriate, though, since most tumors grow and shrink irregularly in 3D. Therefore, the volume of a tumor has shown to be a more accurate and reproducible measure for tumor size. In order to measure a tumor's volume based on CT, it needs to be delineated in the 3D image, which is known as the segmentation problem. The aim of this thesis is to investigate methods for interactive segmentation and editing of segmentation results in order to support the radiologist in efficiently and reliably measuring a tumor's volume in follow-up examinations. For interactive 3D segmentation, this thesis proposes a general image-independent algorithm that utilizes an object reconstruction approach. To allow an efficient 3D editing of automatically generated, insufficient segmentation results, an image-based as well as an image-independent method are suggested. All segmentation algorithms discussed in this thesis are based on an intuitive sketching interface, i.e., a user interaction in the contour domain. Evaluating algorithms for segmentation editing is challenging, because their quality depends on the user's subjective impression. This thesis discusses the evaluation of segmentation editing algorithms. In order to objectively and comprehensively evaluate segmentation editing algorithms, a qualitative rating-scheme as well as a score that accumulates the quality of intermediate segmentation results are proposed. To allow a more reproducible evaluation without the need for a user, a simulation-based evaluation approach is investigated as well. As CT images suffer from partial volume effects caused by their limited spatial resolution, the delineation of a tumor is an ill-defined problem. Particularly for interactive segmentation methods, this can result in significant differences in the measured volume by different readers or at different points of time. In order to increase the accuracy and reproducibility of volumetric measurements, a fast method for compensation of partial volume effects is proposed that utilizes the information of a given segmentation result.