SmartClick: A Novel Automated Segmentation Tool for Medical Images With Interactive Optimization Capabilities Designed for Liver Cysts

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Liver cysts characterize a multitude of illnesses ranging from liver cancer to autosomal dominant polycystic kidney disease (ADPKD). About 1 in 20 people have at least one liver cyst (Cnossen, 2014). Labeling of these cysts on medical images is referred to as segmentation, but manual methods are long and tedious, often resulting in fatigue and successive segmentations diminishing in accuracy. Thus, a more efficient method is necessary. This study proposes a novel program that combines the U-Net deep-learning architecture (Zhou, 2018) for a liver region-of-interest segmentation and the automated Chan-Vese level-set algorithm (Chan, 2001) with an interactive recursive tool: SmartClick. SmartClick is an iterative region growth function guided by spatial and intensity values for revisions of the previous automated level-set segmentation. A user interface was then created using the QT-python framework for a more practical segmentation workflow. 17 deidentified MRI scans from ADPKD patients were used to compare pre-existing level set segmentation of liver cysts to the novel SmartClick segmentation. Both segmentations were compared against the manual segmentation as ground truth (GT). The novel Smartclick tool reduced the segmentation time by more than tenfold and agreed well with GT (79% dice score and 99% intra-class correlation coefficient [ICC]). The proposed workflow outlined by this study resulted in an 8.92% higher ICC when compared with the deep learning-level set method implemented by Kim (2016) and a 4% higher dice score compared to Alrr (2020). Thus, revisions with SmartClick are feasible for fast, accurate liver cyst segmentation.

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