In-house automatic liver segmentation from CT based on deep convolutional neural network with data augmentation

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Abstract

Purpose

To develop and evaluate deep convolutional neural network (CNN) for automatic liver parenchyma segmentation and test differences in training accuracy based on different normalization and augmentation parameters.

Methods and Materials

21 computed tomography (CT) studies including 11,966 slices of patients qualified for laparoscopic liver resection for oncological purposes were used to develop the network. Data was divided in a ratio of 70% to 30% for training and test sets, respectively. A standard 2D U-Net architecture was employed to the network. We conducted a series of experiments with the same data, modifying normalization range and data augmentation methods. Batch size of 1, 15% validation split and 70 epochs were used consistently throughout the study.

Results

Highest Dice similarity coefficient (DSC) of 0.931 on a test set was achieved for a CNN with normalization in range from -200 to 500 HU and 21 CT augmented volumes created with elastic deformations. CNN with no augmentations or normalization scored 0.799 DSC, while CNN with normalization only improved DSC to 0.895. Augmentations based on rotation and translation only did not improve CNN accuracy.

Conclusion

State-of-the-art CNNs are feasible to develop in-house solutions for accurate liver segmentation. Both normalization and elastic transformations were required to achieve best results, with normalization being the most important factor.