Automatic liver tumor segmentation on computed tomography for patient treatment planning and monitoring

ABSTRACT

Segmentation of liver tumors from Computed Tomography (CT) and tumor burden analysis play an important role in the choice of therapeutic strategies for liver diseases and treatment monitoring. In this paper, a new segmentation method for liver tumors from contrast-enhanced CT imaging is proposed. As manual segmentation of tumors for liver treatment planning is both labor intensive and time-consuming, a highly accurate automatic tumor segmentation is desired. The proposed framework is fully automatic requiring no user interaction. The proposed segmentation evaluated on real-world clinical data from patients is based on a hybrid method integrating cuckoo optimization and fuzzy c-means algorithm with random walkers algorithm. The accuracy of the proposed method was validated using a clinical liver dataset containing one of the highest numbers of tumors utilized for liver tumor segmentation containing 127 tumors in total with further validation of the results by a consultant radiologist. The proposed method was able to achieve one of the highest accuracies reported in the literature for liver tumor segmentation compared to other segmentation methods with a mean overlap error of 22.78 % and dice similarity coefficient of 0.75 in 3Dircadb dataset and a mean overlap error of 15.61 % and dice similarity coefficient of 0.81 in MIDAS dataset. The proposed method was able to outperform most other tumor segmentation methods reported in the literature while representing an overlap error improvement of 6 % compared to one of the best performing automatic methods in the literature. The proposed framework was able to provide consistently accurate results considering the number of tumors and the variations in tumor contrast enhancements and tumor appearances while the tumor burden was estimated with a mean error of 0.84 % in 3Dircadb dataset.

Keyword: CT imaging; Cuckoo search optimization; Fuzzy c-means; Image segmentation; Liver tumor burden; Random walker segmentation