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Deep Learning-Based Liver 3D Slicer for Image-Guided Therapy: Segmentation and Needle Aspiration

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Abstract : Image-guided therapy (IGT) plays a crucial role in minimally invasive procedures for liver interventions. Accurate segmentation of the liver and precise needle placement is essential for successful interventions such as needle aspiration. In this study, we propose a deep learning-based liver 3D slicer designed to enhance segmentation accuracy and facilitate needle aspiration procedures. The developed 3D slicer leverages state-of-the-art convolutional neural networks (CNNs) for automatic liver segmentation in medical images. The CNN model is trained on a diverse dataset of liver images obtained from various imaging modalities, including computed tomography (CT) and magnetic resonance imaging (MRI). The trained model demonstrates robust performance in accurately delineating liver boundaries, even in cases with anatomical variations and pathological conditions. Furthermore, the 3D slicer integrates advanced image registration techniques to ensure accurate alignment of preoperative images with real-time interventional imaging. This alignment enhances the precision of needle placement during aspiration procedures, minimizing the risk of complications and improving overall intervention outcomes. To validate the efficacy of the proposed deep learning-based 3D slicer, a comprehensive evaluation is conducted using a dataset of clinical cases. Quantitative metrics, including the Dice similarity coefficient and Hausdorff distance, are employed to assess the accuracy of liver segmentation. Additionally, the performance of the 3D slicer in guiding needle aspiration procedures is evaluated through simulated and clinical interventions. Preliminary results demonstrate the effectiveness of the developed 3D slicer in achieving accurate liver segmentation and guiding needle aspiration procedures with high precision. The integration of deep learning techniques into the IGT workflow shows great promise for enhancing the efficiency and safety of liver interventions, ultimately contributing to improved patient outcomes.

Keywords : deep learning, liver segmentation, 3D slicer, image guided therapy, needle aspiration
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