報告番号	※甲　　第　　号

主　論　文　の　要　旨

論文題目　Study on Segmentation Methods of Pancreas and Related Regions from Volumetric CT Images(CT 画像を用いた膵臓および膵臓関連領域の自動セグメンテーション手法の研究)

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論 文 内 容 の 要 旨

Computed Tomography (CT) is a widely used modality for acquiring tomographic images in clinical practice. It is the preferred choice for the non-invasive diagnosis of complex anatomical structures, due to its exceptional spatial accuracy and extensive imaging range. The rapid development of CT technology has led to the prominence of 3D CT volumes, replacing the previous reliance on 2D imaging. While 3D volumes offer more valuable information and spatial context of human anatomy, interpreting these volumes has imposed a significant workload for radiologists. The development of Computer-Aided Diagnosis (CAD) systems is desired, as they can assist radiologists in reducing interpretation time and simultaneously enhancing interpretation accuracy. Since segmentation is a critical task for CAD in the field of computer science, its accuracy significantly influences the reliability of the CAD system.

This thesis presents three topics related to the pancreas and its associated regions, aiming to assist in pancreatic diagnosis in clinical usage: segmentation of a healthy pancreas and its surrounding abdominal organs, segmentation of the pancreas and pancreatic tumors, and segmentation of the dilated pancreatic duct. Segmenting larger objects, such as abdominal organs, is relatively straightforward, but the task becomes significantly more challenging when dealing with smaller tissues like the pancreatic duct. The presented research follows a progression from handling simpler tasks to addressing more complex segmentation challenges.

The first topic focuses on the segmentation of a healthy pancreas and its multiple associated abdominal organs. Segmentation of the pancreas in abdo

minal organs is challenging, especially when compared with larger organs like the liver and stomach. The pancreas has notable variations in shape compared to other abdominal organs. Additionally, the low contrast of the pancreas and its boundaries adds to the difficulty. Anatomically, the pancreas is closely situated to neighboring organs like the stomach, duodenum, liver, and spleen. The segmentation of multiple abdominal organs aids in providing relational information for pancreas segmentation. Two distinct methods are proposed for segmenting a healthy pancreas and its associated abdominal organs and tissues. Both methods have successfully improved the segmentation accuracy of the pancreas.

The second topic focuses on pancreatic pathology, where the segmentation targets include the pancreas and pancreatic tumors. Pancreatic cancer, marked by a high mortality rate, demands precise diagnosis, often reliant on detecting pancreatic tumors. Accordingly, a segmentation method for pancreas and pancreatic tumors is proposed. Acquiring diverse abnormal datasets is crucial for robust models, but the challenge lies in collecting extensive medical imaging datasets due to cost and privacy constraints. To address this, an innovative Federated Learning (FL) framework is proposed for efficient pancreas and pancreatic tumor segmentation, offering a solution to the limitations of dataset collection in medical imaging. Two optimization methods for FL are investigated to address the issue of data heterogeneity in FL. The proposed method is shown to outperform traditional model aggregation methods in the segmentation of the pancreas and pancreatic tumor.

The third topic addresses the early detection of pancreatic pathology by focusing on the segmentation of the dilated pancreatic duct. In clinical studies, the dilation of pancreatic duct is regarded as a high-risk indicator for pancreatic cancer. Acknowledging the significance of this observation, the segmentation of dilated pancreatic ducts from CT volumes holds valuable potential for the diagnosis of pancreatic cancer. The small size of the pancreatic duct in abdominal CT volumes poses a challenge for traditional organ segmentation methods based on Fully Convolutional Networks (FCNs). For this topic, a pancreatic duct segmentation framework employing a coarse-to-fine strategy is proposed. To further improve segmentation, a pancreatic anatomical attention method is proposed, and vesselness structure features are integrated, enhancing the precision crucial for timely intervention and improved patient outcomes. The proposed segmentation framework exhibits significant superiority compared to other methods in pancreatic duct segmentation using single-phase CT volumes.

In summary, this thesis presents segmentation methods for the pancreas and its related structures from CT volumes. Chapter 1 provides the aim of thi

s thesis. Chapter 2 proposes two distinct methods for segmenting the healthy pancreas and its associated abdominal organs and tissues. Chapter 3 introduces a framework for the segmentation of the pancreas and pancreatic tumor using FL. Chapter 4 presents a framework for the segmentation of the pancreatic duct. Chapter 5 establishes a connection between the research presented in this thesis and Real-World Data Circulation (RWDC). Finally, Chapter 6 provides a summary and outlines directions for future work.