報告番号	※甲　　　第　　　号

主　論　文　の　要　旨

論文題目　Tubular and Solid Organ Segmentation Methods and Their Applications to Computer-Aided Kidney Diagnosis
（管腔臓器および実質臓器のセグメンテーション方法とそれらのコンピュータ支援腎臓診断への応用）

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論 文 内 容 の 要 旨

Rapid advances in medical image-processing technology have brought the goal of fully automatic computer-aided diagnosis (CAD) systems. With the assists of computers, doctors can obtain precise diagnostic information efficiently. An accurate and reliable CAD system is the basis for realizing this vision. CAD system is composed of a lot of medical image-processing techniques, such as image segmentation, detection, classification and registration. Always, a combination of these processing techniques is required to constitute a CAD system for one specific clinical problem. Among these techniques, segmentation has always been a fundamental part of CAD system. Segmentation is the process of extracting meaningful part from an image. In medical imaging-processing field, the objects of segmentation often correspond to different tissues, organs, or other anatomically relevant structures.

Due to the complexity of human body, segmentation of different anatomical structures may have different factors need to be considered when designing the segmentation methods. Different structures have different appearances in medical imaging. For instance, blood vessels have a bright elongated appearance in contrast-enhanced CT scans, while bronchi are shown in a dark luminal appearance. This thesis mainly focuses on tubular organ and solid organ segmentation. Tubular organ segmentation methods can be used to extract blood vessels and bronchi, solid organ segmentation method can be used to extract abdominal solid organs such as kidneys, livers. Toward improvement of segmentation accuracy, the proposed methods put attention on capturing geometrical and anatomical information for tubular organs and solid organs, respectively.

This thesis presents three segmentation methods and two clinical applications to kidney-related diagnosis. They are categorized into three research topics.

The first research topic presents two segmentation methods designed for tubular organs. These two segmentation methods for tubular structures use different methodologies. One is a traditional image-processing based method, and the other is modern supervised deep-learning based method. Both of these two methods attempt to exploit the geometrical information in their own methodologies. Experimental results showed that the proposed methods outperformed comparative methods in blood vessels and bronchi segmentation tasks.

The second research topic focuses on solid organ segmentation. In this research, deep-learning based method is adopted to segment the organs. To better capture the anatomical information, a spatially aware unit is introduced to explicitly encode the spatial location information. By using this auxiliary module, the proposed network is able to achieve competitive performance compared to other methods with larger training data.

The third research topic presents two clinical applications using the proposed segmentation methods. In this topic, two kidney-related diagnosis applications are demonstrated to evaluate the clinical value of our CAD techniques. The first application presents presurgical simulation method for partial nephrectomy, the second application investigates the renal function variation between pre- and post-operation. Although, large-scale clinical validations have not been conducted yet. From physician's feedback, the proposed CAD systems indeed helped them in real clinical use.

In summary, this thesis presents segmentation methods for both tubular and solid organs. The key point of the proposed methods is capturing the geometrical and anatomical information for specific organs. Clinical applications are also demonstrated to show the clinical value of the proposed CAD systems. Chapter 1 provides an introduction, background and brief overview of each research topic. In Chapter 2, 3, 4 and 5, detailed descriptions of each research topic are given. Finally, in Chapter 6, this thesis is summarized and further research is discussed.