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Title(English)	Study of a Level-Set Based Active Contour Method for Liver-Image Segmentation
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Category(English)	Doctoral Thesis
種別(和文)	論文要旨
Type(English)	Summary

（博士課程）
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論 文 要 旨

THESIS SUMMARY

専攻： Department of	Information Processing 専攻	申請学位（専攻分野）： Academic Degree Requested	博士 (Engineering) Doctor of
学生氏名： Student's Name	Walita Narkbuakaew	指導教員（主）： Academic Advisor(main)	Prof. Hiroshi Nagahashi
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要旨（英文 800 語程度）
Thesis Summary (approx.800 English Words)

This thesis is motivated from two interesting facts. First, liver cancer has been one of the most common causes of cancer death. Second, liver-image segmentation is a necessary process for several treatment options, such as liver transplantation and radiotherapy.

This thesis proposes a 3D CT liver-image segmentation system based on a level-set image-segmentation method. It consists of three main modules. First, the construction of confident region images is introduced. It describes approximate liver-regions as homogeneous regions after boundaries of anatomical structures are obtained. Actually, these boundaries are generated from combining results of multilevel edge-detector functions. In the second module, a two-resolution level-set image segmentation approach is introduced. This approach firstly performs level-set image segmentation at the low-resolution. Then, its result is used for the initialization process of level-set image segmentation at the original resolution. This approach contains two main components including initialization and level-set evolution processes. The initialization process is studied to construct the good initial zero level-set function. Furthermore, it generates mask regions for preventing the leakage regions outside the rib cage after the evolution process is performed. For the level-set evolution process, a modified Chan-Vese model is proposed to control directions of the curve propagation. Finally, segmentation results are refined by using a Gaussian smooth filter in the last module.

The proposed system was applied to 40 sets of 3D CT liver-images acquired by a 4D-CT imaging system. These data sets are obtained from four patients, and 10 different sets of 3D CT liver-images are available from each patient. In addition, two major issues are investigated. First, influences of gray-intensity, edge, and confident region images were compared when the geodesic active contour (GAC), edge-based, and Chan-Vese (CV) methods were used to control the level-set evolution. From experimental results, the use of confident region images possibly improves segmentation results from using gray-intensity or edge images. This improvement will be occurred if the GAC or edge-based level-set method is utilized to propagate a given curve. Second, a performance of the proposed modified Chan-Vese model was examined in a comparative assessment. Experimental results show that the use of confident region images and the proposed level-set method possibly outperforms other pairs. After a liver-segmented volume is extracted, two kinds of its related applications are investigated in this study.

The first application is liver-tumor segmentation. The integration of modified Chan-Vese model and a spatial fuzzy c-mean clustering method is examined to segment tumor regions in a noisy image. It is assumed that a segmented liver-region includes several tumor areas, which are possibly approximated by

a clustering result. Moreover, the clustering result is used to generate the initial zero level-set function and modify the Chan-Vese model. The proposed method was applied to an eight-bit mock liver-tumor image. Furthermore, this image is contaminated by some levels of image noises, such as Gaussian, speckle, and Poisson noises. From experimental results, if a given image includes some levels of Gaussian or speckle noises, the proposed level-set method possibly gives better segmentation results than the integration of an edge-based level-set model and a clustering method. However, results of the both level-set methods show slightly difference when some levels of the Poisson noises are added into the given image.

In the second application, enhancement in visualization of anatomical structures is considered. The segmentation result is combined with the original 3D-CT data before applying a ray-casting technique. This combination probably improves visualization of anatomical structures. Moreover, opacity and color transfer functions are simply studied to control appearances of segmented volumes. In addition, it is possible to demonstrate an example of simple visualization of liver's motion when the 4D CT data set is provided and translation parameters are determined by using an image registration technique.

This thesis consists of seven chapters and they are organized as a following outline. Chapter 1 describes the motivation, the literature review, and the objective of this study. Chapter 2 briefly explains concepts of related methods. It starts from a definition of a level-set method and several ideas of level-set image segmentation with free re-initialization. Then, three state-of-the-art level-set models including geodesic active contour (GAC), Chan-Vese (CV), and edge-based level-set model are summarized. Chapter 3 describes the proposed 3D CT liver-image segmentation system. It begins with an overview of the proposed system. Next, the constructions of specific image representations including edge and confident region images are explained. Afterwards, a two-resolution level-set image segmentation approach and its related processes are described. Then, chapter 4 shows experiments and results of the proposed 3D CT liver-image segmentation system. Subsequently, two related applications of liver-image segmentation are studied. Chapter 5 introduces a liver-tumor segmentation application. Chapter 6 presents an example of visualization application. Chapter 7 summarizes major contents from the liver-image segmentation system and two related applications.