An Automatic Segmentation of Liver Volume That Contained Disconnected Regions Using 2.5D Level Set Approach

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Abstract - *Segmentation of liver images that contain disconnected regions had always been overlooked problem. Previous works on liver segmentation either ignore this problem or used manual initialization when facing this disconnected region. Therefore, in this paper we proposed a liver level set (LLS) algorithm which able to segment disconnected region automatically. The LLS algorithm is based on level set framework together with hybrid energy minimization as the stopping function. By using the LLS algorithm in a looping manner, we allowed the current liver boundary to inherent the topological changes from previous images in a 2.5D environment. We also conducted an experiment to obtain an average factor for dynamic localization radius based on liver anatomy to improve the segmentation accuracy. Our experiment gave a respective segmentation result with dice similarity coefficient (DSC) percentage of 87.5%. Plus, our LLS able to segment all connected and disconnected liver region automatically and accurately.*

Keywords: liver segmentation, disconnected region, level set algorithm.

1 Introduction

The aim in liver segmentation process is to extract liver volume accurately and automatically in less time as possible. Notable that liver had been considered as the most difficult organ to segment in abdominal area and even with radiologist assistants, extracting liver contour from each slice still a daunting tasks. The intricacy for this segmentation process is cause by the liver's physic itself, since liver is made from soft tissues, there a large variation of liver geometry between patients. Plus, liver has similar tissues density with neighbouring organ such as the heart and kidney, causing a limited contrast in CT grey level between them.

Another frequently overlook feature of liver's physic is that the liver has a multi-lobe structure, thus different lobes can exhibit as disconnected regions in a transverse slice. Hence in the worst case scenario, liver may have more than two disconnected region with variation of shape in a single CT image as shown in figure 1. Currently, there still lack of on paper solution for extracting this disconnected region automatically. Usually, some user interference still needed when segmenting liver images that contain this disconnected region.

Figure 1: The disconnected region highlighted with red region

Level set algorithm is a highly potential to carter disconnected region problem due to the ability of level set to handle merging and separating curve propagation. First attempt to segment the liver using level set is done by Pan et al [8]. He introduced an accumulative level-set speed function which varied by time to improve the detection sensitivity of weak edges. Plus, he also incorporated prior liver location based on anatomy knowledge to help in the segmentation process. Pan's 2D algorithm begins by initializing the curve through putting a small circle inside the liver region for each slice. Thus, if a disconnected region occurs in the current slice, a user needs to initialize a circle for each disconnected regions.

Lee advances the level set by predicting the initial liver shape using 2.5D shape propagation [9]. So instead of placing the curve in each slice, Lee's method required a