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Liver Segmentation Techniques of CT Images for Clinical Diagnosis

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Abstract: ***Liver Segmentation has become one of the most efficient and systematic tasks in the case of medical applications. Recently, the segmentation of liver has found its part in the research areas also. It has become a common feature to hinder the accurate and the proper segmentation of the liver intensities and its neighbor organs in the human body. Different techniques of liver segmentation can be performed with CT images, MRI images and PET. Among these CT images have a wide application in the detection, identification and segmentation of the liver deficiencies. Manual segmentation of the liver seems to be more time consuming yielding less precision and robustness. Nowadays, many techniques have been developed for the segmentation of liver that are more efficient, fast with accurate as well as better results than the traditional methods.***

Keywords: Liver, Segmentation, CT, MRI

I. INTRODUCTION

The Liver is an abdominal organ and is the largest digestive gland of the human body. It acts as a detoxification organ that additionally produces bile. The liver resides on the upper quadrant of the abdomen. The diaphragm surrounds the liver superiorly, laterally and anteriorly. The stomach, duodenum and the transverse colon are layered along the median of the liver, the hepatic colonic flexure are found along the inferior part; and the right kidney and the adrenal gland are found in the posterior.

In the recent years, liver diseases have become a frequent cause of death all over the world. Hence it becomes crucial to prevent and treat the liver diseases all over the world. Most of the high resolution anatomical structures of the human organs are obtained by the use of CT images. Computed Tomography (CT) imaging has delineated to be one of the vital imaging techniques for diagnosing and in the treatment of clinical liver diseases.

Liver diseases diagnosed from the CT images are essential in medicine. Liver Segmentation is a crucial analysis subject in medical imaging. Liver segmentation will facilitate to determine the contours and the lesions structures present in the liver from the other tissues; hence certain applications like the evaluation of the liver, identification of the tumor in the liver and the surgeries are found to be efficient and accurate when it comes in the case of medical treatment of the deficiencies. In some cases, the organs like the abdomen, intestine and spleen might tend to have minor variations, whereas the liver may undergo sturdy discrete variations due to external forces which causes changes in the structure and the position of the liver.

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Hence an efficient and accurate segmentation of the liver in a CT image tend to be one of the challenging functions worldwide.

II. RELATED WORK

Kaijian et al [1] proposed an improved DeepLab-v3 framework that includes a Pix2pix network of the adversial model. A semantic segmentation algorithm was developed for the segmentation of the CT images. According to this proposed model, the deep feature and the multi-scale semantic feature are combined to design an improved framework segmentation. The generalization ability and the accuracy of the CT images is improved by combining the loss-function of the cross entropy in a traditional multi classification system with the generator output loss function and the discriminator output loss function. Here, the outcomes and performance of the proposed algorithm shows better results than the other segmentation models. It can improve the efficiency of segmentation of the space consistency of the CT images. The comparison of the other segmentation models are shown in Fig 1.

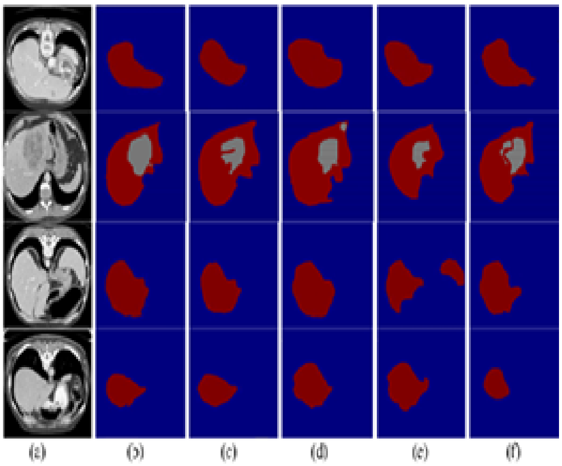

Fig 1. Comparison of the results of different segmentation models (a) raw CT image; (b) Ground truth; (c) Proposed; (d) DeepLab V3 (e) SegNet (f) DeconvNet

Mubashir et al [2] developed a deep belief network that is based on the automatic feature of the learning algorithm. This algorithm is based on the training of the unsupervised pre-training and supervised fine tuning which is termed as DBN-DNN model for liver segmentation. In the post-processing stage, an automatic liver contour method is applied. The results were more satisfactory upon the healthy CT images that produced a dice similarity coefficient range of 95%. The segmentation results of the DBN-DNN are shown in Fig 2.

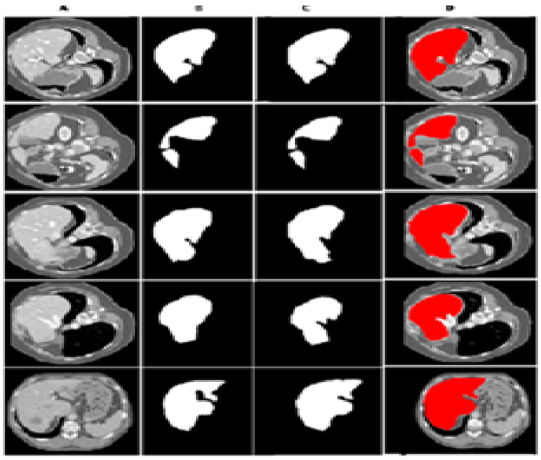

Fig 2. Segmentation results of the DBN-DNN model with different angles. (A) Contrast enhanced CT image (B) Original label of the image (C) Segmentation of liver by DBN-DNN method (D) Overlapping of the segmented liver on CT image.

ZhenZhou et al [3] proposed a heuristic approach of multiple thresholds based on the slope difference distribution to segment the liver automatically. In order to delineate the liver boundary the results of the segmentation of the liver were combined together and a 3D image of the liver was created using the function of energy minimization globally. The performance of the segmentation process avail that the Ct images of the liver were robust as well as automatic. The segmentation results are shown in Fig 3.

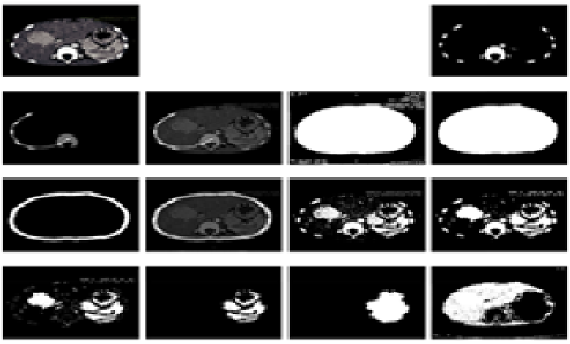

Fig 3. Demonstration of the segmentation with a typical image. (a) original image (b) the segmented ribs and spine (c) the fitted curve based on the ribs and the spine (d) the fitted curve ovelaying the original image (e) the segmented body (f) the segmented body after morphological filtering (g) the extracted circular part of the erosion (h) the circular part overlaying on the original image (i) the segmented stomach (j) the segmented stomach after energy minimization (k) subtractuion of the bones (l) the extracted stomach after morphological filtering (m) the merged stomach (n) the segmented liver

Mohammed et al [10] proposed a Modified K-Means Algorithm for estimating the automatic liver volumes towards SIRT. According to this algorithm the human intervention will be minimized when the region contouring of the masks are initialized. Based on the proposed work, the Modified K-Means method is combined with the localized contouring algorithm. The slice of the liver can be segmented into different regions and they belong to various structures. The different regions of the liver can be segmented further by means of the localized contouring algorithm. The segmentation results produce a volumetric dice coefficient of around 0.92 and the accuracy of 97%. The results of the Modified K-Means Algorithm is shown in Fig 4.

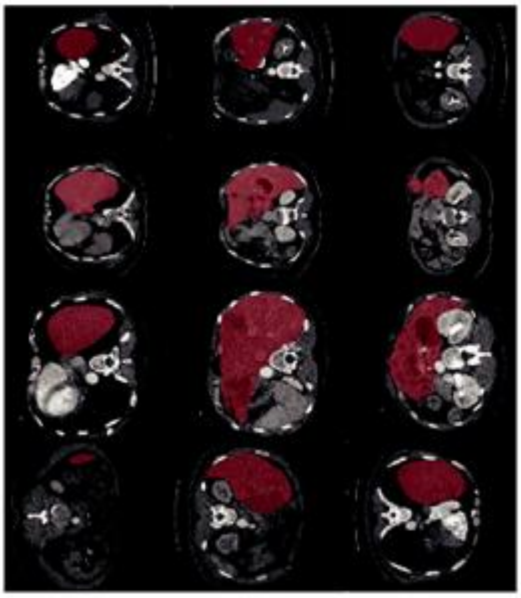

Fig 4 Segmentation results of different datasets

Huiyan et al [11] proposed a GrowCut Algorithm along with the Snakes model which was used to segment the region of the liver in case of CT images. A pretreatment process of the K-Means algorithm is performed by the improved GrowCut method. The improved version of the GrowCut algorithm can be used as the contour for the Snakes model initially. The segmentation results show that the proposed algorithm has better precision and robustness and also add an overall efficiency than the other traditional algorithms.

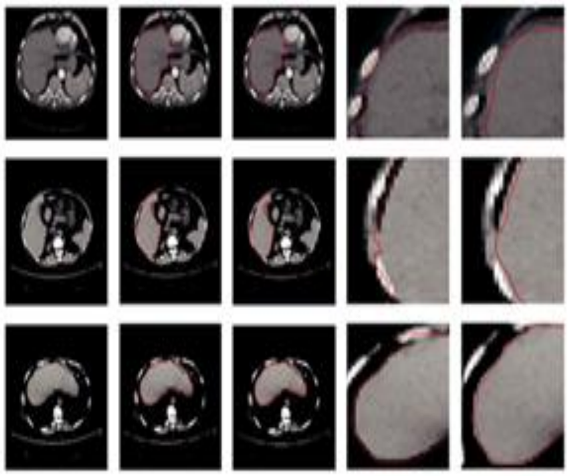

Fig 5. Segmentation results of medical images based on the KIOC approach and the KIOC Snakes algorithm

Table 1. Advantages and Disadvantages of various Liver Segmentation algorithms

Ref.No	Authors	Algorithm	Advantages	Disadvantages
[1]	Kaijian Xia	Semantic Segmentation Algorithm – DeepLab V3 Network	To improve the segmentation efficiency for abdominal CT images.	The boundaries of the liver region of the CT images seem to be blurred.
[2]	Mubashir Ahmad	Automatic Feature Learning Algorithm	Saves memory and computational time	Less sensitive to tumor on the boundary of the liver
[3]	ZhenZhou Wang	Slope-difference distribution based Threshold Selection Method	-Very efficient. -Accuracy is better	The optimal accuracy of the liver region cannot be achieved in case of unsupervised segmentation.
[4]	Baochun He	CNN-ASM Segmentation Algorithm	More accurate with smaller standard deviation	Accuracy not as high as marginal space learning method.
[5]	Yong Chang Zheng,	Appearance and Context based Liver Segmentation Algorithm	Saliency of liver is improved compared to other organs	Running time takes a long image analysis
[6]	Weiwei Wu	Improved Fuzzy C-Means and GraphCut Algorithms	Improved time efficiency of liver tumor segmentation while maintaining accuracy.	Relatively under segmentation and over segmentation errors occurred
[7]	Xuehu Wang	Sparse A Priori Statistical Shape Model (SP-SSM)	Effectively converge to the liver boundaries obtaining more accurate segmentation results.	Average time required for liver segmentation can still be significantly improved.
[8]	Weiwei Wu	Supervoxel based GraphCut Method	Reduce computational time and memory requirements.	Liver boundaries may be misclassified.
[10]	Mohammed Goryawala	Modified K-Means Algorithm	Correctly segments liver region from other organs in the body.	Accurate calculation of liver volume may tend to cause precise radioactive dosage to patients
[11]	Huiyan Jiang	Snakes Model and GrowCut Algorithm	Better robustness and precision and faster than traditional GrowCut Algorithm.	does not improve the accuracy

III. LIVER SEGMENTATION TECHNIQUES

Segmentation algorithms can be classified into two main categories: fully automated segmentation and semi-automated segmentation methods. Fully automated algorithm are the threshold-based method, clustering method, region-based method, Snakes-based method. Semi-automated methods are termed to be interactive image segmentations based on graph cut, the random walker technique.

A. Thresholding

Thresholding methods are the sum of the weights of any number of probability densities with normal distribution and an approximation of the image histogram that represent a distinct approach termed as optimal thresholding or iterative threshold selection. The threshold will be set as a closest gray-level of the corresponding minimum probability between the maxima for two or more normal distributions, which results in minimum error segmentation.

B. Region Growing Segmentation

A segmented image using region growing method might contain either very few regions or more regions due to the setting of the optimal parameter. For the purpose of the enhancement and the classification of the CT images, a huge number of post processors are being evolved.

C. Active Contour Model

Active Contour Models are mainly used in the case of the segmentation of the images such as liver and the image understanding concepts. Active Contour models are mainly applicable for the 3D image data and the analysis if the image data's. The active contour model, or snake is defined as an energy minimizing spline- the snakes energy depends on its shape and location within the image. Local minima of this energy then correspond to desired image effects. A common proficiency of the equivalent deformable image model can be analyzed using the Snakes model and also the energy minimization.

D. GraphCut Segmentation

The GraphCut Segmentation can be identified as the automotive and an interactive method for either one or more points representing the object and one or more points representing the background- these points are called the seeds and serve as segmentation hard constraints.

E. Semantic Image Segmentation

Semantic approaches represent a significantly advanced field of image segmentation. Semantic image segmentation may comprise with different interpretation of the image regions and parts and the other image understanding ideas. Most of the semantic algorithms are based on the syntactic information of various systems. They also tend to combine the regions based on their local resources and are normally heuristic in nature.

F. Gaussian Mixture Models and Expectation Maximization

In the case of Expectation-Maximization (EM) Algorithm, the maximum value can be determined and identified locally. The obtained EM is computed more frequently and is of a good quality. During each phase of the computation the Gaussian value is estimated upon the sample which is termed as the expectation and the Gaussian parameters are refined which is termed as the Maximization.

IV. DISCUSSION

Most of the liver segmentation techniques have their own advantages and disadvantages which seems to be more effective in certain cases. Some methods improve the efficiency of the segmentation of the abdominal CT images. We can also identify that the robustness and precision of the liver segments are improved compared to the traditional algorithms. Certain methods offer inadequate accuracy during the segmentation process, which do not produce better results. In order to provide accurate results, certain algorithms can be used as a hybrid and enhanced to produce good outcomes.

V. CONCLUSION

This paper summarizes the liver segmentation techniques for the abdominal CT images. Most of the techniques are based upon the image segmentation and image understanding concepts. Some of the algorithms are compared and their performance is listed in the Table 1. It is possible to identify the problems of the earlier segmentation algorithms and make a solution to it. Here we point out that there are still multiple techniques that are available and they can be utilized together to achieve better results in future.

REFERENCES

1. Kaijian Xia, Hongsheng Yin, Pengjiang Qian, Yizhang Jiang, Shuihua Wang, "Liver Semantic Segmentation Algorithm Based on Improved Deep Adversarial Networks in Combination of Weighted Loss Function on Abdominal CT Images", IEEE Access, VOLUME 7, 2019, pp 96349-96357.
2. Mubashir Ahmad, Danni Ai, Guiwang Xie, Syed Furqan Qadri, Hong Song, Yong Huang, Yongtian Wang, Jian Yang, "Deep Belief Network Modeling for Automatic Liver Segmentation", IEEE Access, VOLUME 7, 2019, pp 20585-20595.
3. ZhenZhou Wang , Cunshan Zhang, Ticao Jiao, MingLiang Gao, and Guofeng Zou, "Fully Automatic Segmentation and Three-Dimensional Reconstruction of the Liver in CT Images", Journal of Healthcare Engineering, Volume 2018, Article ID 6797102, 10 pages
4. BAOCHUN HE, DEQIANG XIAO, QINGMAO HU, AND FUCANG JIA, "Automatic Magnetic Resonance Image Prostate Segmentation Based on Adaptive Feature Learning Probability Boosting Tree Initialization and CNN-ASM Refinement", IEEE Access, VOLUME 6, 2018, pp 2005-2015
5. Yongchang Zheng, Danni Ai, Jinrong Mu, Weijian Cong, Xuan Wang, Haitao Zhao and Jian Yang, "Automatic liver segmentation based on appearance and context information", Zheng et al. BioMed Eng OnLine (2017) 16:16
6. Weiwei Wu, Shuicai Wu, Zhuhuang Zhou,Rui Zhang, and Yanhua Zhang, "3D Liver Tumor Segmentation in CT Images Using Improved Fuzzy C-Means and Graph Cuts", BioMed Research International Volume 2017, Article ID 5207685, 11 pages, pp 1-11.
7. Xuehu Wang, Yongchang Zheng, Lan Gan, Xuan Wang, Xinting Sang, Xiangfeng Kong, Jie Zhao, "Liver Segmentation from CT images using a Sparse priori statistical shape model (SP-SSM)", PLOS ONE, https://doi.org/10.1371/journal.pone.0185249, pp 1-23.
8. Weiwei Wu, Zhuhuang Zhou, Shuicai Wu, and Yanhua Zhang, "Automatic Liver Segmentation on Volumetric CT Images Using Supervoxel- Based Graph Cuts", Computational and Mathematical Methods in Medicine, Volume 2016, Article ID 9093721, 14 pages
9. Lianfen Huang, MinghuiWeng, Haitao Shuai, Yue Huang, Jianjun Sun, and Fenglian Gao, "Automatic Liver Segmentation from CT Images Using Single-Block Linear Detection", BioMed Research International, Volume 2016, Article ID 9420148, 11 pages,
10. Mohammed Goryawala, Seza Gulec, Ruchir Bhatt, Anthony J. McGoron, and Malek Adjouadi, "A Low- Interaction Automatic 3D Liver Segmentation Method Using Computed Tomography for Selective Internal Radiation Therapy", BioMed Research International Volume 2014, Article ID 198015, 12 pages, pp 1-12.
11. Huiyan Jiang, Baochun He, ZhiyuanMa, Mao Zong, Xiangrong Zhou, and Hiroshi Fujita, "Liver Segmentation Based on Snakes Model and Improved GrowCut Algorithm in Abdominal CT Image", Computational and Mathematical Methods in Medicine Volume 2013, Article ID 958398, 12 pages

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