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Segmentation of Liver from images of Visceral Organs through Automatic Processing – A review

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Abstract: Automatic organ segmentation is an upcoming new field of research in image processing. The extraction of liver image for the diagnosis of its structural defective details is a difficult task for medical experts. Automatic extraction which is known as segmentation by computer processing may minimize the burden as well as time consuming. Several methods have been suggested for the above image segmentation particularly liver image capture. This present paper reviews the various methods. In addition it also discuss the merits and merits of the image processing procedures described in the current literature. This review may help to find a new scientific solution to overcome the issues addressed by the users and innovate new approach for the automatic liver segmentation from abdominal CT scan digital image pool.

Keywords: Automatic Liver Segmentation, Methods of Image Segmentation, Extraction.

I. INTRODUCTION

In human beings heart, liver, lungs brain and kidney are the most five vital organs. Among these five organs liver is said to be the important organ. It is a centre for the various metabolic and anabolic biochemical reactions apart from the secretion of digestive juices. Many of the toxic chemicals entered into our system through food get detoxified by the hepatic cells of liver. The liver of human being has five lobes consisting of unique type of hepatic cells. Because of its vital function liver is subjected to the manifestation of many diseases. Liver cirrhosis, hepatic carcinoma, liver jaundice, enlargement of liver lobes, bleeding in liver vessels and rupture of liver edges are some of the major diseased state of liver [1, 2].
Liver is occupied in abdomen along with other visceral organs of spleen, pancreas, kidneys and intestine. The morbidity and mortality of liver diseases are said to be comparatively greater than other fatal diseases. There is substantial increased death rate due to liver structural defects and functional complications worldwide. Most likely the medical treatments for liver disorders are not so encouraging unless the defect is identifiable at an early stage. For example there are no hopeful and proved allopathic medical treatments for the infective hepatitis. It is described that infective jaundice is more fatal than HIV / AIDS [3].

Hence to treat the various liver diseases by health professionals in modern way they need computerized CT scan images to undertake treatment steps. It is highly difficult to arrive corroborative diagnosis of liver defect by mere direct interpretation of CT scan images of abdomen region. This is because scanned images of liver, vessels and hepatic cellular injuries are showing more tissue homogeneity. Liver has low contrast and high intensity of image and similarities with the images of other visceral organs located adjacent to liver such as spleen, pancreas and kidneys.
Moreover liver digital images of CT scan are very complex to draw a conclusion for the diagnosis. It is becoming a challenge task for the radio diagnostic expert. Hence this area of research is appeared to be a scope for further venture on the automatic computer analysis of abdominal CT scan as well as liver images.

It has been a separate discipline as a liver segmentation in abdominal images and analysis of liver images for the prediction of liver diseases. Equally several methods such as region growing active contour level set, graph cuts, clustering have been innovated for the determination of liver by segmentation as well as abnormalities. The present paper is a review of the various methods in practice for the automatic extraction of liver and its abnormalities through image processing [4-6].

2. What is Segmentation?

The abdomen is the body region where many organs are located. To overcome the burden of identification of specific organ and its defect in abdominal CT scan cut images, the boundaries and shape of the visceral organs are analyzed. The selection process is known as segmentation technique. Different theoretical applications and statistical methods are employed for segmentation of liver image out of images formed for other organs [7].

3. Gray-Level Methods

Gray-level is more understandable and clear way in selection of character of image by extractions from image pools. To capture an image of interested object out of many digital images, the principle of gray-level is applied to identify the shape and boundaries of the desirable

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object. In many gray level procedures for image analysis normally algorithms are not used. It is a semi-automatic technique and requires role of user's operation. However it has its own demerits during the prediction of liver when the intensity is appeared as less between the object and background [8].

3.1.1 Region Growing

It was first proposed by Adams and Bischof [9]. It is described as Seeded region growing algorithm. It is a comparative analysis of bar diagrams of various selected regions growing with some features of gray level intensity. The advantage of this technique depends on the strong seed points and the role of user's quality is prerequisite for the selection of seed points. There are three types of constrains. They are 2D region growing with knowledge hindrance, 2D voxel classification with transmission and Bayesian rule-based 3D region growing.

There is also an introduction of a fully automatic region-growing method which is based on tissue homogeneity. Some alternative methods are also tried for unhomogenized situation, first segmentation by grey-level and separate the organs by anatomical features .Dissimilar images are formed if larger lesions are developed in liver issue. Such situation, the centered of the largest connection of the image is used as a threshold region of growing. The enhancement of segmentation can be achieved by the sequential methods of following a pre-treatment with gray casting algorithm to change the image into a projection plume. Then adopting region growing method for liver segmentation [10-13].

3.1.2. Active contour

The image curves of organs are called as active contour. These contours give unequal shapes to select an organ. They are two types. One is known as parametric active contours and the other one is geometric contours. The parametric contours are based on Langrangian formulations and represented in explicitly. But geometric curves are developed from Eulerian formulation and implicitly represented [14].

Parametric curves form undulating waves like snake shapes on image domain due to internal and external forces. These snakes like curves are implemented as gradient vector force. It is very easy to capture the interested object image by this snake curves. It is considering an image without initial boundaries. It can also be used as an additional method for blood vessel segmentation. The parametric curves give considerable accuracy and regions of the image segmentation [15].

On the other hand the geometric active contours are adopted on the Principle of curve evolution and curve level set methods. Level set is taken as a contour at zero level with higher dimensional function. The important effect of level set contour is to obtain surface topography. It is widely practiced in medical digital image processing. However in certain incidences it is resulted in over segmentation arbiters. It is a process of time consuming. It can be improved by using a new fuzzy level set algorithm. This provides a clear curve when the background is simple. This method is recently optimized for multi curvatures, multi-growth strategy and multi-resolution level [16-20].

3.1.3. Graph cuts

It is not fully automatic. The area is selected by the seed points and mark it as an "object" in the background. Generally for liver segmentation by this way is to locate injured blood vessels or tumors in liver cells. It is difficult to identify those images when the liver tissue background is highly homogenous. The graph-cut method is highly advantageous for vascular injuries, hepatic cell injuries, inflammation in liver lobes and cancerous growth. In this analysis the images are represented by an undirected weighted graph. Every node indicates each pixel is connected by edges. The similarity of grey level, colour of texture between two pixels is determined by the weight of edges [21].

As per the above concept the technique for full automatic operation several algorithms are recommended. Further to enhance the reliability of results mathematical models, statistical principles and morphological analysis have also been employed to obtain segmentation of liver in the homogenous background of abdominal CT scan images. Most likely statistic adaptive threshold initialization and k-means clustering may solve the purpose of extracting liver from other visceral organs in abdominal region. But comparative studies with other methods, it has been shown that this method is not more helpful than the segmentation by other gray-level techniques [22,23].

3.1.4. Threshold Based Method

This procedure is often used for retrieval of images or seed points as pre-processing. Best image position of liver from other tissues can be obtained by this technique since the contrast between liver and tumor is much more pronounced. The first step is to increase the contrast of gray-level then the cut image slices are added. Morphological filters are used to ascertain the segmentation after employing threshold determination. The images obtained out of the farmer step are sensitive to noise. Therefore roundness and information of adjacent slices are also analyzed to reduce the burden of false detection [11-13, 24, 25].

3.1.5. Clustering Based Method

The clustering based technique is designed under the principle of n-dimensional feature space. The shorter or longer distance between samples and their similarities are considered. There are two problems are encountered while using clustering based method. The determination of similarities between distant samples and the threshold similarities for the same are the two issues addressed by the users. However it is fully automatic. Despite of easy operation it may have certain demerits that even often false positive regions are noticed. It needs post processing to substantiate the findings [26, 27].

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The important steps of the preceding method consist of two classes such as Fuzzy-C-Means (FCM) clustering and k-means clustering. The initial image is segmented by FCM and then smoothed by stereological processing. Then the selected regions are by computing properties. Finally the liver and nodes, tumors of liver are segmented. It is notable that K-means is not used as a primary clustering. FCM application is highly advantageous than k-mean clustering. FCM is meant for refining the images with rough segmentation [28].
Apart from the above cluster based processes, there are some other methods like Hierarchical agglomerative clustering added with self constructed map also used for liver image extraction [29].

4.1 Structure Base Methods
One of the most effective methods of liver image segmentation in medical practice is the structure based image analysis. The recaptured geometry of an image is applied to pulling out the interested object in abdominal CT scan pictures. A probable picture with salient characteristics mode image is generated to understand the variations of organ shape. This prior simulation tells the issues of an image for segmentation. Hybrid of proposed form with statistical shape is too evolved. It has been shown by many researchers that by this mean about 72.4% accuracy could be arrived. There are four fully automatic structure based techniques of segmentations available for the recovering liver image from the pool of visceral organs [30-32].

4.2 Texture Based Methods
This scheme is mainly concern with the texture features of an image unlike other techniques where boundaries and shapes are considered. In this type initially texture features of desirable image are read. Then a classifier is introduced to classify the features. Finally by post processing segmented regions are identified and subjected for the smoothness [33]. Along with this way wavelet co-efficient are adopted for the extraction of liver. Out of this mean four different types of extractions are carried out. They are neighborhood mean, neighborhood variance, Law's texture, Unser's sum-and-difference and histogram to extract liver in 3D CT scan images. The important significant benefit of texture based method is the minimum redundancy and maximum relevancy [34]. Again in this technique wavelet co-efficient is followed to capture texture features of liver. Lun et-al [35], and Luo et.al [36] have shown an absolute segmentation of liver in abdominal cut images using higher statistically determined texture features.
Several classifiers are followed for the liver segmentation by wavelet features of liver cancer growth size, shape and volume by water shed transform. The morphological analysis is also performed for the precision segmentation of liver as post-processing.
For decision making for firm findings of liver tissue defect, neural network (or) non linear data modeling adopted as tools. It is most suitable procedure for classifying fizzy-C-mean clustering similar technique also be utilized for liver cancer mass image extraction. Recently colour information of liver images developed by magnetic resonance. Hopfield neural network of spaces is adopted for liver segmentation [37].
Genetic algorithm and extreme learning nubbin steps have also been demonstrated in liver segmentation either individually and combining with other texture based methods [17,18].

II. DISCUSSION

The foregoing account of various methods of liver segmentation has their own advantages and disadvantages. However there is a frequent modification for the improvement of effective segmentation of liver is underway. Several review papers explaining the alterations and the efficiency have appeared in literature [6,7,38].

The gray-level based procedure involves direct utilization of characteristics of images. These methods are often entertained in clinical practice. The drawback is these image processes mean depends on the developments of grey-level of liver targets. When grey-level is not stable the extraction speed is get minimized. Histogram comparisons are also considered in some methods. In some grey-level method manual analysis or rough segmentation is also be made. The methods those are devoid of using prior knowledge the accurate prediction may fail when percentage of liver image low. The notable merit of the above methods is they are more sensitive to boundaries of the digital images. Above and beyond they are more close to capture boundaries since the single individual image has numerous boundaries. Sometimes this may lead to an under or incomplete segmentation. The adding of neural-network and manual involvement may refine the gray-level methods to overcome many issues [8]. The structure base methods concern with the unclear image of the liver and using prior knowledge. The limitation of the methods is they require large instruction data to cover all the aspects of liver texture [31].
On the other hand the texture methods are more complex and the involvement of human eye sight to do segmentation. The main advantage is more details of features are considered at a specified time and interpretation of results by manual segmentation. Nevertheless even when the liver boundaries are not clear, texture based method extraction beneficial for best results. Studies for the improvements are on and machine learning plus pattern identification with less processing are looked for [37]. On comparison, the grey level based methods are more sensitive and give reliable results than other methods. However combination of two (or) more methods is also followed for complex segmentation.

CONCLUSION

The present review paper focuses on the various methods for the liver segmentation from the abdominal CT scanned

pixel images. It classifies all the suggested methods. This would help to find a new novel solution for a specific segmentation. There are many gaps to innovate possible answers to address the issues explained in this review. Liver segmentation is still an open discipline. There is a scope for the application of future multiple approaches for better liver segmentation from visceral organ images.

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