Liver Segmentation Based On Feature Extraction and Shape Prior Features Using CV Model

Er. Rishm
(M.Tech.Student)
GZSCCET, MRSPTU, Bathinda.

Dr. Naresh Kumar Garg
omputer Science and Engineering Department
GZSCCET, MRSPTU, Bathinda

Abstract: Partitioning of a digital image into different segments is called image segmentation. The main goal of segmentation is to simplify the complex image so that it can easily help us in locating objects and their boundaries like line, curves etc. In segmentation we provide label to every pixel in the image in such a way the pixels with the same label have same characteristics. They are computed on the basis of local or global features whereas local features are categorized by edges, corners, lines, region and global features include texture, shape and colour. Segmenting the liver is difficult task but it can be made little easy using feature extraction. Chan-Vese model (CV model) is successfully applied for the segmentation of liver which is derived from Mumford-Shah functional that is used for segmentation to get shape prior information of liver and to retrieve statistical image intensity information.

The results obtained with the proposed technique are very challenging.

Keywords: CV Model, Segmentation, Features, Shape Prior

I. INTRODUCTION

Medical imaging plays an important role in medical field as it is the process of looking inside the human body without any surgical activity and it helps in getting maximum information about the abnormalities present in the body. Medical imaging uses different methods to diagnose the problem and for its treatment .Medical imaging uses different imaging techniques like CT image, MRI, and Ultrasound .All these make use of harmful radiations. To find out the problem inside the body the doctors takes images using different scans according to the problem like CT scan are carried out for abdominal problems or liver infections, MRI scan for brain tumour detection, Ultrasound scan helps in pregnancy period etc. and then the segmentation is carried out on those image to find out the location of actual problem called region of interest (ROI). This can be done with the help of feature extraction. Feature extraction is the process of collecting information from the image so that it can be analyzed properly by doctors to retrieve important and helpful information out of them. These features can be categorized as pixel-level features (used to calculate at each pixel points like colour, location), local features (like edges, curves, corners, regions whereas the intensity level change occurs widely at the edges), or global features include:

(1) **Texture features:** These features provide us the information about textures that can be smooth, vertical, horizontal which helps us to find different patterns formed in the image that is needed to be segmented to detect disorders in human body. Some of the measures of texture feature inculcate are: entropy, homogeneity, contrast and wavelets

a) Entropy: It is the statistical measure of texture feature that is based on the measurement of randomness of textured input image.

$$\text{Entropy} = - \sum Pj \ \log 2 \ Pj$$

b) Homogeneity: It is the process of measuring the closeness of the elements present in gray level matrix. It is done using the local spatial statistical features. The equation is given by:

$$\sum_{i,j} \ p(i,j)/1+|i-j|$$

c) Dissimilarity: It is the measure that helps us in comparing the different results obtained in segmentation using different algorithms. It is calculated by considering to feature vectors and are given by :fg = (fg,t : t= 1,…..,T) and fq= (fq,t : t= 1,…..,T) .Then, D(g, q) is represented as equation :

$$D(g, q) = \sum_{t=1}^{T} \ fq, t \log_{fq,t} fq, t$$

d) Statistical Features: Under these we consider the intensity levels so that liver status can be easily determined by using colour space RGB (Red, Green, and Blue). Intensity features can be considered coloured or gray level.

$$I=1/3(R+G+B)$$

1) Mean intensity : Mean intensity is the region of interest that we need to find and is denoted by μ :

$$\mu = 1/N\int_{x,y} \ ROI(x, y)dx\,dy$$

To determine all these different type of features we have taxonomy to determine feature vectors like structural feature uses region properties, statistical features uses intensity properties, and texture features uses GLCM (Gray level co-occurrence matrix) .Then all these features are combined to get ROI. For this we make use of Chane-Vese model (CV model) is suitable for the images that are very complex and have different frequencies, it is very flexible in nature. CV model is derived from Mumford-shah functional for segmentation that is especially used for segmentation. It is derived by the equation in which ***f* is denoted by the gray level of the image, Ω it is the domain**

$$\arg_{u,c}\mathbf{min}\ \mu\ \text{Length}(C) + \lambda \int_{\Omega} (f(x) - u(x))^2\, dx + \oint_{\Omega/c} |u(x)|^2\, dx,$$

The main objective of this research is to study the different technique for segmentation and extraction of features so to implement shape prior information for liver segmentation.

II. LITERATURE SURVEY

Di Liu, et al.(2017) [2] Hepatocellular carcinoma(HCC) is a presence of tumour in the liver of patients with many more liver problems and cirrhosis. Liver tumour expands and spread in such a way that it becomes cause of death. In this paper, we have different segmentation techniques that our used in combination with each other and implemented in the field HCC for segmentation of image. The techniques that are mainly used are: K-mean clustering along with region growing method, for foreground and boundary we have watershed algorithm, region growing is based on gray level .This paper also discuss the new method of region growing on the basis of LBP. It's the most reliable plan for segmentation; its accuracy and result rate make it a best plan for liver segmentation.

Akshat Gotra ,et al.(2017) [3] Liver boundaries are weak in nature so segmenting the liver in the presence of neighbouring organs by using CT images (computed tomography) is challenging task. Non Subsample Shearlet Transform (NSST) is the edge enhancement technique that uses different scales for liver segmentation using CT images and also uses different intensity levels either for high or low frequency coefficients. For the accuracy Sum Modified Laplacian (SML) is used and to get accurate edge information. Using NSST we can finally get enhanced image. The accuracy of the method is measured by applying segmentation with fusion process and without it. The proposed technique for the fusion framework provides the detailed knowledge of the given image and provides us with good edge information that we can retrieve from individual images. Research has provided with 60.11%of accuracy.

Shraddha Sangewar, et al. (2017) [4] Medical imaging is the process of looking inside the human body this process is carried out using different machineries which are required to get images of the different parts of the body as it is an effective way to get maximum information about the interior abnormalities of body. It is the most challenging task due to the presence of different gray levels due to the extraction of different boundary areas as they are difficult to segment due to the different intensity levels. Liver segmentation is the difficult task if done manually that's why we try to use a different methods to determine tumor and other abnormalities in liver and so to provide proper treatment to the patient.3d analysis of liver organs is done to get more detailed information of liver rather than 2D view. Comparative study has been done between k-mean and graph cut technique of segmentation for extraction of liver problems and the result gave us the accuracy of 82.23%

M.Midhila, et al. (2017) [5] Classification of the liver problems using computer based analysis methods is done. Ultrasound image are used to analyses the diseased areas with the help of segmentation, Feature extraction or classification. Automatic liver segmentation using ultrasound image is difficult process due to the presence of number of overlapping organs and irregular shape of liver, diseases and poor image quality, different intensities, blur boundary areas. The effectiveness of this paper is that different techniques are used in different biomedical images for removing noise present, boundary blurriness, and feature extraction. The research was made using different gray levels and was applied on 10 different types of liver problems to analyze the affected parts.

Xinyu jin, et al. (2017) [6] Automatic liver segmentation using CT image is very time consuming and space requiring task due to high resolution of images. The old method of segmentation of liver do not provide us with the accuracy and even it was not convenient method to determine the problems the patient is facing, this entire process is dependent upon doctors expertise that's why it is necessary to have automatic liver segmentation method. Fully conventional network(FCN) models are used to solve many problems due to its accurate results and self learning property, FCN is getting greater achievement in the field of liver segmentation using different medical images(MRI,CT,X-ray etc.).This paper has designed FCN method for liver segmentation which is very effective and also efficient application and the results of experiment provide us with high accuracy and high superiority approach.

III. SDF-BASED STATISTICAL SHAPE MODEL

To incorporate the shape statistical information into the liver segmentation, the PCA on the signed distance functions (SDFs) representing the set of training instances. This shape model is based on PCA that determines the best orthonormal basis to capture the main variations of the training set. From the values of corresponding shape coefficients, we can see that some of them are beyond the limitation for well shape representation. The poor results are shown in the second row using the truncated shape coefficients. Although without the limitations, the shape is also in the space expanded by the principal components which contributes to our shape constraints.

IV. EXPERIMENTAL SETUP

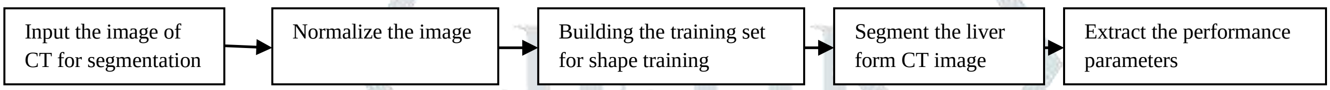
In order to evaluate the proposed segmentation method, we implemented these experiments on MATLAB R2013a installed in a computer with Intel Core i7 CPU, 3.40GHz, 64GB RAM. The testing data contains two public database SLIVER07 (only training part) and 3D-IRCADb-01 (abbreviated as IRCAD). Five error measures, namely Volumetric Overlap Error (VOE, %), Relative Volume Difference (RVD, %), Average Symmetric Surface Distance (ASD, mm), Root Mean Square Symmetric Surface Distance (RMSD, mm), Maximum Symmetric Surface Distance (MSD, mm), are used for segmentation evaluation

V. ALGORITHM

Various steps are followed for segmentation of the liver from the CT image.

i. Input the image of the CT into the segmentation program.
ii. Normalize the image for post processing phase.
iii. Extract the shape prior features image trained using training set.
iv. Extract the liver based on features extracted after training of the liver sizes and shapes.
v. extract the performance parameters for performance comparison.

VI. FLOWCHART



VII. PERFORMANCE PARAMETERS

i. Volumetric Overlap Error (VOE, %)
ii. Relative Volume Difference (RVD, %)
iii. Average Symmetric Surface Distance (ASD, mm),
iv. Root Mean Square Symmetric Surface Distance (RMSD, mm),
v. Maximum Symmetric Surface Distance (MSD, mm),

VIII. RESULTS AND DISCUSSIONS

The segmentation on to the image for both SLIVER and IRCAD dataset is performed and extracted segmented image is shown in.

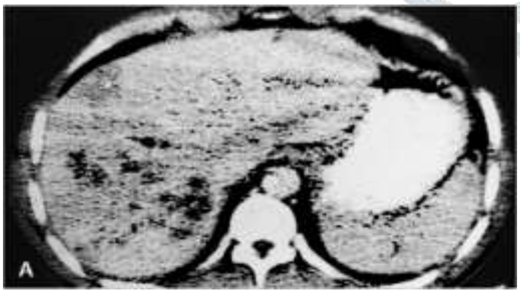


Fig. 1 Original image

Fig.1 shows the original image belongs to the SLIVER dataset.

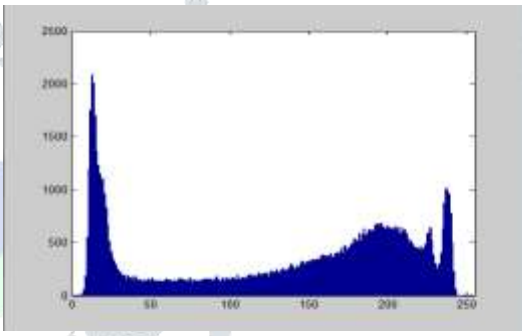


Fig. 2 Intensity histogram

Fig. 2 shows the Intensity histogram for the whole CT image.

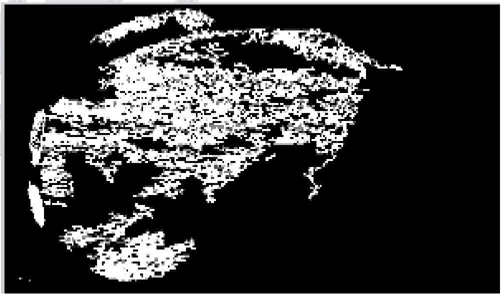


Fig. 3 Segmented image of Liver

Fig. 3 shows the segmented image using shape prior features and C-V model.

8.1 Mean results of the comparison metrics on two datasets

(The smaller the absolute value, the better result is).

Table 1 Sliver Dataset

Data	Method	VOE	RVD	ASD	RMSD	MSD
SLIVER	Existing	7.6	-0.1	0.8	1.5	20.8
	Proposed	7.3000	-0.0800	0.6400	1.3200	19.2000

Table 2 IRCAD

Data	Method	VOE	RVD	ASD	RMSD	MSD

IRCAD	Existing	6.5	4.1	1.9	2.1	18.9
	Proposed	6.1000	3.8000	1.3000	1.2000	17.4000

IX. CONCLUSION

Segmentation for medical image for identification of certain organ is very complex issue. Various researches are being done in identification of liver from CT image. As per the literature the combination of feature extraction and shape prior information has not been used .The success rate for the segmentation has large variance. Because the different type of image quality and different types of noises in the image. Shape prior features based on SLIVER dataset and IRCAD dataset, SLIVER dataset is used for training purposes. Based on training of the shape of the liver further testing is performed on to the IRCAD dataset. Various performance factors like Volumetric Overlap Error (VOE, %), Relative Volume Difference (RVD, %), Average Symmetric Surface Distance (ASD, mm), Root Mean Square Symmetric Surface Distance (RMSD, mm), Maximum Symmetric Surface Distance (MSD, mm). is being evaluated the results in the proposed technique has improved over to the existing. All the performance parameters has shown the improvement in both the datasets like SLIVER and IRCAD.

X. FUTURE WORK

Current research is based shape prior features of the liver in CT image. The proposed technique has been applied on two well known datasets like SLIVER and IRCAD. In future this work can be enhanced by increasing the size of the dataset and develop more robust approach for automatic segmentation of the liver from CT image.

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