IJCSE International Journal of Computer Sciences & Engineering Open Access
Research Paper Volume-4, Issue-11 E-ISSN: 2347-2693

Automatic Detection of Liver Tumor in CT Image Using Region Growing and SVM Classifier

Sreeraj R[1*] and Raju. G[2]

[1]*Bharathiyar University, Coimbatore, India*
[2]*Department of IT, Kannur University*
sreerajr@gmail.com,kurupgraju@gmail.com

Available online at: www.ijcseonline.org

Received: Oct/09/2016 Revised: Oct/16/2016 Accepted: Nov/12/2016 Published: Nov/30/2016

Abstract—This paper presents an approach to automatic detection of liver tumor in CT images by using region-growing and Support Vector Machine (SVM) which is successfully classifies the liver cancer types such as hepatoma, hemangioma and carcinoma.The method rectifies the problem of manual segmentation and classification which is time consuming due to the variance in the characteristics of CT images.Our proposed method has been tested on a group of CT images obtained from hospitals in Kerala with a promising results both in liver and tumor segmentation. The average error rate and accuracy rate obtained from our proposed method is 0.02 and 0.9.

Keywords—Region-growing,preprocessing,feature extraction,Segmentation, SVM Classifier.

I. INTRODUCTION

Liver tumor is one of the highest cause of death due to cancer.Early detection of tumor helps to plan properly administers treatments for tumor[1],[2]. There are so many algorithms are existing for the segmentation and classification of tumor. The segmentation process is a very essential step for the accurate detection of tumor cells.The liver segmentation process is to extract liver region from the abdominal CT image which is a challengingtask[3],[4]. This paper present a method for fully automatic detection of liver tumor and eliminates the need for manual interaction. It provides an accurate segmentation and decreased computation time. The liver organ is segmented from CT images by using Region-Growing method and classification of tumor using support vector machine (SVM) classifier[5],[6].

In this paper, we propose a technique for automatic liver tumor segmentation and classification of the abdominal CT image. The contribution of the research uses a combination of region-growing and SVM which improves the detection rate of the liver tumor. The proposed method shows significant improvement in the accuracy and error rate

This research paper has been organized as follows. Section II reviews several published algorithms for segmentation and classification of liver tumor. Section III describes the proposed method for automatic segmentation. Section IV describes the SVM classification. Section V presents the results and discussion.

II. RELATED WORKS

There are different approaches for liver tumor detection.D.Selvathi et al.[7] used an adaptive threshold technique to segment the liver from the abdominal organs.In this method different threshold value is set to different regions in the image, because each liver CT images would be of different size and shape. The Fuzzy C Means technique is used to extract the tumor from the liver. The FCM algorithm assigns pixels to each type of image region by using Fuzzy membership. Classification is done with counterlet transfer, which produces a multi resolution directional tight frame, designed to efficiently approximate images.

Weimin Huang et al.[8],[9] proposes an extreme learning machine (ELM) for both segmentation and classification. In this work ELM machine is trained by a number of samples of CT images of liver.Initially, a preprocessing step is done for removing the noise from the images.This is due to the different characteristics of CT images in different patients. It is done by normalizing the window level. Some features like intensity, intensity power, entropy, intensity co-occurrence are generated in 3D volume. For classification,ELM is trained with tumor and non-tumor features. Tumor cells are detected by comparing these features.

Lei Meng et al.[10] proposed a support vector machine based liver cancer detection using magnetic resonance images. SVM machine accepts MR images as input. for feature extraction and ROI (Region Of Interest) selection, It uses a histogram based feature extraction method. It extract feature information from each row of MR images. It performs the data normalization to remove the problems of signal intensity difference between the sample images and acquired images.

III. PROPOSED METHOD

The proposed method achieves an automatic liver segmentation which is shown in figure1. The source image is a CT image is preprocessed using median filter. Next the preprocessed image is segmented using region growing method and feature extraction[11].SVM classifier has been used for classifying hepatoma, hemangioma and cholangio carcinoma.

A. Pre processing

The noise in theCT image can be eliminated by smoothening ofthe image using median filter. Minimum and maximum value of the intensity is calculated from histogram, based on the peak value (p). It can be defined as;

$$I_{min} = p - 3 \; and \; I_{max} = p + 3 \quad (1)$$

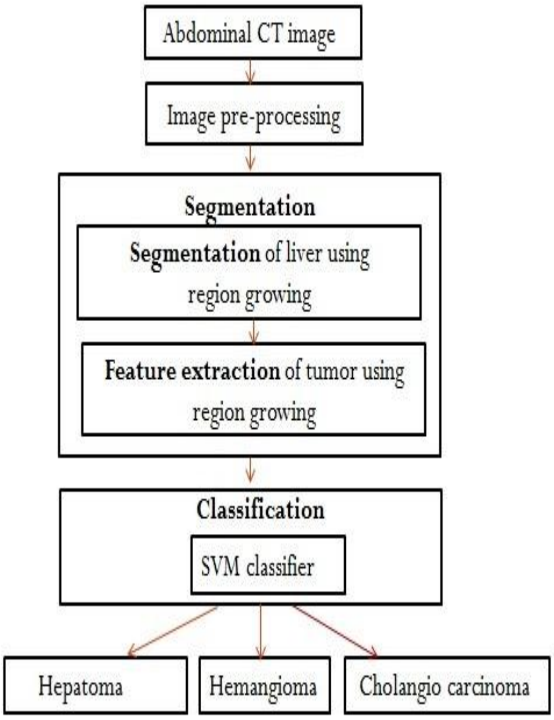

Figure 1. The proposed methodology

Figure 2. Original abdominal CT image

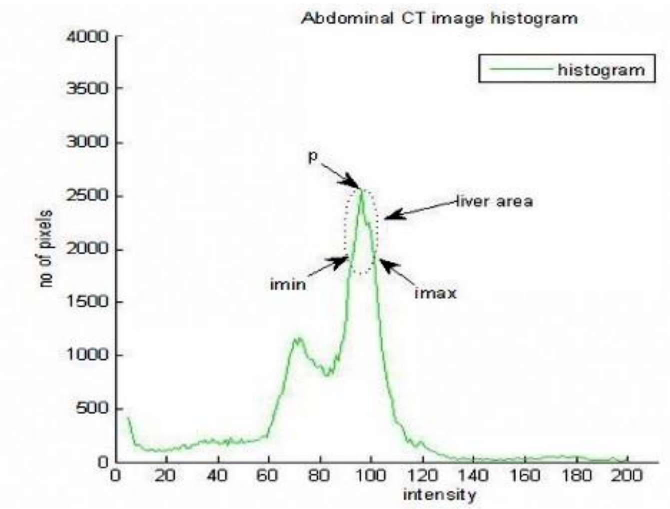

Figure 3. Histogram of CT image without right bottom part

B. Region growing

The procedure of region growing method in this paper is explained as follows:-

- The seed point has been selected by considering the features of that seed point. The region is made too large by selecting the neighboring points with the same property of seed point.

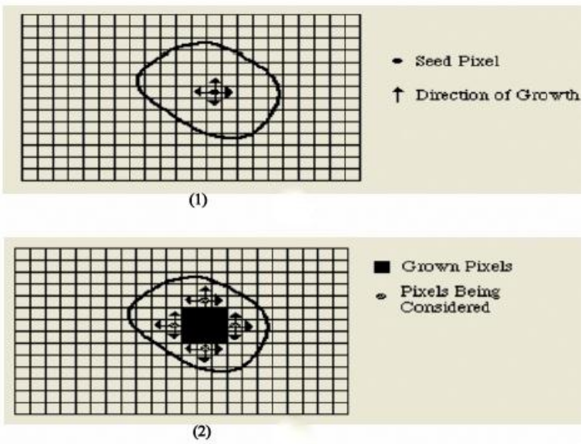

Figure 4. (1)Start region growing (2) Growing process after a few iterations

- Seed point is selected using the region of interest. Let *P* be the set of unallocated pixels has a border at least one of the region can be expressed as

$$x \notin \quad \bigcup_{i=0}^{n} A_i \; |N(x) \cap \bigcup_{i=0}^{n} A_i \neq \emptyset\}|$$

The minimum difference between N (x) and the region mean $\mu$is used a measure of similarity is defined as

$$\delta(x) = min \left| N(x) - \underset{x \in Ai}{\mu} [g(x)] \right| \quad (3)$$

$\delta(x)$ is the difference between the pixels grey level value and the mean intensity of the region grown. A (x) is the grey level value of the current pixel andmean (A(y)) is the mean of the already grown region.

C. Tumor segmentation

The tumor segmentation is also achieved using region growing method. The intensity of liver tissue is greater than the intensity of tumor. From the histogram ,we can understand that pixels with intensity values less than are considered as the tumor region. This tumor region is extracted from the liver. This resulting image is called approximated image.

As we know that the first step of region growing is selecting the seed point. For that we are selecting the centroid from the image. The following algorithm is used for segmenting the tumor

Algorithm: Tumor Segmentation

- Compare the intensity of the health tissue and the tumor tissue
- If the difference is less than the predetermined threshold value

  then
  - approximated tumor region will be the segmented one

  otherwise
  - usethe seed pointfor region growing algorithm

IV. SVM CLASSIFICATION

Support vector machine (SVM) is used to detect and classify the liver tumor. SVM helps to detect the liver tumor at the early stages[12].

A.Design and implementation

Liver cancer is also known as the hepatocellular carcinoma. The initial process of SVM classification is training the machine. Collected CT images of both tumor and non tumor affected persons are used to train the machine. This process is known as model construction.After completion of the model construction stage,it is tested using another set of CT images.

B.Input data and pre-processing

To begin with, 3 numbersof CT images from the first set (say s0,s1 &s2).The s0 images are used without contrasting agent where as s1 and s2 images are used with contrasting agents. Let s_h and $s_p$are the captured images when the peak value of the contrast agent appears in the hepatic artery and peak value of the contrast agent is appearedin the portal vein. Images s_p,s_h,s_0 are the input to the the system. Therefore, changes of signal intensities are calculated as follows.

$$\Delta sh = \frac{sh - s0}{s0} \; x \; 100 \quad (4)$$

$$\Delta sp = \frac{sp - s0}{s0} \; x \; 100 \quad (5)$$

V. RESULTS

The proposed algorithm has been tested using different abdominal CT images.Our algorithm has successfully segmented the liver region as a first step in the segmentation of liver tumor. The classification of the tumor has been done with SVM classifier.Thetumor segmentation from the abdominal CT images are shown in Figure5.

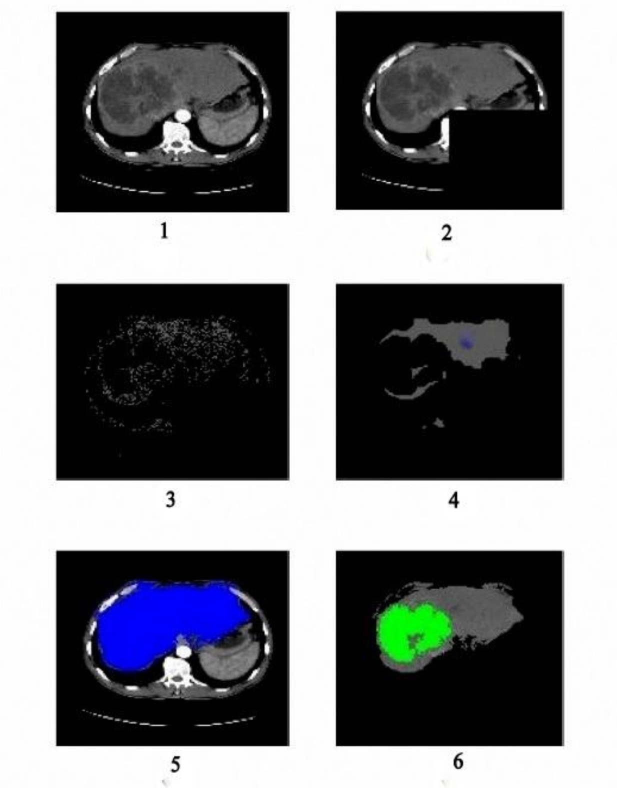

Figure 5. 1) Original abdominal CT image, 2) CT image without right bottom part, 3) simplified CT image 4) Eroded image with centroid, 5) Region grown liver, 6) Region grown segmented tumor.

The proposed algorithm has been tested on 3 sets of abdominalCT images,each carrying 25 images. Table 1 lists the liver segmentation results of CT image. Table 2 lists the tumor segmentation results. Sensitivity and specificity are statistical measures of the performance of binary classification test. Sensitivity measure the proportion of actual positives which are properly identified. Specificity measures the proportion of negatives which are correctly identified.

Sensitivity=TPI (TP+FN)
Specificity=TNI (FP+TN)
Accuracy=TPI (TP+TN+ FN+ FP)
Error Rate=TPI (TP+TN+FN+FP)

- **TP**=true positive, liver (tumor) pixel, classified as liver pixel.

- **TN**=true negative, non-liver (tumor) pixel, classified as not liver pixel.
- **FN**=false negative, liver (tumor) pixel, but classified as liverpixel.
- **FP**=false positive, non-liver (tumor) pixel but classified asliver pixel.

TABLE 1. Liver segmentation results

CT image	*Sensitivity*	*Specificity*	*Accuracy*	*Error rate*
1	0.973	0.996	0.991	0.009
2	0.966	0.988	0.982	0.017
3	0.967	0.995	0.985	0.014
4	0.965	0.999	0.996	0.004
5	0.965	0.978	0.968	0.030
6	0.969	0.991	0.986	0.014
7	0.986	0.980	0.982	0.018
8	0.984	0.990	0.979	0.018
9	0.970	0.998	0.986	0.020

TABLE 2. Tumor segmentation results

CT image	*Sensitivity*	*Specificity*	*Accuracy*	*Error rate*
1	0.950	0.995	0.992	0.008
2	0.965	0.988	0.999	0.001
3	0.942	0.999	0.985	0.001
4	0.936	0.999	0.999	0.001
5	0.930	0.998	0.999	0.003
6	0.916	0.991	0.997	0.002
7	0.924	0.998	0.997	0.003
8	0.891	0.999	0.997	0.001
9	0.945	0.998	0.996	0.002

Table1 shows liver segmentation results which includes the mean values of sensitivity, specificity, accuracy and error rate.The values are obtained as 97.2 ± 0.16%, 99.2±0.7%, 99.1±0.8% and 1.2±0.7% respectively.Table 2shows tumor segmentation result which includes the mean values of sensitivity, specificity, accuracy and error rate which are 93.6±0.32%, 99.7±0.22%, 99.7±0.2%and 0.2±0.2% respectively.We alsoimplement a classification method of early stage liver tumor based on abdominal CT images. This is achieved by applying histogram based feature vectors extracted from the samples of liver tumor and a kernel based SVM tumor classifier are trained.The results shows that the trained SVM achieves an accuracy of 98% in classifying and the liver tumor and helps in early stage cancer detection.

VI. CONCLUSION

In this paper, we proposed an effective algorithm for automatic segmentation and classification of liver and tumor. The proposed algorithm decreases the computation time by removing the unwanted region. The liver region has been segmented from the abdominal CT image using the region growing method and also the tumor segmentation from the liver has been done using region growing. The classification of liver tumor is done by SVM classifier. Our algorithm achieves an average accuracy rate of 98% in liver segmentation and an average accuracy rate of 99.17% in tumor segmentation. For a better classification SVM is trained using weighted features of data classification.

REFERENCES

[1]. Daniel, D. Arul Pon, K. Thangavel, and K. T. Rajakeerthana. "Empirical study on early detection of lung cancer using breath analysis." Innovations in Information, Embedded and Communication Systems (ICIIECS), 2015 International Conference on. IEEE, 2015.

[2]. Gao, Fei, and Yuanjin Zheng. "A correlated microwave-acoustic imaging method for early-stage cancer detection." 2012 Annual International Conference of the IEEE Engineering in Medicine and Biology Society. IEEE, 2012.

[3]. Zhang, Xing, et al. "Interactive liver tumor segmentation from ct scans using support vector classification with watershed." 2011 Annual International Conference of the IEEE Engineering in Medicine and Biology Society. IEEE, 2011.

[4]. Chen, Bin, et al. "Segmentation of liver tumor via nonlocal active contours."Image Processing (ICIP), 2015 IEEE International Conference on. IEEE, 2015.

[5]. Meng, Lei, Changyun Wen, and Guoqi Li. "Support vector machine based liver cancer early detection using magnetic resonance images." Control Automation Robotics & Vision (ICARCV), 2014 13th International Conference on. IEEE, 2014.

[6]. [6] Zhou, Jiayin, et al. "Segmentation of hepatic tumor from abdominal CT data using an improved support vector machine framework." 2013 35th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC). IEEE, 2013.

[7]. Selvathi, D., C. Malini, and P. Shanmugavalli. "Automatic segmentation and classification of liver tumor in CT images using adaptive hybrid technique and Contourlet based ELM classifier." Recent Trends in Information Technology (ICRTIT), 2013 International Conference on. IEEE, 2013.

[8]. Huang, Weimin, et al. "Liver tumor detection and segmentation using kernel-based extreme learning machine." 2013 35th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC). IEEE, 2013.

[9]. Huang, Weimin, et al. "Random feature subspace ensemble based Extreme Learning Machine for liver tumor detection and segmentation." 2014 36th Annual International Conference of the IEEE Engineering in Medicine and Biology Society. IEEE, 2014.

[10]. Lei Meng; Changyun Wen, Guoqi Li proposed in their journal "Support Vector Machine based Liver Cancer Early Detection using Magnetic Resonance Images" published in 2014.

[11]. Abd-Elaziz, O. Fekry, M. Sharaf Sayed, and M. Ibrahim Abdullah. "Liver tumors segmentation from abdominal CT images using region growing and morphological processing." Engineering and Technology (ICET), 2014 International Conference on. IEEE, 2014.

[12]. Javed, U., et al. "Detection of lung tumor in CE CT images by using weighted support vector machines." Applied Sciences and Technology (IBCAST), 2013 10th International Bhurban Conference on. IEEE, 2013.

[13]. Lee, Seungchan. "Weighted Support Vector Machine for Data Classification.", term proje

