Extracting Liver and Tumor from Computer Tomography Images Using Hybrid Techniques

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ABSTRACT
Computer tomography imaging Technique plays an important role in medical imaging research for diagnosis of liver diseases. Automatic detection of liver is the most essential parts in computer-aided diagnosis for liver CT as well as computer-aided surgery. CAD is used by radiologists as a second opinion in detecting tumors, accessing the extent of diseases and making diagnostic decision. Automatic segmentation of liver from CT images is difficult due to size, shape, position and presence of other objects with the same intensity present in the image. In this paper, hybrid technique for the segmentation of liver from the CT image is proposed. The hybrid technique used combination of one or more segmentation algorithms: FCM clustering and label connected algorithm. The objective of the proposed method is to segment the liver and detect the tumor from the segmented liver. The experimental results are discussed with radiologists doctor and demonstrates this algorithm is effective for automatic segmentation of liver.

Keywords
Computer Tomography, FCM clustering, Label connected component algorithm.

INTRODUCTION
Medical imaging analysis and processing are very much important in the field of medicine, especially for noninvasive treatment and clinical study. Medical imaging techniques and analysis tools enable both doctors and radiologists to arrive at a specific diagnosis. Imaging helps the Doctors to visualize and analyze the image for understanding of abnormalities in internal structures. Image segmentation is mainly used to locate objects in images. Each pixel of the one part or region of an image is similar with respect to some characteristics like color, brightness etc. but adjacent regions are different with respect to the same characteristics. Thus we can say different regions are differentiated on the basis of these characteristics thus segmentation is carried out. In medical science detecting disease in liver is a difficult task. Thus segmentation proves to be very beneficial in this case.
Liver is the largest organ in our body and Liver cancer patients is increasing day by day. If treated in the early stage, liver cancer can be successfully cured. Liver cancer is of two types namely the primary liver cancer where it starts from the liver and secondary (metastatic) liver cancer where cancer which started in another part of the body such as bowel, pancreas, stomach, lung or breast has spread to the liver.
The most common medical imaging studies for early detection and diagnosis of liver tumors include Ultra Sonography (US), Computed Tomography (CT), Magnetic Resonance (MR) Imaging and Angiography [1]. Among all CT imaging is preferable, because of noninvasive, high quality and cost is reasonable and most commonly used.
imaging technique for analyzing the cancer cells. Several approaches have been used for segmentation of liver from CT image datasets. The intensity threshold-based liver segmentation methods [9] require few threshold values to be defined manually, the deformable model methods require large number of manual inputs, in statistical model-based methods, the search for optimal model requires too much time, Level set requires high computation, and Snake algorithm requires considerable processing time. Level set, Watershed and Active contour based segmentation requires points on the tumor to be defined manually.

Generally radiologists segment the tumors manually slice by slice from computed tomography (CT) scans, and then calculate the volumes. However, most of these methods are tedious and time consuming, produce over segmentation and unsatisfied results and could not respond identically to different patients The goal of the approach presented in this paper is to achieve the segmentation automatically in computer tomography images of the abdomen and, to obtain the volume of the liver and its internal structures, in particular the tumors.

The rest of this paper is organized as follows: Section II describes the various terms relevant to the paper. Section III describes the proposed method in detail. Section IV presents the results and the discussion and finally Section V gives the conclusion.

II. PRELIMINARIES
A. CT Scan
CT Scan [11] is a computerized tomography scanning method. It is an X-ray exam to produce special images of the body. The image retrieved from this exam mainly defines the shape, size and position of the internal body parts allowing for a diagnosis. Advantage of using CT scanning:
1. The quality of the image is improved.
2. Internal complex features can be precisely measured without destructive testing.
3. Parts are scanned in a Free State environment without applying stresses that could have damaged the delicate parts or give a warped display

B. Abdominal CT image Liver
The liver is located in the upper right quadrant of the abdomen, right side of the stomach and above the intestines. It extends from the abdomen to the thorax. From the perspective of the observer the liver is located on the left side of the CT image. The liver is the largest organ in the abdomen and the entire human body. Liver segmentation based on CT image is a challenging task due to the presence of similar intensity objects in the abdomen with no clear delineation between these objects and the liver.

![Fig.1: Axial slice of CT image]

1. Right lung 2. right hepatic vein. 3. Liver. 4. left hepatic vein. 5 Stomach. 6. splenic flexure. 7. Rate. 8., the left lung. 9, Aorta.

C. CT data set
Our dataset is composed of 40 abdominal contrast enhanced CT images. They have been
acquired at the Malathi Manipal Hospital in Bangalore with a Siemens multi detector spiral CT. Images are stored into a PACS system in DICOM format. Our dataset contains patients with normal, fatty, cirrhotic, overextended livers and livers with cancer, so that we have to take into account a big anatomical and gray level variability in the data.

D. Median filtering

The median filter [8] is a nonlinear digital filtering technique, often used to remove noise. The main idea of the median filter is to run through the signal entry by entry, replacing each entry with the median of neighboring entries. The pattern of neighbors is called the "window", which slides, entry by entry, over the entire signal.

E. Label connected component

Label Connected component is one of the most common and effective segmentation algorithms. It is primarily used for finding similar regions in an image. It is also known as blob extraction or region labeling. A graph-theoretic approach is used for connecting pixels in a 2D/3D image and assigning the connected pixels a label based on some heuristic such as euclidean distance. Label Connected component works well for binarized images or thresholded images. The algorithm works for medical images, microscopy images, and for finding alphabets.

To compute connected components of an image, split the image into horizontal runs of adjacent pixels, and then label the runs uniquely. In the second pass, adjacent runs of different labels are merged. The algorithm ensures regions of similar value are labeled with one label.

F. Morphological Operation

Morphology[7] here is a tool for extracting image components with the help of structuring elements that are useful in the representation and description of region shape such as boundaries and skeleton. Most elementary morphological operations are dilation, erosion, opening and closing. In this paper, dilation and erosion techniques can be used.

Erosion is a process used to shrink or thins the area of object in the image. Image details smaller than the structuring elements are filtered from the image.

Dilation is a process used to grows or expand the area of object in the image. Image details larger than the structuring elements are filtered from the image.

F. FCM Clustering

Fuzzy c-means (FCM) is a method of clustering which allows one piece of data to belong to two or more clusters. This method is frequently used in pattern recognition. It is based on minimization of the following objective function:

$$J_m = \sum_{i=1}^{N} \sum_{j=1}^{C} u_{ij}^m ||x_i - c_j||^2$$

where $m$ is any real number greater than 1, $u_{ij}$ is the degree of membership of $x_i$ in the cluster $j$, $x_i$ is the $i$th of d-dimensional measured data, $c_j$ is the d-dimensional center of the cluster, and $||\cdot||$ is any norm expressing the similarity between any measured data and the center.

III. PROPOSED METHOD
The proposed method of our work is explained in following lines. It consist of various steps and each will be explained in detail.

1. First, select suitable slices in CT dicom file. Liver distribution varies from one slice to another. Moreover liver occupy the largest portion in the abdomen. And middle slice is preferable, that will give high accuracy and suitable for segmentation.

2. Second, preprocess the original image. Without preprocessing, directly if we extract the liver leads to the following problem – undesirable boundaries resulting from its adjacent organs are extracted. Here preprocessing is done by median filtering. This is mainly used to smoothen the image and enhance contrast, remove noise and emphasize certain features that affect segmentation algorithm and morphology operator.

3. For the preprocessed image, investigate and analyze the intensity distribution. So histogram of the preprocessed image is drawn and analyzed. For the fast and accurate liver segmentation, consider a prior knowledge of the liver on abdominal CT image such as shape, location and intensity value. From the prior knowledge, we can conclude the following things
   (i) Liver is located on the left side of the CT image.
   (ii) Liver is the largest organ in the abdomen and occupies more area.
   (iii) Right bottom region of the image is discarded because that portion does not contain the liver.

4. For filtered image, 3 class of fuzzy c means clustering is applied. And output of the image is binary. The algorithm is composed of the following steps:
   FCM Method

   Step 1: Get the data from Image.
   Step 2: Fix the number of Clusters and assign the initial cluster centers.
   Step 3: Compute the membership function.
   Step 4: Update the cluster centers.
   Step 5: Repeat steps (3-4) until the termination criterion is satisfied.

5. Output of the previous step is applied as input to the label connected component algorithm. The algorithm has two module:
   (i) Labelling of connected components
   (ii) Search for the largest component.

   Steps involved in connected component labelling:
   (i). Take the filtered image as the input.
   (ii). Scan all ‘P’ pixels from left to right and top to bottom i.e scan pixel by pixel
   (iii). Check the condition if the pixel ‘P’ is not equal to background then
       if only one of two top and left neighbors has a label e then mark P with e
       Else if these two neighbors have the same label then mark p with e
       Else if then mark P with min(top pixel, left pixel)
   (iv). If the condition is not satisfied then assign new label to pixel P.

6. For the output of label connected component, apply morphological filter to fill the holes.

7. Contour detection was performed by applying the nonlinear filter of Sobel. The superposition of the contour on the original image allows us to deduct the region of the liver and tumor on the liver.

IV. RESULTS AND DISCUSSION
The image data has been acquired using CT system. The images are provided in dicom format with 512×512 pixel matrix. Our segmentation method of liver was tested with
five abdomens of five patients. To evaluate our proposed method, in this section, experimental segmentation of liver slices were carried out by using MATLAB 9. The sample shows five images that are Original Image, proposed method output, morphological operation output by filling holes, segmented tumor and contour detection output.

![Fig.1: Input CT image](image1)

![Fig.2: Proposed method output](image2)

![Fig.3: Morphological operation](image3)

![Fig.4: Detected tumor image](image4)

![Fig.5: Contour detection](image5)

V CONCLUSION

A new method for extracting the liver region and tumor detection is presented in this paper. The proposed algorithm uses FCM based on label connected component and morphological closing to simplify the image which helps to decrease the computation time and efforts by removing the regions of other structures and tissues. In future, our proposed method is further improved by integrating with fuzzy logic and genetic algorithm.

VI. REFERENCES

[1] Gao, L., Heath, D., Kuszyk, B., Automatic liver segmentation technique for three-