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Liver Tumor Detection in CT Images by Adaptive Contrast Enhancement

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***Abstract*— Automatic tumor detection and segmentation is main topic for the computer-aided diagnosis of live tumors in CT images. However, It is a complex work in low-contrast images as the low-level images are too weak to detect. In this project, we propose a new technique for the automatic detection of liver tumors. We alternatively enhance the intensity contrast of CT images by probability density function estimation. To find tumorous regions, we use the expectation maximization/maximization of the posterior marginal. Finally we use shape constraint to reduce noise and identify focal tumors.**

***Index Terms*— Liver tumors, CT images, FCM, DRLSE, Median filter.**

I. Introduction

Liver cancer is the most common cancers and it has become the greatest killer which is dangerous for human health. Liver cancer is one of the malignant tumors which grow rapidly, it always occur at the age of 45 to 65, If patients never seek medical diagnosis until the symptoms involve, it indicate the liver cancer is of a final stage. Therefore, if the liver cancer cannot be diagnosed in early stage and get proper medical treatment, patients often die within half a year after the liver cancer diagnosed. Therefore, how to prevent the occurrence of liver and the treatment of liver cancer of has become the very important issue. The symptoms of the liver cancer are starts due to excess of fat in liver and it is out of the capacity for save in the liver. During this period of time, the normal tissues in the liver will change into the warehouse for saving fat so, tissues in the liver cells and around liver cells all becomes fat organizations. Because of this, the liver cells cannot get enough blood supply, and result in absorbing less nutrients and oxygen than they require. It is prone to inflame or necrosis. Liver inflammation will stimulate the proliferation of fibrous tissue in the liver, these fibrous tissues then become scar tissue and surround the liver cells and change into the fake hepatic lobule. After affected by some additional carcinogenic factors, it transformed into liver cancer [2]. Initial phase of liver cancer does not show any disease status. Even some large tumors will also not cause pain or other disease symptoms until late liver cancer. In later liver cancer, tumor is large enough to directly pressure to the large blood vessel and make damage to liver function. Tumors may also break and bleed then cause to abdominal intense pain, even shock and die because loss too much blood. Liver tissue image segmentation is to classify scar tissue and normal cells in the image, in this study, both of the features are used in judging and segmenting. In general, the scar tissue in late phases of the liver cancer, the distribution area is larger and more closely, and the color is darker than normal cells. The segmentation method consists of five stages, the first stage is pre-processing, main operation is to convert color images of liver tissue to gray scale images. The second stage is one of the contrast enhancement methods, at this stage, pixel intensity values are used to increase contrast enhancement of image, it makes a clear distinction between scar tissue and normal cells. In the third stage which includes cross adaptive filter, which uses cross mask to scan the entire image, and by adjusting the mask size to improve the effects of ambient light uneven. The mean and standard deviation values are used to set two thresholds, which can convert an image to binary Images and then extract the scar tissue. After aforementioned processing, there is still a little voids and redundant tissues, the fourth stage is using the majority filter to fill these voids and remove redundant tissue. Finally, the fifth stage is dealing with small residual noise. Under this stage, regional label methods are used to reduce noise.

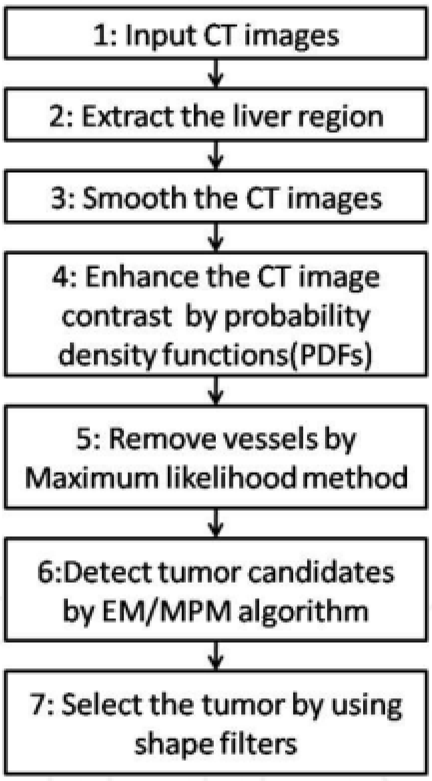
II. EXISTING METHOLOGY

Liver cancer is one of the major causes of death in humans. Initial detection of tumors is essential for increasing the survival chances of patients. Several growth are happened in medical imaging modalities have enabled the acquisition of high-resolution CT datasets, and thus, allowing physicians to identify both small and large tumors by manual visual inspection. Owing to the numerous images in medical datasets, it is difficult to manually analyze all images, and useful diagnostic information may be overlooked. Moreover, the diagnoses are mainly based on the physician's subjective evaluation and are dependent on the physician's experience. Consequently, computer assisted diagnosis (CAD) and computer assisted surgery have become one of the major research subjects.

III. PROPOSED SYSTEM

We propose a new method for detecting tumors in CT images. Our method is depend on adaptive contrast enhancement and the expectation maximization / maximization of the posterior marginal (EM/MPM) algorithm. User interaction is not required and both large and small tumors can be accurately found. Compared with our previously reported method, the newly proposed method is also suitable for images with poor contrasts.

A. BLOCK DIAGRAM



B. METHODOLOGY

1) Contrast enhancement

As tumor detection is mainly depend on the intensity of CT images, the contrast of the images is very important. Two typical histograms of CT images having high and low contrasts are shown in Figs. 1 and 2(b), respectively. if the contrast of CT images is high, the tumor is in a variety intensity range (left small peak) with the liver (right large peak) and the tumor can be easily detected by the intensity threshold, while if the contrast of CT images is low, the tumor is in the same narrow intensity range as the liver. and it is complex to detect the tumor from the liver volume. Density value of every objects is in a narrow range. So we have to increase the contrast of CT images as a preprocessing.

2) Removement of vessels by applying Maximum likelihood method

Previous tumor detection step, we first remove vessels from CT images. In the conventional method, as the intensity of vessels is higher than those of health liver tissues and tumor tissues, intensity threshold method is used to remove vessels. We segment the CT volume into 3 classes by using Maximum likelihood method. And then, voxels of the class with the highest mean are removed as vessels. Later this process, CT images only include tumor and healthy liver tissues. The tumor detection problem can be compressed as a 2-class classification problem. This process will also significantly reduce the detection time.

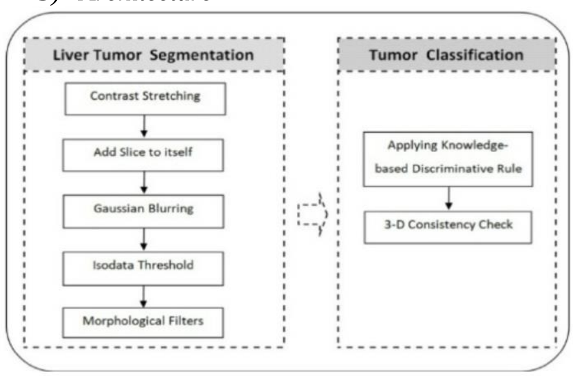
3) Tumor candidate detection by using EM/MPM algorithm

To take out tumor candidate, we used the EM/MP Malgorithm. It is based on a Bayesian framework that assumes a Gaussian mixture to model intensity distribution and concurrently estimates both the labels of the voxels and the model parameters. In MPM, the cost function is defined to minimize the total number of misclassified voxels.

4) Candidate selection with shape filter

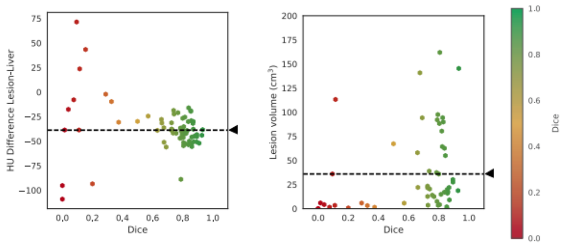
The tumor candidates were detected in the previous section, include many false positives because the detection used only intensity information. Furthermore, in this step, we perform a selection process using a shape filter. We define the following five evaluation criteria: (1) size, (2) shape of each slice, (3) regional variation among the slices, (4) location in the image, and (5) numbers of connectivity among the slices. In this study, we assume that the shape of a tumor is approximately spherical. Furthormore, for the second criteria, we use a shape filter. For each tumor candidate, we first find a center of gravity, and then calculate distances from it to the 12 points which are on the edge of tumor 4 points are cross points with the bounding box (line of a rectangle). 8 points are boundary points sampled at intervals of 45 degree as small circle points. The ratio of maximum distance and minimum distance is utilized as a measure of shape. The ratio is a value larger than or equal to 1. If the candidate's shape is like a circle, the ratio will be 1. Since the tumor is considered having a spherical shape, the candidates are rejected if their ratio is larger than a pre-defined threshold (in our research, the threshold is set as 4).

5) Architecture



IV. EXPERIMENTAL EVALUATION

We included our proposed method to five sets of CT images. Information on each image is shown in Table 1. Data sets 1, 2, and 3 were used in the JAMIT CAD contest in July 2010, while Data sets 4 and 5 were utilized in the MICCA Liver Tumor Segmentation Challenge 2008. Table 2 shows the results of tumor detection. In this study, if a part of a tumor is detected in the correct region, we consider the result as a true positive. Because only the ground truth for Data sets 1, 2, and 3 were known, Table 2 shows comparisons between the detected results and the ground truth for Data sets 1–3. The proposed method gives accurate detection results for Data sets 1 and 2. For Data set 3, the detection rate is about 50% in fact the image includes numerous minute tumors.



Analysis of lesion segmentation performance

V. CONCLUSION

We have introduced a new method to detect tumors automatically in CT image. Under using contrast enhancement with PDFs of different tissue classes in a newly devised histogram transformation method, we can enhance the image contrast. Furthermore, by using the EM/MPM algorithm, we can detect tumors more accurately. We plan to improve our work to handle the large morphology variation of tumors.

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