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Segmentation of Liver Organ using Marker Watershed Transform Algorithm for CT Scan Images

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Abstract: *The Liver is a largest gland in the body. Distinctdiseases affected on the liver. Liver diseases is one of the most serious health problem worldwide. For detecting the liver diseases the Segmentation Technique is essential. Segmentation is used for the classification of liver diseases. The liver diseases are focal or diffused is easily understood by the physician using segmentation. We use CT scan image for segmentation but the noise is present in the image. Therefore preprocessing is applied on the image for the removal of noise. In this paper, Watershed Transform segmentation Algorithm is used because it produce complete division of images in separate region even if contrast is poor. Therefore this method could be achieved 92.1% accuracy.*

Index Terms: *Liver Diseases; Preprossesing; Segmenation; Watershed Transform Algorithm*

I. Introduction

In the Human body Liver is a vital internal organ. It is a metabolic organ in the body and perform different functions ie produce a protein, cholesterol and bile acid. Livers main job is to filter blood coming from the digestive tract, before passing it to the rest of the body. In metabolic function of the body, the circulatory system is used to circulate blood by the heart and carried out to the liver. Every minute 1-1.5 litres of blood is transported to the liver through portal veins. The hepatic artery brings oxygen-rich blood to the liver similarly the portal vein transports nutrient.[1-4]The portal veins are used to passed to the blood through the gastrointestinal tract and absorbed large amounts of nutrients. The primary factor of liver diseases are excessive consumption of drugs, poison and drinking too much alcohol. The liver affects different diseases like cirrhosis, hepatitis virus A,B,C , cancer etc. This diseases are affect on any age and no age limit. The main symptoms of this diseases are weakness, excessive weight loss or gain, pain in the upper right abdomen where the liver is present. Fig. 1 show the healthy liver that perform a normal functions[5].

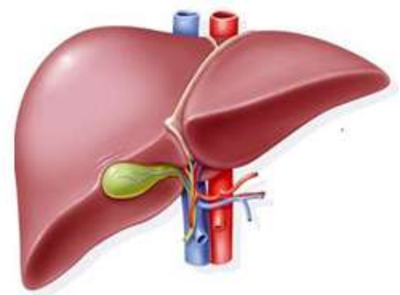


Fig. 1. Structure of Healthy liver

Liver segmentation from abdominal images is a process of subdividing a medical image such as magnetic resonance imaging (MRI), ultrasound scan imaging and computed tomography (CT) into parenchyma area of liver and non-parenchyma areas of liver. There are many methods of Liver segmentation . For every one of the medical image analysis tasks, image segmentation is a significant process, that is used for image comprehension, analysis and for basic higher-level. For surgical planning, early disease detection and 3D visualization, great segmentation provides important information and is very useful for clinicians and patients. To be able to solve the issues of medical image segmentation, already many advancements have been done in many practical methods in this field[6]. These generally include thresholding method, fuzzy cluster method ,region-growing method, watershed segmentation and so on. To make the task of liver segmentation simpler and less time consuming. This paper is formed as follows Section II presents preprocessing the, Section III explains the segmentation. Section IV explains the result.

II. Preprocessing

Image Preprocessing is an crucial and challenging factor in medical image processing. It is use to process the image so that segmentation and feature extraction algorithm work correctly. There are different ways for pre process the image like image re-sampling, manual correction, gray scale contrast enhancement and noise removal. Most of the abdominal CT images are noisy and the edges of objects are not cleared enough in the image. The preprocessing is use to enhance the manipulation of datasets and also improve the visual appearance of images. Generally medical images like MRI, CT etc. always contain a large amount of noise caused by equipment, operator performance, and the environment, which can lead to serious inaccuracies[7-10]. So that filtering method is useful to improving the visual appearance and for removal of noise it gives more accurate values. Before applying filter, image sharpened is use to enhance quality of edges without adding new details and improve eye visualization[11-12].

A. Weiner Filter

The noise is removed using Weiner filter. Weiner filter preserves edges as well as high frequency areas. It takes 3 inputs: i).Image to be filtered, ii).Point Spread Function (PSF) with which noise is distributed and iii). Noise-to-Signal Ratio (NSR). This is basically a restoring method, which performs an optimal trade off between inverse filtering and noise smoothing [8]. Weiner filter is the MSE-optimal stationary linear filter i.e. it minimizes the mean square error (MSE) which is given as the difference between some desired response and the actual filter output. This filter is not suitable for non-stationary inputs. It perform image filtering adaptively by computing local image variance. It performs a little smoothing for large local variance . Weiner filter requires more time than linear filtering and works best provided that the noise is constant power additive noise such as Gaussian noise. The restoration process using this filter incorporates both the degradation function and statistical characteristic of noise.

$$e^2 = E[(f - \hat{f})^2]$$

$$\hat{F}(u,v) = \left[\frac{H(u,v) S_f(u,v)}{S_f(u,v)|H(u,v)|^2 + S_\eta(u,v)} \right] G(u,v)$$

$$= \left[\frac{H(u,v)}{|H(u,v)|^2 + S_\eta(u,v)/S_f(u,v)} \right] G(u,v)$$

$$= \left[\frac{1}{H(u,v)} \frac{|H(u,v)|^2}{|H(u,v)|^2 + S_\eta(u,v)/S_f(u,v)} \right] G(u,v)$$

$$S_\eta(u,v) = |N(u,v)|^2 = \textit{power spectrum of the noise}$$

$$S_f(u,v) = |F(u,v)|^2 = \textit{power spectrum of the } \textbf{undegraded} \textit{ image}$$

$$\hat{F}(u,v) = \left[\frac{1}{H(u,v)} \frac{|H(u,v)|^2}{|H(u,v)|^2 + K} \right] G(u,v)$$

$$\hat{F}(u,v) = \left[\frac{1}{H(u,v)} \frac{|H(u,v)|^2}{|H(u,v)|^2 + S_\eta(u,v)/S_f(u,v)} \right] G(u,v)$$

III. Segmentation

Image segmentation is a process for partition of an image into non-overlap regions, which is an important step in the image processing area and is a base for the analysis and identification in image processing. Image segmentation is a principal process for most of the medical image analysis tasks, which is basic for higher-level image comprehension and analysis. Clinicians and patients will derive benefit from good segmentation since it provides important information for early disease detection, surgical planning, and 3D visualization. In order to solve the problems of medical image segmentation, there has been advancement in many practical methods in this field. Image segmentation is the process of dividing image into regions according to its characteristic such as color and objects present in the images. Segmentation is in the form of images that are easier to understand, more meaningful, and easier to analyze. In order to locate objects and boundaries in images feature extraction of optical density, object shape, and texture, surface visualization, compression image segmentation and image registration is used. Correct segmented results are very useful for the analysis, predication and diagnoses.

A. Watershed Transform

The Watershed is a powerful region based image segmentation algorithm. Watershed was introduced by Beucher and Lantuejoul, Since its introduction it has been widely studied and achieved encouraging results in image segmentation . Its basic idea is to consider image as a topography topology of geodesy Fig. 1, The pixel gray value of each point of image stands for the every local minimum value, altitude of that point, and its impact region are known as the collection basin and the borders of the basin form the watershed[11]. Intuitively, the watershed of a function is composed of the various locations from which a water droplet could flow towards different minima. The immersion process is simulated from the heights of local minima. The water level rises in each basin and when two basins meet, a watershed is created between them.

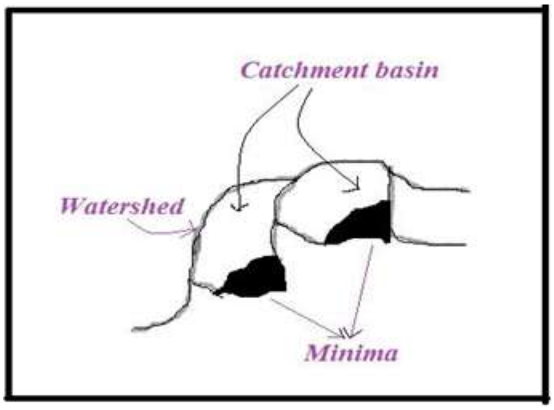


Fig. 1. Watershed Segmentation simplified in 2 dimension

IV. Result

The procedure took for watershed segmentation is described details as follows[9]:

Step 1: Convert image to grayscale and enhance the image contrast.

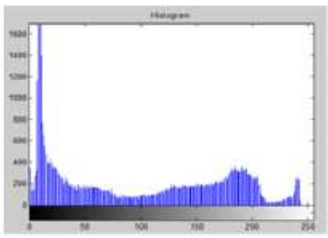
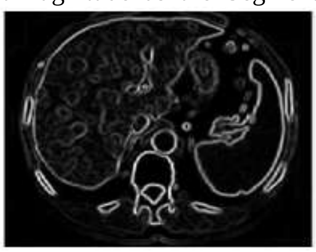


Fig. 2. Original Image Fig. 3. Histogram of image

Step 2: Use the Gradient Magnitude as the Segmentation Function.



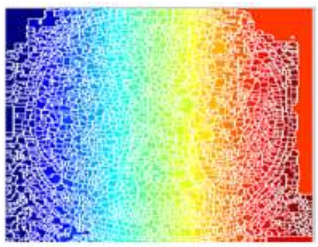


Fig. 4. Gradient Magnitude Fig. 5. Watershed Transform Gradient Magnitude

Step 3: Marking the Foreground Objects.

Fig. 6. After Opening

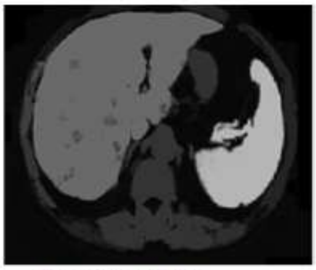


Fig. 7. Opening by reconstruction

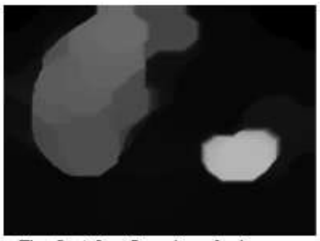


Fig. 8. After Opening-closing

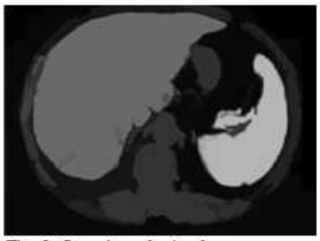


Fig. 9. Opening-closing by reconstruction

Step 4: Compute Background Markers.

Fig. 10. Regional maxima of Opening –closing reconstruction

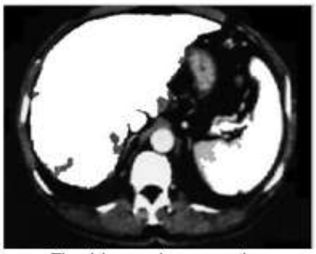


Fig. 11. maxima superimpose on original image

Step 5: Modify the Segmentation Function.

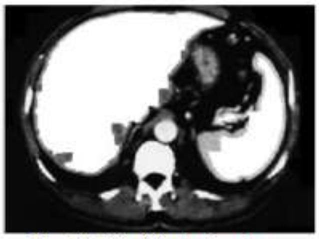


Fig. 12. Modified regional maxima.

Fig. 13. Thresholded opening-closing by superimposed on original image.

Step 6: Compute the Watershed Transform of the Segmentation Function.

Fig. 14. Markers and object boundaries

Step 7: Visualize the Result.

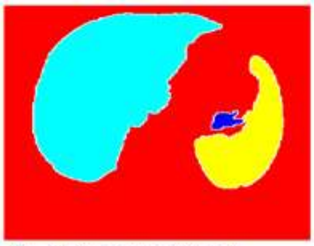


Fig. 15. Colored watershed Labelmatrix.

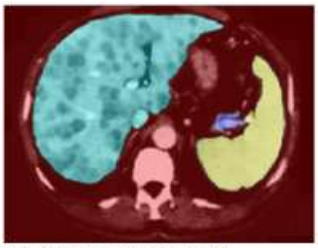


Fig. 16. Lrgb superimposed transparency on original Image

V. Conclusion

In this paper, Image Segmentation method is important step in any image processing method can be proceeded. The CT scan images has noise. Preprocessing is a step to clear the image noise before applying the watershed segmentation and for this Weiner filter is used which gives good result as compared to other filters. This segmentation gives region of interest, minimum probability to identify the background and the affected region in CT scan images. It also used to separate the touching objects in the images. This method avoid the over segmentation and identification of main edge of the images. The proposed method gives 92.1% accurate result as comparing with other used techniques.

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