

LIVER CANCER DETECTION USING IMAGE PROCESSING

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Abstract - The abnormal growth of cells in the liver causes liver cancer which is also known as hepatic cancer, where, Hepatocellular Carcinoma (HCC) is the most common type of liver cancer which makes up 75% of cases. The detection of this tumour is difficult and mostly found at advanced stage which causes life-threatening issues. Hence it is far essential to discover the tumour at an early stage. So the principle intention of this project is to detect liver cancer at earlier stage using image processing technique. Here the malignant liver tumours are detected from Computed Tomography (CT) images. The image undergoes enhancement using anisotropic diffusion filters and segmented by morphological operations which is simple and easy to work. This operation uses combination of two processes, dilation and erosion. The scope of this propounded technique is to highlight the tumour region present in the Computed Tomography.

Key Words: Liver cancer, Morphological operations, Computed Tomography, Early stage, Highlighting tumour region.

1. INTRODUCTION

The formulation of the term cancer was in 460 - 370 BC. It is credited to the Greek Physician Hippocrates who is known as "FATHER OF MEDICINE". Billions of cells in our body divides each day to produce new cells. The newly formed cells occupies the space of dead cells. Basically, cells get together to form tissues, tissues get together to form organs. Hence, in some abnormal cases, cells divide more than the body needed and form as lumps or growths normally called as tumors. In this project we proposed simple method of cancer detection using image processing.

Digital image processing is the technique of using computers to process the image with the necessary algorithms. The software used here is MATLAB. Computed tomography image of liver cancer is employed to detect the tumor region. Detection of liver cancer involves three main steps. It includes preprocessing of image, processing of image and highlighting tumor region. Preprocessing of image involves image enhancement using anisotropic diffusion filter to remove noise and imperfections in image. During thresholding, there may be some chance of noise creation. This step plays an important role in detection of cancer, because a small deviation which may be caused due to imperfections or noise will leaves a major effect in detection process. After image enhancement, image is segmented for detection of tumor region in processing stage. For

segmenting image, morphological operations are used. It includes dilation and erosion which is the basic process for completing the whole detection operation.

Morphological operations are simple and very easy to work because it operates on basic set theory and does not contain complex mathematical equations. The last step is to highlight the tumor region in the given image for easy and clear observation. For understanding the whole process obviously, the sub plotted image of all processed image is shown which includes original image, filtered image, tumor region, bordered tumor image and highlighted tumor region in original given image.

2. LITERATURE REVIEW

[1]Rong Zhu, et.al., "Application of Improved Anisotropic diffusion Filter on Image Processing" proposed that anisotropic diffusion filter is the most commonly used method in removing noises. This paper describes the improved algorithm of anisotropic diffusion filter to remove salt and pepper noises of the images

[2]Ravi S, et.al., "Morphological Operations for Image Processing: Understanding and its applications" described morphological operations are easy to apply and it works on the principle of set theory. The objective of using this type of operation is to remove the imperfections in the structures of the images

[3]Wassem Abdulrahman, et.al., "Diagnosis of Liver Tumors Using Image Processing" aimed to identify the specific regions of liver area in the scanner images to abdominal area. This uses a new method for extraction the region of tumor in the CT.

[4] Amit Verma, et.al., "A Survey on Digital Image Processing Techniques for Tumor Detection" describes the image processing techniques for tumor detection. It gives the best result for detecting and classifying the tumor by comparing with the existing methods.

[5] Jinshan Tang, et.al., "An Adaptive Anisotropic Diffusion Filter for Noise Reduction in MR Images" proposed The stepped forward anisotropic diffusion filter uses adaptive threshold selection. The proposed technique became carried out to real MR images and the outcomes are fantastic.

[6] Gabriel Ramos-Llordén, et.al., “Anisotropic Diffusion Filter With Memory Based on Speckle Statistics for Ultrasound Images” recommend an anisotropic diffusion clear out with a probabilistic-pushed memory mechanism to triumph over the over-filtering problem by using following a tissue selective philosophy.

[7] Alireza Mazloumi Gavvani, et.al., “Noise reduction using anisotropic diffusion filter in inverse electrocardiology” used anisotropic diffusion filter to cancel the noise at the frame floor potentials measurements with the aim of enhancing the corresponding answers of the inverse hassle of electrocardiology.

[8] Reitseng Lin, et.al., “Morphological operations on images represented by quadtrees” proposed set of rules to directly carry out morphological operations on photographs represented via quadtrees and produce the dilated/eroded snap shots, additionally represented through quadtrees

[9] Ruchika Chandel, et.al., “Image Filtering Algorithms and Techniques” described the diverse image filtering algorithms and techniques used for image filtering/smoothing. Image smoothing is one of the most critical and widely used method in image processing.

[10] N. Howard, et.al., “A Novel Fully automated Liver and Tumor Segmentation System using Morphological Operations” purposed to develop an automated Hepatocellular Carcinoma detection system in Computed Tomography images with high sensitivity and low specificity.

3. PROPOSED METHODOLOGY

Liver cancer detection using image processing can be done with three main phases. They are,

- Preprocessing of image
- Processing of image
- Highlighting the tumor in given image

Computed tomography (CT) images are used for observation of liver tumors. MATLAB is the software used for processing the images given.

3.1 Work Flow of Process

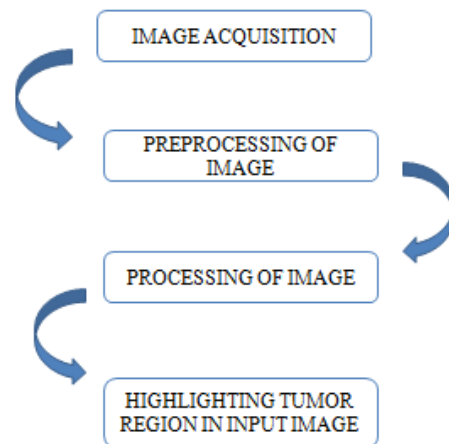


Fig -1: Work Flow

3.2 Software Description

MATLAB is the most popular software used for Digital Image Processing. MATLAB (matrix laboratory) is multipurpose tool used for matrix manipulation, plotting of functions and data, implementation of algorithm and creating user interface. For detecting liver cancer using image processing, MATLAB software is used. It is a general usage programming language. When it is used to process images by generally writing function files, or script files to perform the necessary operations. It forms a formal record of the processing used and the final results can be tested and replicated by others. It provides many important advantages for forensic image processing.

3.3 Preprocessing of Image

Preprocessing of an image is the first and foremost step in image processing. The main aim of preprocessing in image processing is to improve the quality of image, suppressing unwanted distortions in image due to noise and enhance image features for further processing. Normally in performing medical image processing, preprocessing of an image plays a crucial role so that the input image does not have any impurities or imperfections, and it is done to be better for the upcoming process such as segmentation, feature extraction, etc

3.4 Anisotropic Diffusion Filter

Diffusion filters contain two different filters called isotropic diffusion filter and anisotropic diffusion filter. Isotropic filters are linear and anisotropic filters are non-linear filters. Linear filters are homogeneous in nature and is with constant conductivity. Hence to overcome this smoothing Perona and Malik proposed the non liner method called anisotropic filters. Anisotropic filters are also called as perona-Malik equation. It is the powerful image enhancer.

The main aim of this filter is to reduce noise without removing significant parts of given image, sharp edges and significant lines. Image processing with anisotropic diffusion in MATLAB code contains some important parameters. The anisotropic diffusion is represented as,

Diff_image=anisodiff(Im, NUM_ITER, KAPPA, LAMBDA, DELTA, OPTION)

Here, Im is the input image, Num_itr is used to represent number of iterations, Kappa is the conduction coefficient, lambda is the maximum value of 0.25 for stability, delta is integration constant. There are two options first prefers smaller region over wide region whereas next prefers wide region over smaller one. In this project the input image is computed tomography image of liver as shown in the figure 2. This image is preprocessed for further processing.



Fig -2: Input Image

After applying anisotropic diffusion filter the given image is filtered and the noise and imperfections are removed for clear inference. It plays an important role in processing the image in next stage for clear observation of liver tumor region. The filtered image is shown in the figure 3.



Fig -3: Filtered Image

3.5 Processing

Processing of image is performing certain operations on the image to obtain certain information from the image. It is a type of signal processing where the input is an image and output is a feature extracted from the image. Digital image processing helps in manipulation of image using digital computers with help of certain algorithms. It avoids building of noise and distortion of image during processing.

3.6 Thresholding

It is one of the image processing method which converts the image from gray scale to binary images which is one of the segmentation method by setting up threshold value. It is most commonly used in binary images but can be applied for coloured images also. The pixel values greater than the threshold is converted into white (binary value 1) and the pixels lesser than the threshold is converted into black (binary value 0).The binary image should contain certain necessary information like position and shape of objects.

The steps to be followed for thresholding are, Set the initial threshold value, specifically the 8-bit value of original image. Separating the image into two parts, Pixels less than threshold –background Pixels greater than threshold – foreground Identify the average mean value of two images. Calculate the new threshold by finding the average of two mean values.

$$G(x,y)=f(x)=1, \text{if } f(x,y)>T; G(x,y)=f(x)=0, \text{if } f(x,y)\leq T$$

3.7 Bounding Box

Bounding box are imaginary boxes that are created around an object. It is also one of the method of identifying the target on the image. In digital image processing bounding box is nothing but the rectangular border that covers or encloses the digital images. The coordinate in the upper left corner is x and the coordinate in the lower right corner is y. Here we extract the tumor region present in the liver by covering it with a rectangular box which is nothing but bounding the tumor region. A specified pixel range of the original liver computed tomography (CT) image will be selected in the form of box which represents the tumor region of the image.

As shown in figure 4, the original image is being pre-processed for further image enhancement and filtered for reducing the noise signals present in the image and a rectangular box (bounding box) is made in the specified region. This region is the tumour region whose threshold value is greater than the normal threshold value.



Fig -4: Bounding box in given image

3.8 Morphological Operations

Morphological operation is a non-linear operation which is related to shapes or morphological features of an image. This operation depends on the ordering of the pixels in the image and not their numerical value. The operation deals with structuring element producing output image of the same size. The morphological operation has two common processes which is, Dilation and Erosion

3.8.1 Dilation

The dilation adds pixels to the edges of the object in the image. The number of pixels added in an image depends on the dimensions of that image. The assess of the output image is maximum in case of dilation and in binary image the pixel is to made 1 with respect to the neighbouring pixels. The dilation expands the object and fills the holes.

3.8.2 Erosion

The erosion removes pixels to the edges of the object in the image. The number of pixels subtracted in an image depends on the dimensions of that image. The assess of the output image is minimum in case of erosion and in binary image the pixel is to made 0 with respect to the neighbouring pixels. The erosion contracts the object and removes small objects in the image. The eroded image is shown in the figure 5

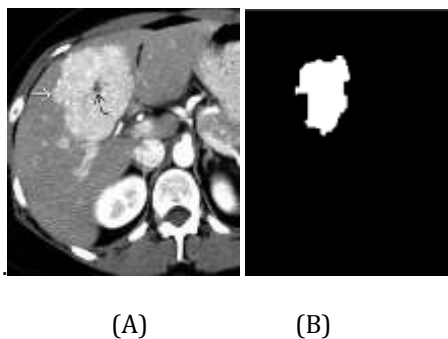


Fig -5: (A) Input image (B) Eroded image

3.9 Highlighting Tumor Region In Given Image

The last step is to present a clear indication of tumor region from the original image for our easy interpretation. By showing the tumor region alone is not sufficient for identification for normal humans. Hence this phase gives the obvious detection of tumor with its border in the given input image. When tumor is shown in any other image, it will not be that effective. One can find easy to observe in given input image and so this method is implemented.

The final phase not only indicates the tumor normally it also border the tumor region in different color for spontaneous observation. Because the image is already given in the grey scale, so it is useless to show the tumor region in black or white. The other option is to represent it in red or green or

blue. Here the tumor region will be indicated in red color as shown in the figure 6.



Fig -6: Highlighting tumor region in the given image

Finally for clear observation all the processes image in step by step is sub plotted and shown clearly. The figure 7 shows the complete processed images of whole process.

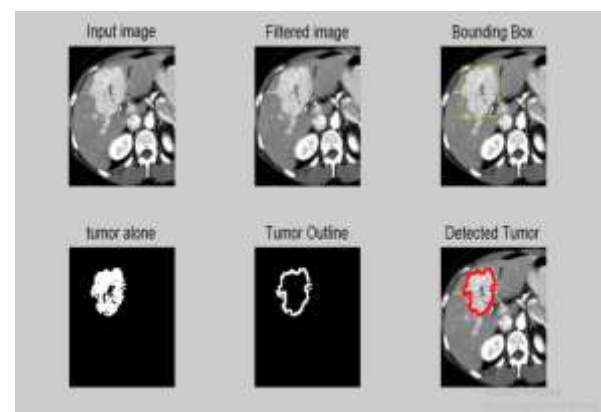


Fig -7: Complete images of whole process

4. RESULTS AND DISCUSSIONS

Liver cancer detection using image processing is implemented and the tumor region is found medical images used for analysis and the complete observation is shown in the table 1.

Table -1: Test results

IMAGES ANALYSED WITH SPECIFIC FEATURES	ACCURACY PERCENTAGE OBTAINED	RESULT OF THE PROCESS
Liver image with tumor in a single mass	96%	Outlines the tumor region clearly
Healthy liver	97%	None of the region is specified

This method liver cancer detection using image processing is analyzed with different kinds of sample for complete analysis. When image of liver cancer with single mass is given as input it outlines the tumor region with red color after processing. When images of healthy liver is given the indication will be of no specific region indication. Some deviations and inaccuracy takes place when very small tumors around the single mass of tumor are present. According to the proposed algorithm, it identify only the single mass of tumor in the liver. Many suspecting regions are discussed with medical persons for getting better accuracy.

5. CONCLUSION

The proposed research presents a liver cancer detection using image processing using morphological operations such as dilation and erosion for abdominal computed tomography scans. The obtained results ensure that this liver cancer detection can be effectively used to help medical persons in diagnosing hepato cellular carcinoma. It has been shown that morphological operations require less computational power and mathematical equations and calculations when compared to other image segmentation algorithms. A limitation of this research is that the performance was designed for only single mass of tumors. In future, we will collect clinical and computed tomography image data to ensure accuracy of evaluation and perfect validation for multiple tumors in the liver. We also intended to process with magnetic resonance imaging images and apply classification algorithms for classifying the tumors.

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