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Automatic Liver Cancer Detection using Sobel Edge Detection & Morphological Dilation in Digital Image Processing

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Abstract: *Image processing is a field that is widely used in medical science to identify various cancers or tumors. Diagnosing liver cancer is not an easy task and is usually performed by doctors and diagnosed manually. Filtering technique should be used precisely by not compromising the sensitive information. Most of the technique may distort the actual information that causes false alarm rate. A liver is an uneven or bit complex in structure where there are various spots may be considered as tumor that provokes the system towards invalid turing test. This paper proposes a system that would be able to recognize cancer automatically from a tomographical image along with high precision that stabilize the system with less processing time. Here the objective of the system is to obtain the result using Sobel operator that retains edges and eroding the unwanted areas and preceding high accuracy with less error rate. System also intended to extract the impaired area that has been affected by liver cancer. System acquired the better precision rate as compare to the previously implemented systems with minimal error rate.*

Keywords: *Liver Cancer Detection, Sobel Edge Detection, Morphological Dilation, CT Scans, Segmentation.*

I. INTRODUCTION

Automatic detection of liver cancer from a CT image is still a challenging task. Image processing is the process of gathering information from an image. Automatic liver cancer detection is a tool to automatically detect liver cancer. But precision suffers in the field of medical science; false identification endangers human life. Therefore, accuracy is very important with high original acceptance and false rejection rates. Liver cancer is one of the most deadly and life-threatening diseases. There are various imaging techniques to scan organs for diagnosis. Liver cancer is the most common cancer that occurs now a day. The majority of liver cancers are cytosis and hepatitis associated with Duto alcohol. Liver cancer is a sophisticated disease that can be recognized in a difficult manner, so it is a challenge to detect it in an early stage. The separation of the infected area is also a challenging task because it has a complicated structure and sudden it takes a bit time to obtain the actual infection that form a tumor in the liver. If system is not able to detect the cancer then it might be considered as illegitimate system proficiency and compromising with the human life that is why it should be highly effective and a better methodology should be adapted in all prospects. Sobel edge detection and dilation are the operations that can detect liver cancer in an effective manner and an ideal accuracy or precision can be obtained. Sobel is a gradient magnitude based detection technique by which the absolute gradient magnitude is calculated on the indication of a 2D input liver image, which is then associated with the morphology operator.

Fig. 1.Liver Cancer Affected Image

Segmentation of the liver cancer area from the liver CT images is very important to assess the pathogenesis of liver disease, and it is noted that it is a challenging task due to the complexity of the liver shapes in different slices of CT.

II. RELATED WORKS

F. P. Romero et al. [3] proposed an approach to capture the effective feature of the Inception V3 by combining the remaining connections from the image and the rest of the trained weight. The potential of the lesion type is that the architecture consists of completely comprehensive classification layers to create the output product.

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They used bio-clinical data with 230 liver images from distinct 63 patients where an accuracy of 96 % with F1 score have been obtained and surpass the sophisticated method for obtaining the desired precision with an effective approach. Atrayee Dutta et al. [4] proposed a technique for medical applications that use a variety of diagnoses and treatments. It has been used to detect liver cancer cells.

The OSTU method is used here to enhance the MRI image, and the watershed method is used to separate the cancer cell from the image.

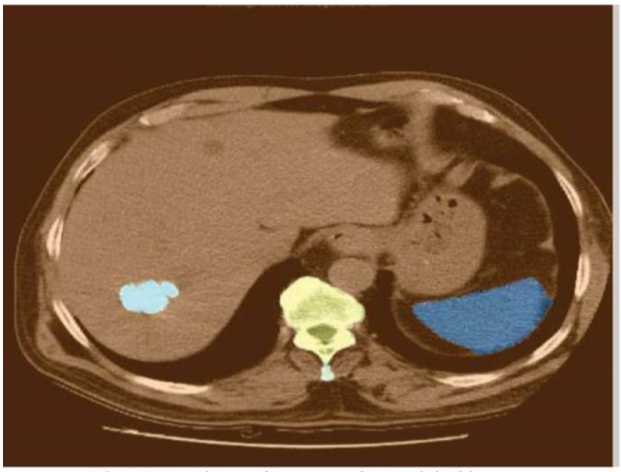

Fig. 2.Superimposed transparently on original image [4]

B.Lakshmi Priya et al. [5] proposed a channel level set segmentation algorithm with an elastic optimization model with a contrast drive to achieve better partition accuracy. Implemented the Global Visual Accounts approach to detect the boot-up salinity in curve optimization. Mohamed Yaseen Jabarulla et al. [6] proposed a work that is enumerated by the Anisotropic Diffusion Filter (SRAD) Five Image Filtering Techniques for Evaluation and Performance Analysis, which reduces quantum, frost, fish, median and speckles from the spatial filtration process for liver US data. U.S. Application of Hepatic The result shows that the SRAD filter is better than other denominating filters with PSNR = 31.11 dB, MSE = 31.07 and MSSIM = 0.895. Hong Zhou et al. [14] proposed a method where the biosensor 20 ng / ml AFP detection was experimentally tested using a staphylococcal protein A (SPA) binding reagent. This work provides an approach to flexible, low-cost, fast and unlabeled biological innovation that will benefit BIOS development. Shao-Kuo Tai et al. [15] proposed a system that uses artificial intelligence to provide quantitative and objective results to physicians and pathologists. Author proposed a method of in-depth study to estimate the separation of the liver nucleus, proving that the efficiency of our method with test results is 90.5%. Samy A Azer et al. [8] proposed a system which is based on deep learning with convolutional neural network that have been used in the interpretation of artificial intelligence images and in the diagnosis of hepatocellular carcinoma (HCC) and liver mass. The machine learning algorithm, similar to the in-depth study, demonstrated the ability to detect CNN and specific features that can detect pathological lesions. Shi-hui Zhen et al. [18] proposed a system which is based on Deep learning method. Author used CNN to develop an in-depth study system (DLS) to classify liver tumors based on clinical data, including improved MR images, improved MR images, and text and laboratory test results. Rajesh G et al. [9] proposed a system which is based on PeSOA and PNN classifier. Detecting and dissecting liver abnormalities is a testing and important step in a treatment plan that extends the patient's survival. Liver cancer increases mortality because side effects cannot be detected because cancer is also in its progression. Namrata Ghuse et al. [10] proposed a system which is based on wavelet transform. This research puts forward an image processing system to detect liver cancer. The specific identification method uses MRI and CT. If a system is able to recognize the area of interest for classifying the cancer area is the best approach for determining the cancer in a best way. There are various distinct operations through which a ROI can be determined and correct recognition can be performed with less processing time.

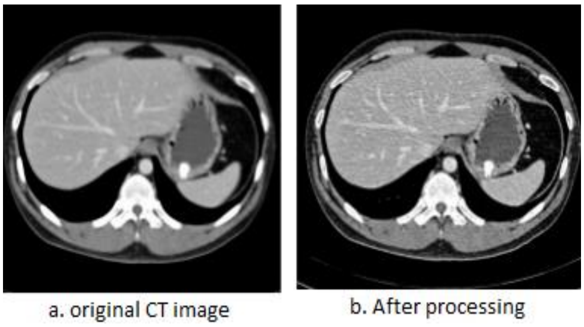

Fig. 3.Noise removal process [10]

III. PROBLEM IDENTIFICATION

Amita Das et al. [7] proposed a system which is based on watershed transform and Gaussian mixture model. In this work author proposed a new system called the Watershed Gaussian Based Deep Learning (WGDL) technique to effectively describe cancerous lesions in computed tomography (CT) images of the liver. A total of 225 images were used in this work to develop the specific design. Initially, the liver was isolated using a marker-controlled watershed separation process and finally the cancerous lesions were classified using the Gaussian Composite Model (GMM) algorithm. After tumor division, various morphological features were isolated from the divided area. The Deep Neural Network (DNN) classification for autoimmune classification of three types of liver cancer is classified in this category: hemangioma (HEM), hepatocellular carcinoma (HCC) and metastatic carcinoma (MET). It is hard to train a model that can recognize distinct liver cancerous spot because there is no particular shape or size or pattern of liver cancer cell. If a system has been trained for certain patterns then system will become limited with the samples and false error rate may rises due to insufficient data samples. It is better to predict the cancer using some filtration and morphological technique that can easily extract or segment the cancerous spot from liver with high level of accuracy. Here the system achieved 95.02% of accuracy and proposed system will provide better accuracy as compare to the previous one.

IV. PROPOSED ARCHITECTURE

Proposed system is liable to attain the liver cancer from a tomographical image with high precision. System uses Sobel operator along with morphological dilation for improving the detention of the image for obtaining the cancerous area for better level of prediction.

System also uses various pre defined image processing approaches such as histogram equalization, segmentation by thresholding and many more. System is tentatively capable to classify the blood vessels that can be considered as background area and rest will be entertained as foreground one. Sobel is a filter that can express the image with edges and a structure can be obtained through that. Sobel is a gradient filter that separately obtain the edges by horizontally as well as vertically and later merge the result for better appearances. System work with grayscale image instead of RGB image because it has specifically it has various gray levels that can be lies between 0-255 color range. Sobel is filter that can emerge the deep inner edges that can classify the nerves as well as the impaired areas.

$$G_x = \begin{bmatrix} +1 & 0 & -1 \\ +2 & 0 & -2 \\ +1 & 0 & -1 \end{bmatrix} * A$$

$$G_y = \begin{bmatrix} +1 & +2 & +1 \\ 0 & 0 & 0 \\ -1 & -2 & -1 \end{bmatrix} * A$$

$$G = \sqrt{G_x^2 + G_y^2}$$

Where G_x is a horizontal gradient and G_y is a vertical gradient magnitude kernels. G is the absolute gradient magnitude. Since the intensity function of a digital image is known only at specific points, the derivatives of this function cannot be defined unless we assume that the sample points have an inherently different intensity function. With some additions, the derivative model of the continuous intensity function can be considered as a function of the intensity function, i.e. the digital image. It turns out that derivatives at any given point are functions of intensity values at virtually all image points. However, the approximations of these derivative functions can be defined with more or less accuracy.

Fig. 4.Sobel Edge Detection of CT Liver Image

Morphological operation is a broad set of image processing function that process images based on contour. It is also known as a tool used to collect image elements that can be used to indicate and describe the shape of an area. Dilation adds pixels to the borders of the objects in an image, while the erosion removes the pixels from the borders of the object. The number of pixels added or removed from objects in an image depends on the size and shape of the structural element used to process the image.

f c(x,y) = 1 if f(x,y) = 0, and f c(x,y) = 0 if f(x,y) = 1

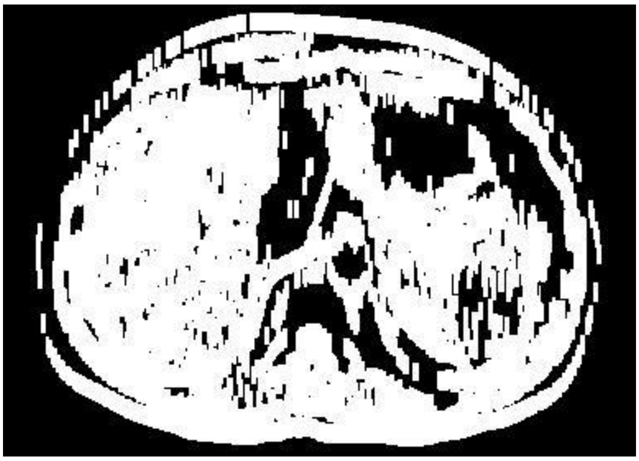

Fig. 5.Dilation of CT Liver Image

Proposed work process the liver image with different phases such as histogram equalization, segmentation by thresholding, sobel edge detection with smoothening, morphological dilation, filling small holes and cancer area extraction.

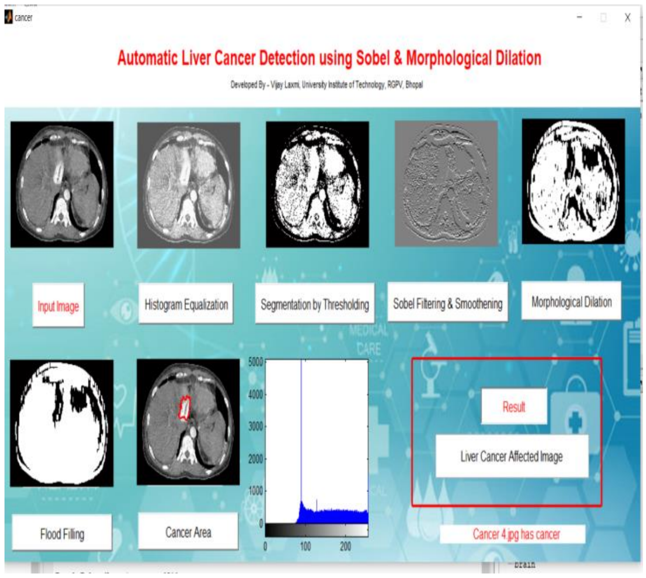

Fig. 6.Proposed Work GUI

Let it be more precise with the flow chart of proposed system. At very first an input liver image will be attained for various distinct processing for enhancing the image with greater extent of visibility. It is a possibility in the previous system where background area can affect the accuracy in various possible extents but the proposed system is able to observe the impaired area very effectively.

Once all the preprocessing has been employed then sobel is to be tenanted for extracting edges for segmenting the unwanted background and classifying the foreground area. Once the sobel has been applied, its inverse matrix will be obtained for better classification of background and foreground.
Then Dilation will be applied for dilating the holes that have been missed during the edge extraction and once it has been dilated, system will measure the entropy and if entropy or contrast is greater than the threshold value then system will declare as it is cancerous image otherwise it will be retain as normal one.

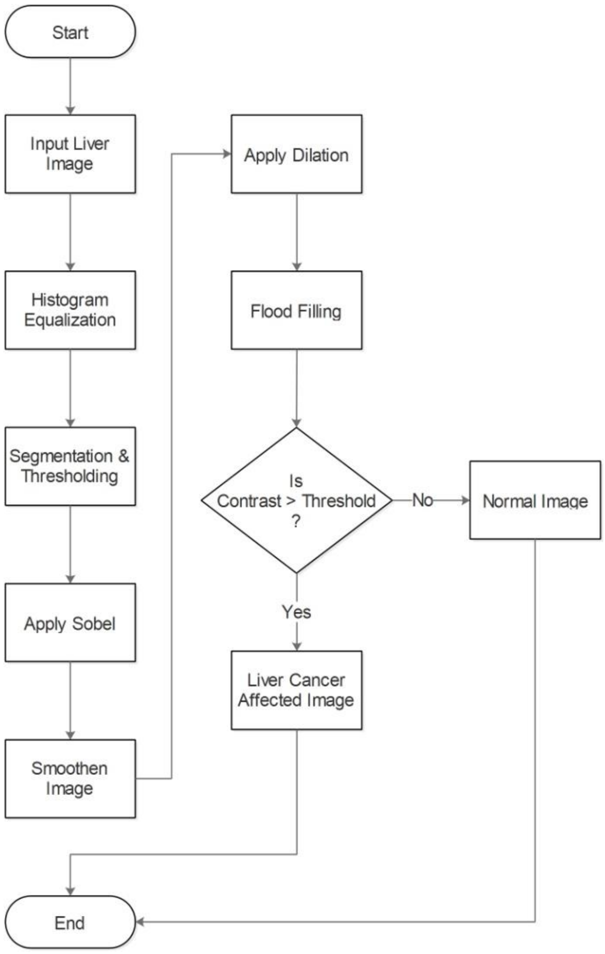

Fig. 7.Proposed Work Flow Chart

A. Sobel Kernel Algorithm

Input: 2-D Liver Image Matrix
Output: First Order Image Derivatives
Step 1: Input 2-D Liver Image Matrix A
Step 2: Initialize Sobel function S(x,y) with pixel intensity values I(x,y)

$$\text{Where } S(x,y) = \frac{dI}{dx} + \frac{dI}{dy}$$

Step 3: Apply kernel matrix to the input image array

$$I_x = \begin{bmatrix} +1 & 0 & -1 \\ +2 & 0 & -2 \\ +1 & 0 & -1 \end{bmatrix} \quad I_y = \begin{bmatrix} +1 & +2 & +1 \\ 0 & 0 & 0 \\ -1 & -2 & -1 \end{bmatrix}$$

Step 4: Compute Gradient magnitudes horizontally and vertically based parameters

$$G_x = I_x * A, \; G_y = I_y * A$$

$$G = \sqrt{G_x^2 + G_y^2}$$

Step 5: Apply Dilation by comparing each pixel with neighboring pixels

if $f_n(x,y) = 1$ and $g_n(x,y) = 0$, then $h_n(x,y) = 1$

Step 6: Compute contrast or entropy of the derivatives

Step 7: **if** Entropy > T_r **then**

Liver Cancer Detected;

else

No Liver Cancer Detected;

end else

end if

Step 8: Highlight the cancer area
Step 9: End

V. RESULT ANALYSIS

Here obtained result is emphasized from various parameters such as false positive, false negative, true positive and true negative. Here total number of testing class has been measured as 130 and 62 classes have been recorded as true positive that sustain 62 images that actually contain cancer and system really obtained positively. 64 images that there is no cancer and system tentatively obtained no cancer and 3 images as true negative where there is a cancer cell but system didn't get positively and 1 as false positive. So, as per the result analysis 96.92 % of accuracy has been recorded.

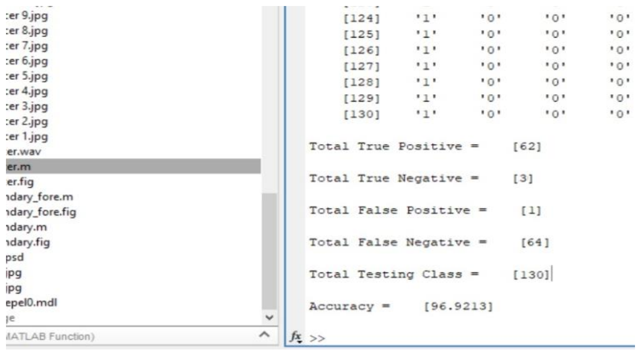

Fig. 8.Console Result

Fig. 8 shows the console result of proposed system. Here the system has been implemented in MATLAB using ODBC and MySQL as database for recording the datasets.

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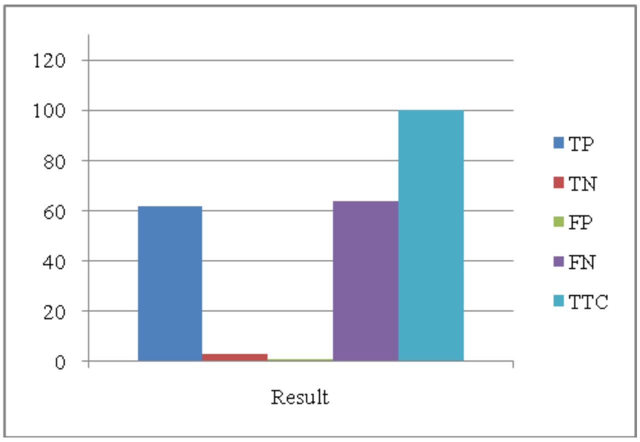
Table- I: Result Analysis

Terms	Result Obtained
TTC	**130**
TP	**62**

TN	**3**
FP	**1**
FN	**64**
Accuracy	**96.92 %**



Graph –I: Result

$$\text{Accuracy} = \frac{TTC-(TN+F}{TTC} * 100\ \%$$

Table- II: Result Comparison

	Amita Das et al. [7]	**Proposed**
Modality	CT Scan Image	CT Scan Image
Method	Decision Tree Classifier	Sobel, Morphological Dilation
Total Liver Images	123	130
Result (Accuracy)	95.02 %	96.92 %

VI. CONCLUSION & FUTURE SCOPE

System uses Sobel Edge Detection and Dilation techniques for acquiring such accuracy which is higher than the Decision Tree Classifier. System preprocesses the liver image with histogram equalization, segmentation by thresholding, sobel edge detection, smoothening, dilation, region filling. Here, the result is based on computed entropy of final image, if image contains a spot it means that there is a liver cancer spot over an image and it should be detected as liver cancer affected image. The system can be enhanced in future by implementing automatic liver cancer detection system with different approach that may acquire better precision with minimal false alarm rate. Because as per the ideal system, accuracy is often important that is why; the accuracy can be enhanced in future with different techniques or filters. Better preprocessing the liver image will resulted good accuracy and less false recognition.

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