

# Lung Cancer Detection Using Image Processing

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**Abstract— Lung cancer is one of the diseases contributing to the rise in mortality rate in the world and early detection could help increase the chances of survival of the people. Diagnosis of the disease at an initial stage has increased the chance of survival from 14% to 49% over the last five years. Computed Tomography is effective to identify the presence of lung cancer. Coupled with various image processing algorithms, it enables in early diagnosis of this disease. The main aim of this paper is to elaborate on the various image processing techniques such as image enhancement, segmentation and feature extraction used for lung cancer detection. The image processing algorithms were tested using the MATLAB image processing toolbox.**

**Keywords —** Cancer Detection; Image processing; Feature extraction; Enhancement; Watershed; Masking.

## I. INTRODUCTION

Lung cancer is a disease of uncontrolled abnormal growth of cells multiplying and growing into a tumor. Survival rate of patients having lung cancer is proportional to growth of the cancer at the time of detection. Lung cancer, if not detected at an early stage, has a poor chance of survival [1]. There are mainly four stages of lung cancer which are categorized depending on the size and node location of the tumor. The primary objective was to use image processing techniques for early detection of lung cancer on Computed Tomography (CT) images. The CT scanned images used for the study consisted of patients having both cancer and non-cancer diagnosis [2].

There are four main stages in processing the image. The first stage begins with gathering a number of CT images that consists of cancer and normal images. In the second stage, several techniques of image enhancement is applied to get best level of quality and clearness. The methods used were auto enhancement and Gabor filter. Among the two practices, Gabor filter was used since it enhances the quality and clarity of the image and also reduces the noise present in it. The third stage is image segmentation. It is used to divide and segment the enhanced images. We used watershed and thresholding techniques from which marked controlled watershed segmentation had better result and more accuracy. The final stage is feature extraction. Masking, binerization, dilation and erosion were some of the feature extracting techniques that we used. The method to be used depends upon the number of black pixels obtained for both normal and abnormal images.

The average of these images is considered and a threshold value is obtained. If the threshold number of black pixel of new image is greater than the previous image, the image is normal and if it is less, the image is abnormal [3]. After the desired output was attained, it was verified by an expert opinion. MATLAB image processing toolbox was used for coding for developing the algorithm.

## II. METHODOLOGY

For the purposes of the project, three different processing techniques have been used to get accurate results. A Graphic User Interface (GUI) was made for displaying the obtained output. The system proposed was as follows:

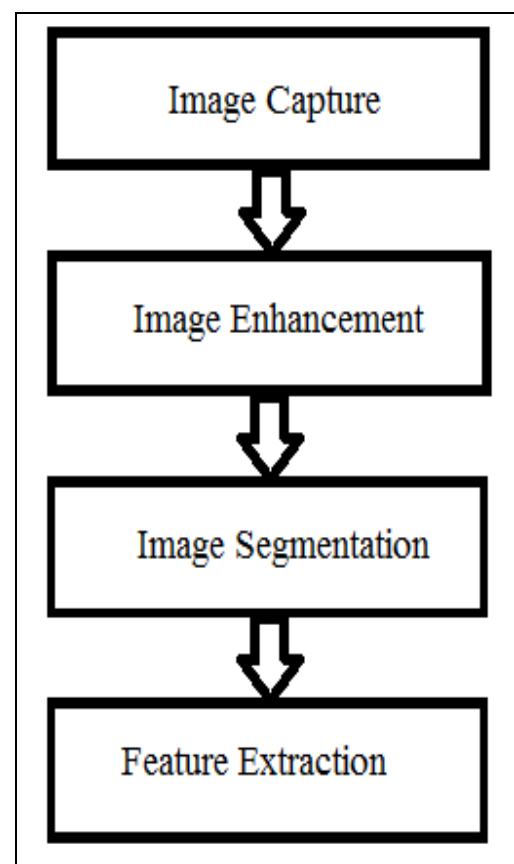


Figure 1: Methodology [3].

**A. Image Capture**

The image can be obtained from various imaging modalities such as X-Ray, CT, Magnetic Resonance Imaging (MRI) etc. For the purposes of this project, we had used CT images only.

The images have been obtained from the database Vision and Image Analysis Group (VIA) [2]. Figure 2, has been used as the input image. For the purposes of this paper, various image processing techniques have been applied on this image.

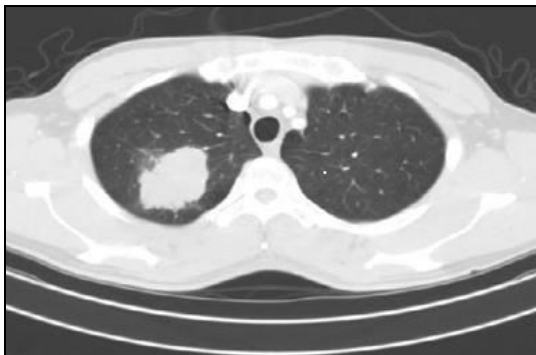


Figure 2: Input Image

**B. Image Enhancement**

The image quality is affected by the problems arising due to uniformity changes in the intensity, dissimilarities, movement and noise; thus making it difficult for the human viewers to read and understand [4]. Image enhancement is used for intensity changes, filtering, noise removal and to enhance image contrast. In this paper, we have elaborated on four techniques of image enhancement which are: Gabor filter, Auto enhancement, Median filtering and Histogram equalization. MATLAB software was used for all the pre-processing techniques.

Gabor filter are particularly appropriate for texture representation and discrimination [3]. In the spatial domain, a 2D Gabor filter is a Gaussian kernel function modulated by a sinusoidal plane wave. The multiplication of a Gaussian and harmonic function is the impulse response of Gabor filter. It has been used extensively for lung cancer detection [3]. The output is as shown in figure 3.

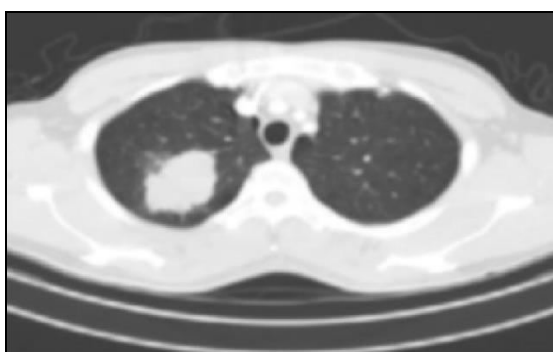


Figure 3: Gabor Filter Output

Auto enhancement is a technique strongly dependent on mean and variance calculation which are statistical operations and also subjective observation. The mean value of the image was calculated and its histogram was plotted. The auto enhanced image can be observed in Figure 4(c).

Histogram equalization is used to improve the contrast of the image. Graphical depiction of the intensity values of various pixels in an image is represented in a histogram [5]. In the histogram, the intensity is represented on the horizontal axis and the numbers of pixels are on the vertical axis. For this project, it was used to get a more enhanced Gabor filter output. An example of histogram equalization can be seen in Figure 4(d).

The median filter is often used to remove noise. Such noise reduction is a typical pre-processing step to improve the results of the next stages of the image segmentation and feature extraction techniques. A pixel value is replaced by median pixel value to produce a low frequency image [6].

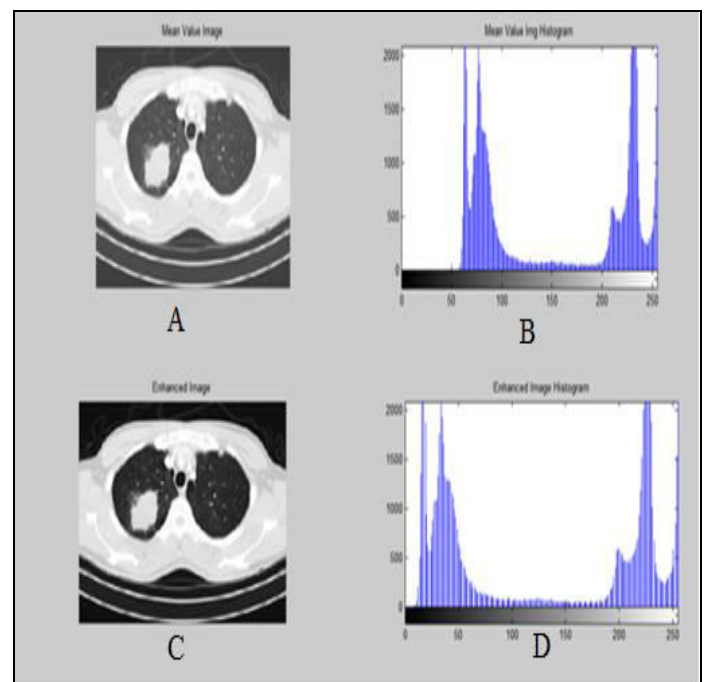


Figure 4: A – Original Image; B- Original Image Histogram; C- Auto Enhanced Image; D- Histogram After Equalization of The Auto Enhanced Image

**C. Image Segmentation**

Image segmentation is dividing the digital image into various segments for ease in the process of analysis. This method allocates a label to every pixel and pixels having similar labels have like characteristics. Pixels in a segment typically have some common characteristics such as texture, colour and intensity. Image segmentation is generally used to find the edges and other objects such as curves and boundaries in an image. In medical imaging, when the segmentation is applied to a stack of images, the contours after segmentation can be used to generate 3D reconstructions [5-6]. Some of the

techniques used are artificial neural network, state vector machine, watershed filter, weibull segmentation and thresholding.

The simplest and most basic segmentation method is thresholding. A threshold value is selected and all the pixels above the intensity value typically become a white pixel (value 255 in a 256 x 256 image) and if less, it becomes a black pixel (value 0) [7]. The threshold output of Figure 2 can be viewed in Figure 5.

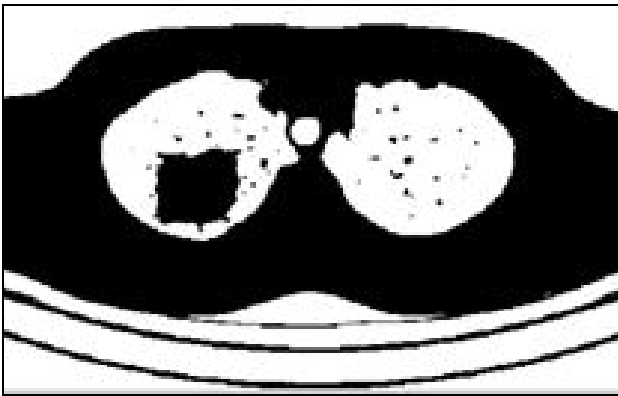


Figure 5: Thresholding Output

The watershed transformation processes the image like a topographic map. The brightness of each point represents its height and detects the lines running along the tops of ridges. Watershed lines can be defined on the nodes as well as on the edges, and hybrid lines on both nodes and edges. The watershed is a separation of the regional minima from which a drop of water can flow down towards distinct minima [1,8-9]. The Figure 6 depicts the use of watershed filter to the input image i.e. Figure 2.

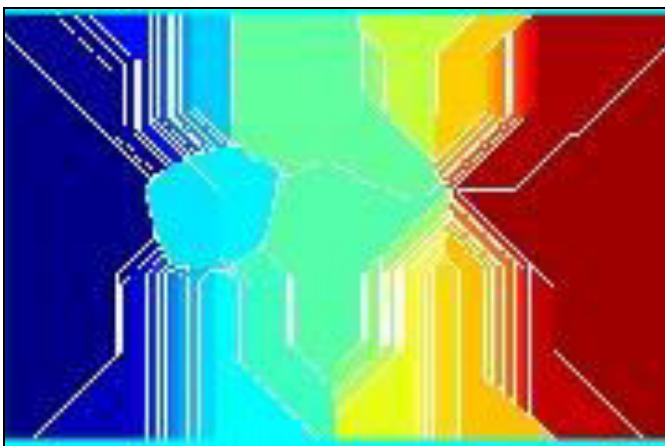


Figure 6: Watershed Filter Output

#### D. Feature Extraction

In feature extraction techniques, the features obtained are informative and non-redundant, thus helping in the generalization steps. If the primary data to an algorithm is very large for processing and may be redundant, such data can be

converted into a feature vector. A subset of the initial features is known as feature selection. The selected features should consist of the relevant information from the primary data, so that targeted task can be completed using the feature selection instead of the primary data. The area, perimeter and eccentricity are the basic characters of feature. We have used three approaches for this project namely binarization and masking and morphological dilation and erosion.

In binarization approach, the image is converted into a binary by extracting brightness as a feature from it. When a pixel is selected in an image, sensitivity is either added or subtracted from the value relevant to the selected pixel value to finalize a threshold value range. When another pixel is selected, the sensitivity is added or subtracted with respect to the new pixel. A new threshold value range is thus finalized. The pixel with the relevant value within the range of the threshold value is extracted and displayed. Hence, in this approach, the object can be distinguished from its background using a certain threshold value [9]. The binarized output of the input image can be observed in Figure 7.



Figure 7: Binarization Output

Masking is the process of separating an image from its background, either to cause the image to stand out on its own or to place the image over another background. In image processing, a kernel, convolution matrix, or mask is a small matrix which is useful for blurring, sharpening, embossing, edge detection, etc. Figure 8 shows how the spot is separated from the background and highlighted using masking.

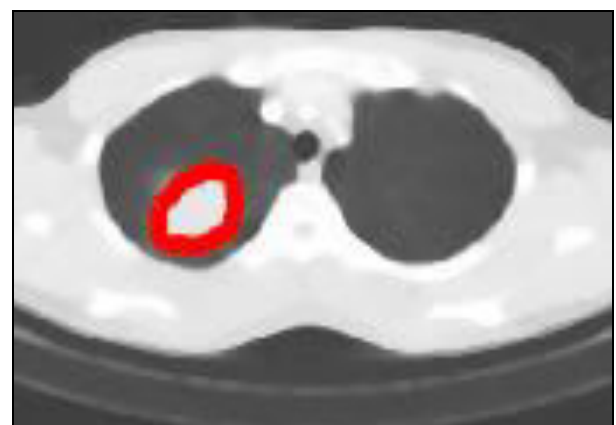


Figure 8: Cancer Spot Highlighted Using Masking

Morphological operations do not depend on the numerical values, but only on the relative ordering of pixel values. They can also be applied to grey scale images where light transfer functions are not available. The structuring element is located at all likely locations in the image. It is compared with the neighbouring pixels. Depending on the processes chosen, the element may fit within the neighborhood or fill the neighborhood [10].

Erosion is represented by  $\ominus$  and all other secondary operations are based on it. It was originally defined for binary images, later being extended to gray scale images, and subsequently to complete lattices. Dilation is peculiarly applicable to binary images; however some of its versions work on gray scale images too. The dilation operator utilizes two pieces of data as inputs. The image which is to be dilated is the first input. A structuring element known as a *kernel* acts as the second input. The structuring element determines the precise impact of the dilation on the input image [10]. Figure 9 (a-b) displays the dilation and erosion technique when the threshold value is pre-defined. Figure 9(c-d) is the output obtained using the MATLAB command ‘imdilate’ and ‘imerode’. Figure 9(e-f) were outputs for other morphological operations (opening, closing).

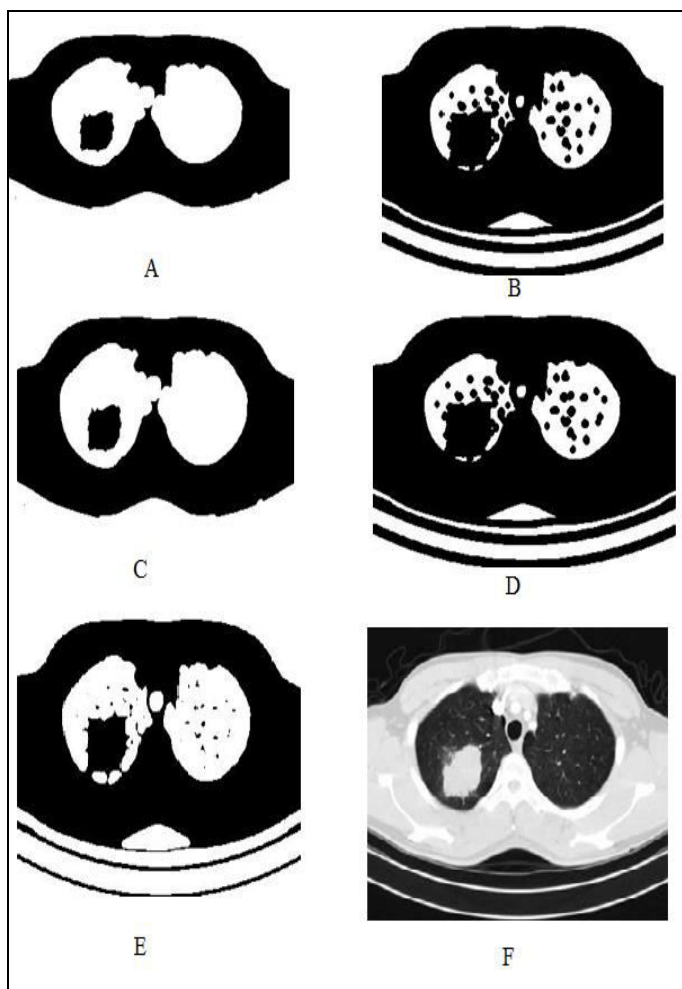


Figure 9: A- Manual Dilation; B- Manual Erosion; C- MATLAB Dilation; D- MATLAB Erosion; E- Image Opening; F- Image Closing

### III. RESULTS AND DISCUSSION

The software that has been used in this project is MATLAB® version 2013. We have used a variety of combinations of the above mentioned image enhancement, image segmentation and feature extraction techniques. These techniques have been incorporated in the GUI. The results thus obtained are discussed in this section.

#### A. Grayscale Image

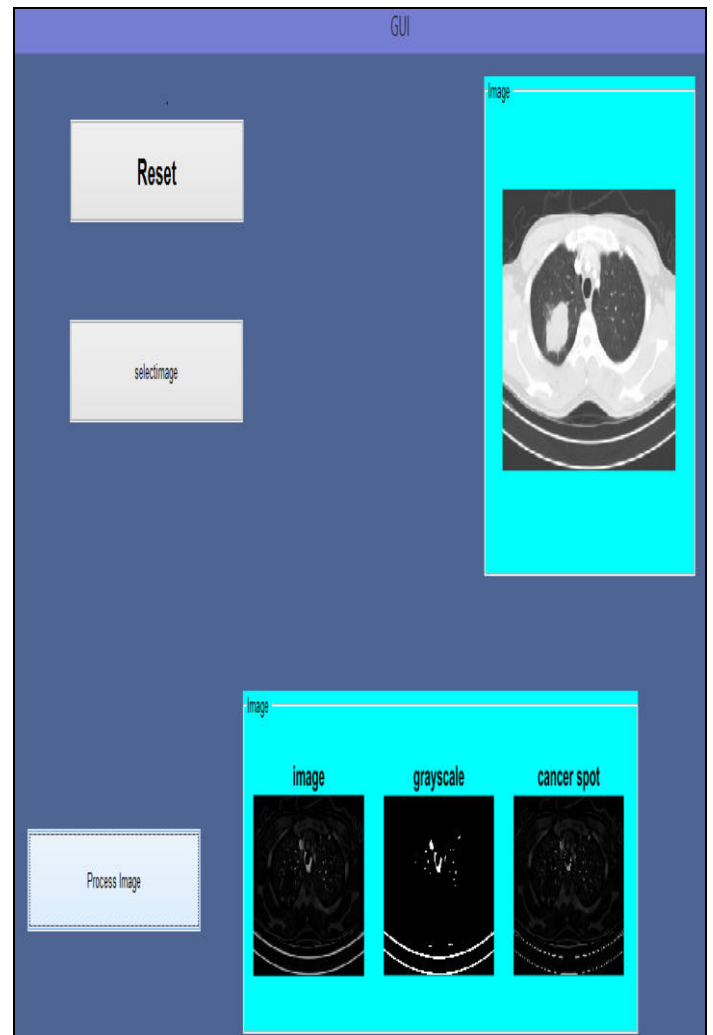


Figure 10: The GUI for an Entirely Grayscale Processed Image.

An image in which the value of each pixel carries only intensity information, is called a grayscale image. A GUI was made in MATLAB® using the basic inbuilt functions having reset for taking new image, select for selection of desired image and process button for applying various filters and getting cancer spot or region of interest (ROI) or output. Figure 10 is a GUI which displays three stages of the processed image. It can be observed that grayscale is not a very effective technique since the cancer spot is dark and not distinguishable.

*B. Combination of Binary, Watershed filter and Binarizations*

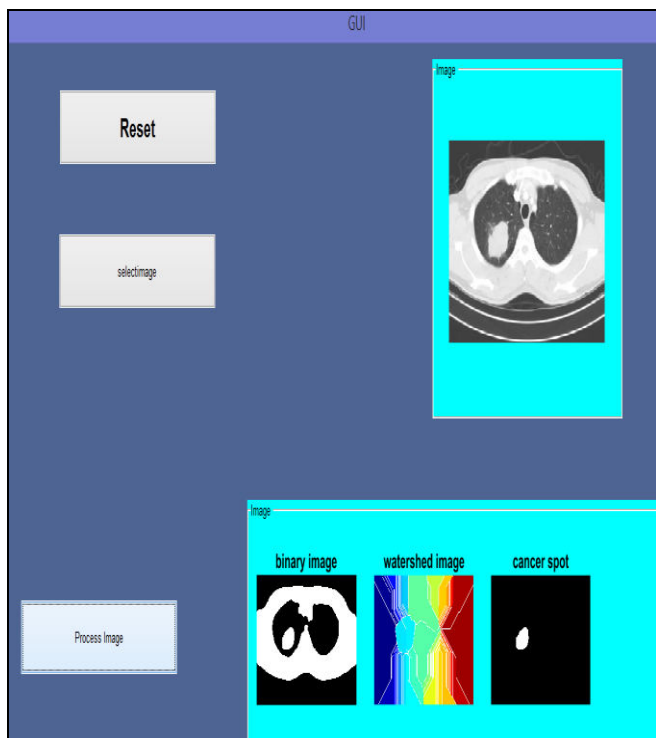


Figure 11: The GUI for a Combination of Binary, Watershed Filter and Binarization

The second combination was to convert the image into binary, apply watershed filter and binarization technique to get ROI or cancer spot. Figure 11 shows the distinct outputs of the processed image showing a binary image, watershed filter output and the cancer spot. The processing deleted the entire background and only the cancer spot remained as it had an eccentricity of white portion less than 0.99 which is isolated and displayed as ROI.

*C. Combination of Gabor filter, Watershed filter and Binarization*

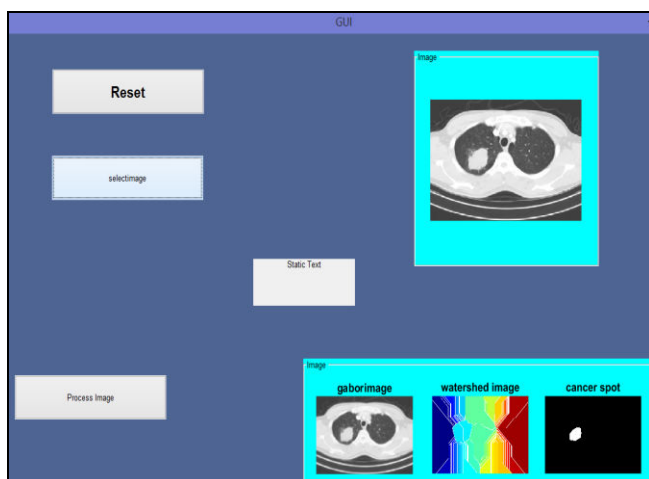


Figure 12: The GUI for a Combination of Gabor filter, Watershed filter and Binarization

The next combination used was applying Gabor filter to enhance the image, Watershed filter for its segmentation and binarization for extracting features. Similar to the previous GUI output as shown in Figure 11, the cancer spot has eccentricity of white portion less than 0.99. However, the output obtained in Figure 12 is better because of the use of Gabor filter. In this case, the filter used not only avoids converting the entire image into binary but also enhances it more accurately.

*D. Combination of Gabor filter, Watershed filter and Masking*

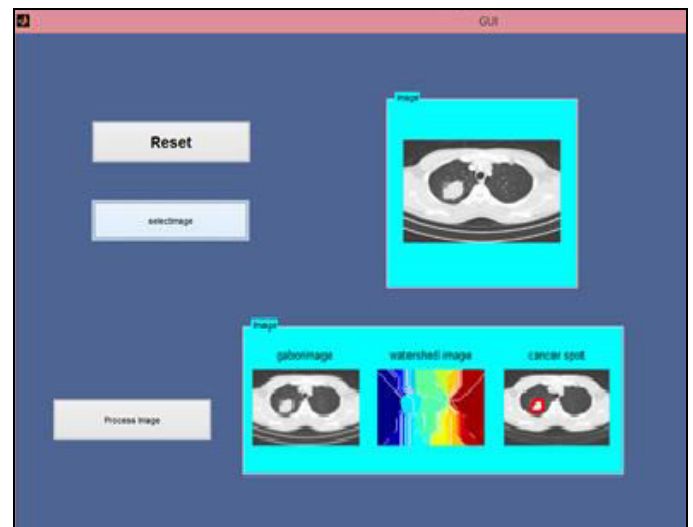


Figure 13: The GUI for A Combination of Gabor Filter, Watershed filter and Masking

The next combination was Gabor filter, watershed filter and masking techniques which can be seen in Figure 13. From the output, it can be inferred that this was one of the best combinations for the detection of lung cancer since the cancer spot was clearly visible and distinguishable from the rest of the image.

The outputs of all the four GUI's mentioned above were shown to the experts and were validated. It was found that the combination of Gabor filter, Watershed Filter and masking was most effective for the purpose of lung cancer detection.

**IV. CONCLUSION**

Early detection of lung cancer is essential for improving the survival rate among the patients. Image quality and accuracy are core factors of this research. Various image processing algorithms have been used and discussed in this paper. It can be inferred that among the techniques used, Gabor filter was the best for image enhancement since it reduces blurring and noise. Watershed filter was very efficient for image segmentation and masking was an effective technique for feature extraction. A combination of the three processing techniques yielded an excellent output for lung cancer detection. Other techniques such as artificial neural networks may be used for improving the prediction and early detection of lung cancer.

## V. ACKNOWLEDGMENT

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