

LUNG CANCER DETECTION USING SEGMENTATION APPROACH FOR CHEST CT SCAN IMAGES

**CSE4019 IMAGE PROCESSING
J COMPONENT Final Review Document
E1 Slot**

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ABSTRACT:

Lungs are an essential part of our body, and help us survive by inhaling oxygen from the atmosphere. However, there are severe diseases related to lungs like lung cancer, that damage the lungs and thus can lead to death. Here in this project, I propose **“Lung Cancer Detection Using Segmentation Approach for Chest CT Scan.”** This project here mainly focuses on using watershed segmentation using **Gabor Filter** which provides a much better efficiency over the previous method that has been used as the proposed model segments the image for about **1200 times compared to just 3 in the previous model**. Moreover, the previous model could only **predict about the lungcancer** by finding the number of circles, whereas in this model I am able to predict that the **segmented image is binarized to find the number of black and white pores** and the comparison of their values to the threshold value automatically decides whether or not the person has lung cancer. Another advantage of using this model is that it uses a more accurate **.bmp** image file which is obtained using CT scan images thus making the result more accurate.

Keywords
1. Segmentation
2. Binarized
3. Filter
4. Gray Scale
5. Bitmap

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1. INTRODUCTION:

The global increase in population has simultaneously raised the awareness to maintain good health in most of the people. The poor quality of food taken and environmental pollution leads to occurrence of lung cancer in most of the people. It is highly important to detect the lung cancer in early stages with minimum time delay and provide a better solution to reduce lung cancer's affect. Early detection of lung cancer is also necessary for efficient analysis and it helps ophthalmologist to deliver the treatment in early stages.

Currently, lung cancer is identified in 2.6 million people and resulted in 1.8 million deaths. It is the most common type of cancer occurring in men and women. Smoking and air pollution are the main reason for lung cancer. So, there is a need for identifying the cancerous cells present in the early stages within a shorter period and provide proper solution.

The conventional thresholding approach and morphological exercises have gotten very old for the present life and subsequently can't match to the pace at which the lungs get harmed nowadays and are every now and again ill-suited to recognize fringe pathology bearing districts adequately and recognize periphery pathology bearing zones consequently it is imperative to utilize a dependable procedure for division that can match to the present pace at which the lungs get harmed so that can decide the accomplishment of the accompanying phases of knob discovery and order. Research work aiming at Image enhancement technique which will help in the detection of lung cancer in the earlier stages. A new technique is proposed to overcome the drawbacks for image enhancement using **Gabor Filters, Discrete Wavelet Transform (DWT), and Auto Enhancement Algorithm (AEA).**

Here in this project, X-ray lung images are considered and processed using various techniques - Gabor filter, DWT and AEA. For real time analysis, obtained results are comparable with standard values. Hence, this new technique using Gabor filter for Image Enhancement using can be used for immediate detection of cancerous cells in patients.^{9,6}

In this study and project I propose a detection method of lung cancer based on image segmentation. Marker control watershed and region growing approach are used to segment of CT scan image.

Detection phases are followed by image enhancement using Gabor filter, watershed image segmentation, and features extraction. From the experimental results, I found the effectiveness of this approach. The results show that the best approach for main features detection is watershed with masking method which has high accuracy and is robust.

2. PROJECT DESCRIPTION AND GOALS

2.1. LITERATURE SURVEY:

During the last decades, computer-aided cancer classification attracts researchers' attention. There was an extensive work in developing the most accurate methods to be applied. Image processing is the foremost step in lung cancer classification and detection.

Whereas in image pre-processing, S A Patil applied median filtering to remove noise or redundant information from the images. According to Cherry Ballanganet, histogram is used in order to support automatic threshold setting for the initial lung segmentation.

During the segmentation for lung cancer images, the segmentation of lungs from the background is highly challenging.

Elizabeth and Raj CSR, (12) proposed an automated approach to segmentation of lung parenchyma from the chest as CT image was presented. The approach involves the conventional optimal thresholding technique, and operations based on convex edge and centroid properties of the lung region. Though the segmentation approach proposed in this work improved the diagnostic performance of the CAD system, it was still not capable of segmenting lungs with peripheral PBRs with a major portion of the lung bearing the pathology. Hence this work aimed at solving the problem of handling segmentation in images with peripherally placed PBRs.

Sluimer (14) proposed a segmentation by registration scheme for segmentation of lung from chest CT in which an atlas-based segmentation of the pathological lungs is refined by applying voxel classification to the border volume of the transformed images. They have compared the performance of the proposed approach and three other segmentation methods, namely, a conventional lung field segmentation based on thresholding and morphological techniques, a conventional segmentation employing user interaction and a voxel classification method.

Lai J (15) has proposed an active contour-based lung field segmentation approach with prior knowledge about shape to fit the lung boundary. It fully exploits the available prior knowledge concerning the anatomic structure of interests. It can be used in pulmonary regions of arbitrary shape, and is especially suitable for the segmentation of lung field with juxta-pleural pulmonary nodules due to fitting with the shape profile for pulmonary area. It requires a lot of knowledge about the structure, size and shape of the lungs hence it lags behind the other methods. This method should only be used for pulmonary regions because it requires a lot of knowledge about the anatomic structure.

An automatic segmentation method for the pulmonary parenchyma. The method is based on a combination of traditional techniques, such as segmentation using global threshold, morphological opening and closing operations, border detection using Sobel's filter(15). Thinning, representation of pulmonary structures using chain code, classification of the structures' areas, and reconstruction of the pulmonary parenchyma using a rolling-ball algorithm. Their algorithm also relies on a rolling ball operator for rebuilding the lung border and hence is unable to track the lung border if the PBR is peripherally placed and larger than the size the rolling ball operator can handle. This method is based on a combination of traditional techniques, hence is slower and more complex

Deevi Sarwinda, Suren Makaju and Shivam Modgil [2, 9, 5] have proposed a model where in I can use CT scanned lung images to detect lung cancer. The CT scanned images are BitMap images(.bmp) which are more precise than any other image thus making it more precise. The images can be filtered using a Gabor Filter the idea for which has been proposed by Avinash S [1, 7].

The segmentation of the image could be done using watershed segmentation which has been proposed by Avinash S and R Nammaran [1, 4].

The lung texture and classification model has been proposed by Qiangchang Wang, Subrato Bharati and Amal A. Farag [8, 6 ,3].

2.2. GAPS OF THE PREVIOUS SYSTEM:

Our model proposes a more efficient and precise model than the previously working system. The previous model used a JPEG format image input which is less precise compared to a Bitmap image that is obtained via a CT scan. The image uses a Gabor filter and watershed segmentation to enhance the image and then the image is segmented 1200 times compared to just 3 in the previous model which makes the image much more accurate. The image also confirms the possibility of lung cancer using threshold values unlike the previous model that could only determine a possible lung defect using the number/amount of circles found in the image.

3. TECHNICAL SPECIFICATION:

WINDOWS 10

MATLAB 2021a Software

Matlab Academic or any other type of membership

Minimum 2.9 GB of HDD space for MATLAB

Minimum 4 GB of RAM

4. DESIGN APPROACH AND DETAILS:

4.1. METHODOLOGY:

In this project, I tried to implement some image processing algorithm for lung cancer classification and detection using Matlab. From low, medium, until high level processing. Several image processing step that I used as follows:

1. Gabor filter for image enhancement
2. Marker controlled watershed with masking for image segmentation
3. Conversion to binary image for image classification

4.1.1. GABOR FILTER FOR IMAGE ENHANCEMENT:

In image processing, a Gabor filter, named after Dennis Gabor, is a linear filter used for texture analysis, which essentially means that it analyzes whether there is any specific frequency content in the image in specific directions in a localized region around the point or region of analysis. Frequency and orientation representations of Gabor filters are claimed by many contemporary vision scientists to be similar to those of the human visual system. They have been found to be particularly appropriate for texture representation and discrimination. In the spatial domain, a 2DGabor filter is a Gaussian kernel function modulated by a sinusoidal plane wave.

4.1.2. MARKER CONTROLLED WATERSHED SEGMENTATION:

Segmentation using the watershed transform works better if you can identify, or "mark," foreground objects and background locations. Marker-controlled watershed segmentation following this basic procedure:

1. Compute a segmentation function. This is an image whose dark regions are the objects you are trying to segment.
2. Compute foreground markers. These are connected blobs of pixels within each of the objects.
3. Compute background markers. These are pixels that are not part of any object.
4. Modify the segmentation function so that it only has minima at the foreground and background marker locations.
5. Compute the watershed transform of the modified segmentation function.

4.1.3. CONVERTING THE BITMAP IMAGE TO A BINARY IMAGE:

The next key step for solving the problem is to convert the current bmp image into a binary image. The reason behind converting the image into a binary image is it allows for the better ability to detect objects within an image the reason behind this is due to the fact now only two different colors exist within the image (black, white).

4.2. CODE SS(screenshot):

4.2.1. LUNG CANCER DETECTION

```
region_seg.m x gabor_fn.m x lung_cancer_classification.m x +
1 %% Preprocessing using gabor filter for image enhancement
2
3 lambda = 9;
4 theta = 0;
5 bw = 3;
6 psi = [0 0];
7 gamma = 2;
8 N = 4;
9 img_in = imread('a.bmp');
10 %img_in = double(dicomread('a.dcm'));
11 %img_in(:, :, 2:3) = [];
12 img_out = zeros(size(img_in,1), size(img_in,2), N);
13 for n=1:N
14     gb = gabor_fn(bw,gamma,psi(1),lambda,theta)...
15         + gabor_fn(bw,gamma,psi(2),lambda,theta);
16     img_out(:, :, n) = imfilter(img_in, gb, 'symmetric');
17     theta = theta + pi/4;
18 end
19 figure(1);
20 imshow(img_in);
21 title('input image');
22 figure(2);
23 img_out_disp = sum(abs(img_out).^2, 3).^0.5;
24 img_out_disp = img_out_disp./max(img_out_disp(:));
25 imshow(img_out_disp);
26 title('gabor output, L-2 super-imposed, normalized');
27 %% Marker controlled watershed using masking
28 I = img_out_disp;
29 se = strel('disk', 20);
30 Ie = imerode(I, se);
```

```
region_seg.m x gabor_fn.m x lung_cancer_classification.m x +
45 %subplot(2,2,2); imshow(m); title('initialization');
46 %subplot(2,2,3); title('Segmentation');
47 seg = region_seg(I, m, 1200); %-- Run segmentation
48 figure
49 imshow(seg); title('Global Region-Based Segmentation')
50 %% For Binarization regarding image classification
51 hasil=ones(512,512);
52 white=0;
53 black=0;
54 for i=1:512;
55     for j=1:512;
56         if seg(i,j)==1
57             hasil(i,j)=img_out_disp(i,j);
58         else
59             hasil(i,j)=1;
60         end
61     end
62 end
63 for i=1:512;
64     for j=1:512;
65         if hasil(i,j)<=0.12
66             black=black+1;
67         else
68             white=white+1;
69         end
70     end
71 end
72 imshow(hasil)
73 threshold=17179
74 if black>threshold
75     ('normal lung')
```

Command Window


```

MATLAB Drive >
region_seg.m x gabor_fn.m x lung_cancer_classification.m x +
CURRENT FOLDER
WORKSPACE
49 imshow(seg); title('Global Region-Based Segmentation')
50 %% For Binarization regarding image classification
51 hasil=ones(512,512);
52 white=0;
53 black=0;
54 for i=1:512;
55     for j=1:512;
56         if seg(i,j)==1
57             hasil(i,j)=img_out_disp(i,j);
58         else
59             hasil(i,j)=1;
60         end
61     end
62 end
63 for i=1:512;
64     for j=1:512;
65         if hasil(i,j)<=0.12
66             black=black+1;
67         else
68             white=white+1;
69         end
70     end
71 end
72 imshow(hasil)
73 threshold=17179
74 if black>=threshold
75     ('normal lung')
76 else
77     ('lung cancer')
78 end

```

4.2.2. USER-DEFINED FUNCTIONS

4.2.2.1. Gabor filter for image enhancement

CODE:

```

MATLAB Drive >
region_seg.m x gabor_fn.m x lung_cancer_classification.m x +
1 function gb=gabor_fn(bw,gamma,psi,lambda,theta)
2 % bw = bandwidth, (1)
3 % gamma = aspect ratio, (0.5)
4 % psi = phase shift, (0)
5 % lambda= wave length, (>=2)
6 % theta = angle in rad, [0 pi]
7
8 sigma = lambda/pi*sqrt(log(2)/2)*(2^bw+1)/(2^bw-1);
9 sigma_x = sigma;
10 sigma_y = sigma/gamma;
11
12 sz=fix(4*max(sigma_y,sigma_x))+1;
13 if mod(sz,2)==0, sz=sz+1;end
14
15 % alternatively, use a fixed size
16 % sz = 60;
17
18 [x y]=meshgrid(-fix(sz/2):fix(sz/2),fix(sz/2):-1:fix(-sz/2));
19 % x (right +)
20 % y (up +)
21
22 % Rotation
23 x_theta=x*cos(theta)+y*sin(theta);
24 y_theta=-x*sin(theta)+y*cos(theta);
25
26 gb=exp(-0.5*(x_theta.^2/sigma_x^2+gamma^2*y_theta.^2/sigma_y^2)).*cos(2*pi/lambda*x_theta+psi);
27 % gb = (gb/2+0.5);
28 % imshow(gb);

```

4.2.2.2 Marker controlled watershed with masking for image segmentation

CODE:

```
function seg = region_seg(I,init_mask,max_its,alpha,display)

%-- default value for parameter alpha is .1
if(~exist('alpha','var'))
    alpha = .2;
end
%-- default behavior is to display intermediate outputs
if(~exist('display','var'))
    display = true;
end
%-- ensures image is 2D double matrix
I = im2graydouble(I);

%-- Create a signed distance map (SDF) from mask
phi = mask2phi(init_mask);

%--main loop
for its = 1:max_its % Note: no automatic convergence test

    idx = find(phi <= 1.2 & phi >= -1.2); %get the curve's narrow band

    %-- find interior and exterior mean
    upts = find(phi<=0); % interior points
    vpts = find(phi>0); % exterior points
    u = sum(I(upts))/(length(upts)+eps); % interior mean
    v = sum(I(vpts))/(length(vpts)+eps); % exterior mean

    F = (I(idx)-u).^2-(I(idx)-v).^2; % force from image information
    curvature = get_curvature(phi,idx); % force from curvature penalty

    curvature = get_curvature(phi,idx); % force from curvature penalty

    dphidt = F./max(abs(F)) + alpha*curvature; % gradient descent to minimize energy

    %-- maintain the CFL condition
    dt = .45/(max(dphidt)+eps);

    %-- evolve the curve
    phi(idx) = phi(idx) + dt.*dphidt;

    %-- Keep SDF smooth
    phi = sussman(phi, .5);

    %-- intermediate output
    if((display>0)&&(mod(its,20) == 0))
        showCurveAndPhi(I,phi,its);
    end
end

%-- final output
if(display)
    showCurveAndPhi(I,phi,its);
end

%-- make mask from SDF
seg = phi<=0; %-- Get mask from levelset
function showCurveAndPhi(I, phi, i)
    imshow(I,'initialmagnification',200,'displayrange',[0 255]); hold on;
    contour(phi, [0 0], 'g','LineWidth',4);
    contour(phi, [0 0], 'k','LineWidth',2);
```



```

region_seg.m x gabor_fn.m x lung_cancer_classification.m x +
118     a = D - shiftR(D); % backward
119     b = shiftL(D) - D; % forward
120     c = D - shiftD(D); % backward
121     d = shiftU(D) - D; % forward
122
123     a_p = a; a_n = a; % a+ and a-
124     b_p = b; b_n = b;
125     c_p = c; c_n = c;
126     d_p = d; d_n = d;
127
128     a_p(a < 0) = 0;
129     a_n(a > 0) = 0;
130     b_p(b < 0) = 0;
131     b_n(b > 0) = 0;
132     c_p(c < 0) = 0;
133     c_n(c > 0) = 0;
134     d_p(d < 0) = 0;
135     d_n(d > 0) = 0;
136
137     dD = zeros(size(D));
138     D_neg_ind = find(D < 0);
139     D_pos_ind = find(D > 0);
140     dD(D_pos_ind) = sqrt(max(a_p(D_pos_ind).^2, b_n(D_pos_ind).^2) ...
141         + max(c_p(D_pos_ind).^2, d_n(D_pos_ind).^2)) - 1;
142     dD(D_neg_ind) = sqrt(max(a_n(D_neg_ind).^2, b_p(D_neg_ind).^2) ...
143         + max(c_n(D_neg_ind).^2, d_p(D_neg_ind).^2)) - 1;
144
145     D = D - dt .* sussman_sign(D) .* dD;
146
147     %-- whole matrix derivatives

```

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FILE NAVIGATE CODE SECTION RUN

```

region_seg.m x gabor_fn.m x lung_cancer_classification.m x +
132     c_p(c < 0) = 0;
133     c_n(c > 0) = 0;
134     d_p(d < 0) = 0;
135     d_n(d > 0) = 0;
136
137     dD = zeros(size(D));
138     D_neg_ind = find(D < 0);
139     D_pos_ind = find(D > 0);
140     dD(D_pos_ind) = sqrt(max(a_p(D_pos_ind).^2, b_n(D_pos_ind).^2) ...
141         + max(c_p(D_pos_ind).^2, d_n(D_pos_ind).^2)) - 1;
142     dD(D_neg_ind) = sqrt(max(a_n(D_neg_ind).^2, b_p(D_neg_ind).^2) ...
143         + max(c_n(D_neg_ind).^2, d_p(D_neg_ind).^2)) - 1;
144
145     D = D - dt .* sussman_sign(D) .* dD;
146
147     %-- whole matrix derivatives
148     function shift = shiftD(M)
149         shift = shiftR(M');
150
151     function shift = shiftL(M)
152         shift = [ M(:,2:size(M,2)) M(:,size(M,2)) ];
153
154     function shift = shiftR(M)
155         shift = [ M(:,1) M(:,1:size(M,2)-1) ];
156
157     function shift = shiftU(M)
158         shift = shiftL(M');
159
160     function S = sussman_sign(D)
161         S = D ./ sqrt(D.^2 + 1);

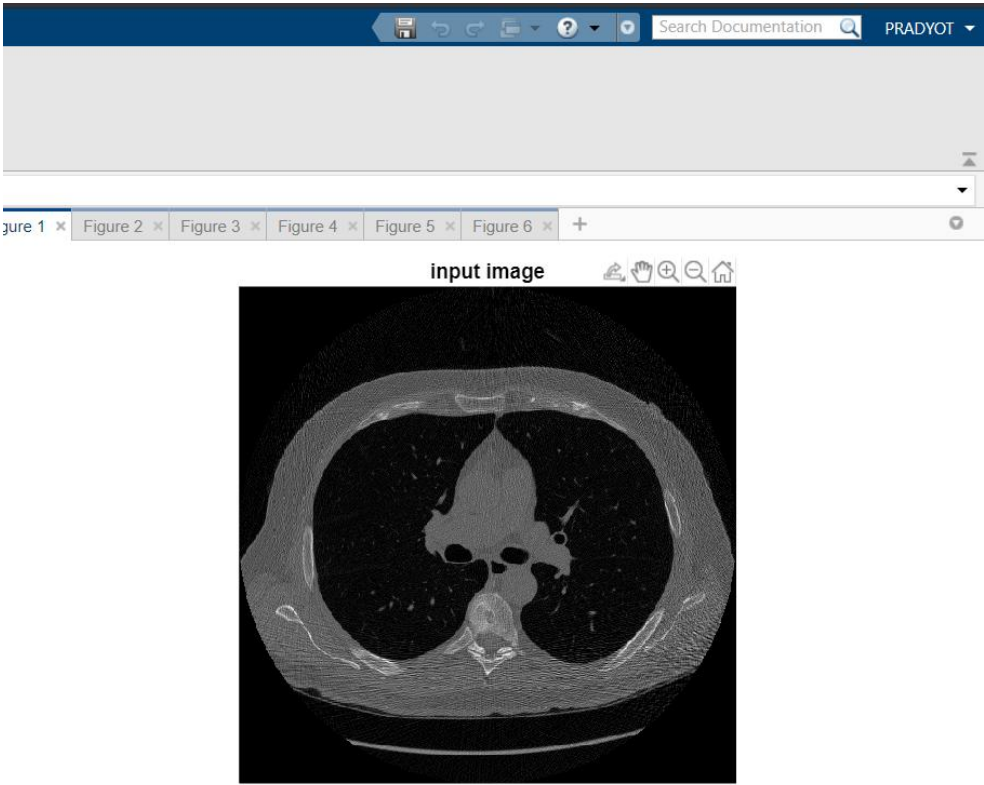
```



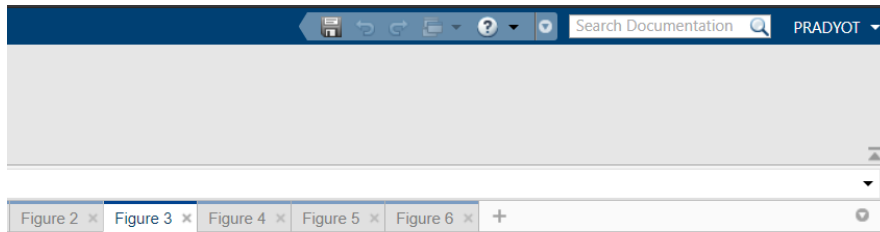
5. RESULTS AND DISCUSSION:

SAMPLE SNAPSHOTS:

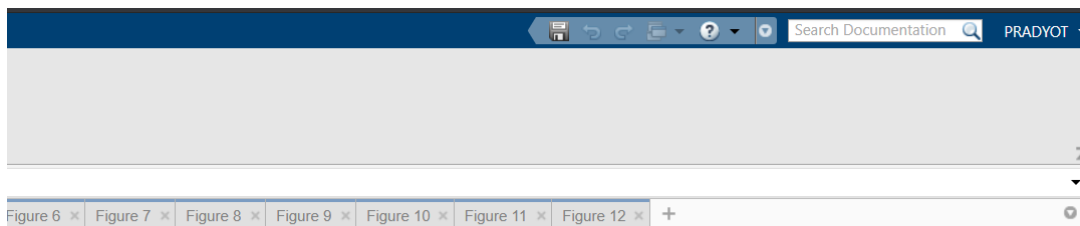
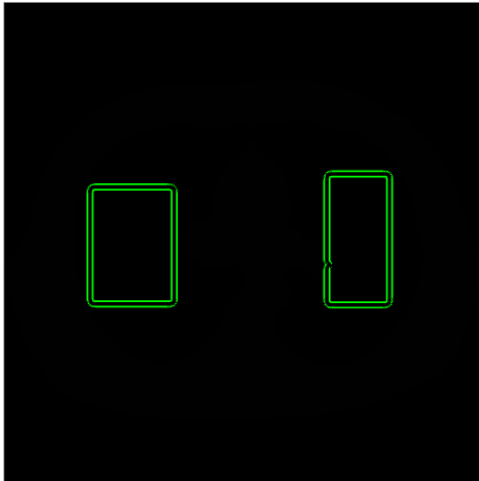
INPUT:



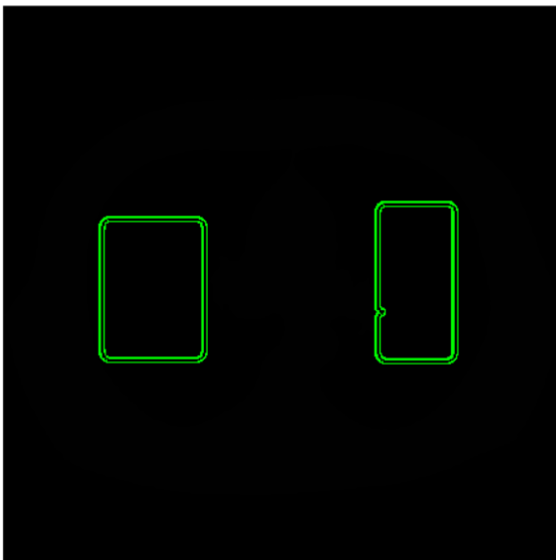
OUTPUT:

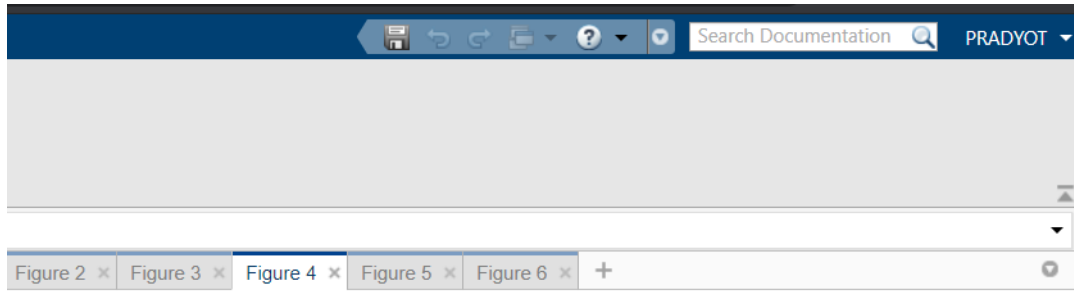


20 Iterations

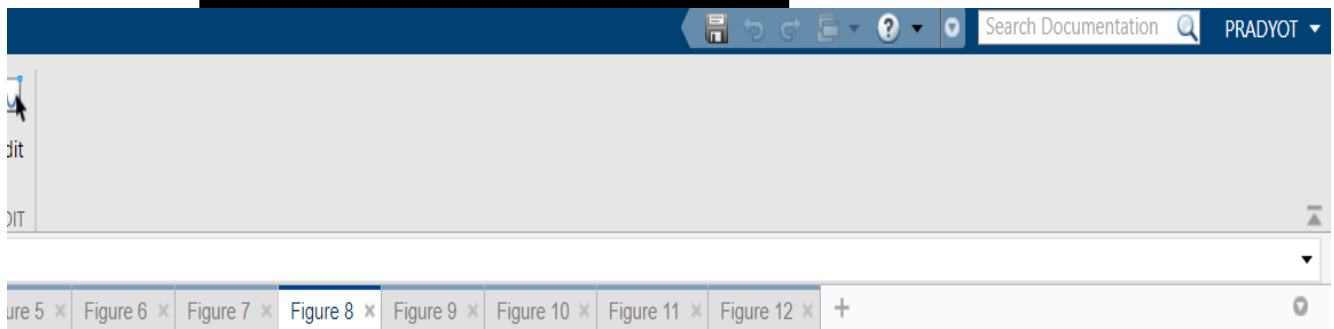
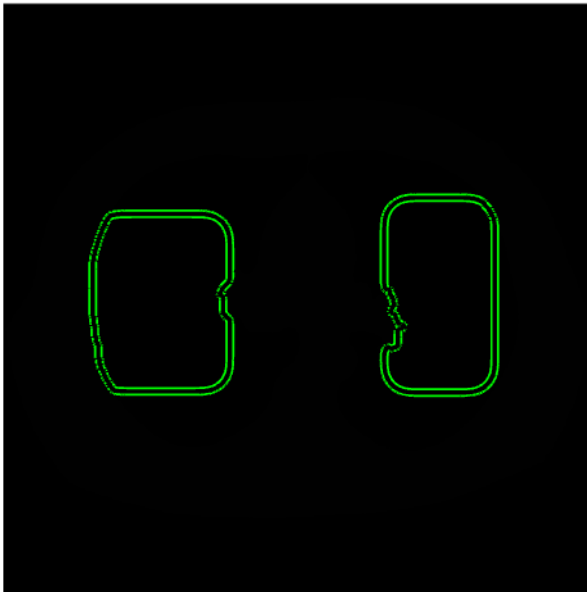


40 Iterations

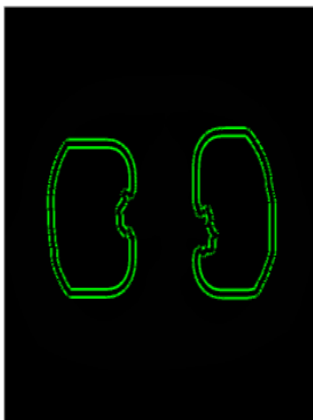


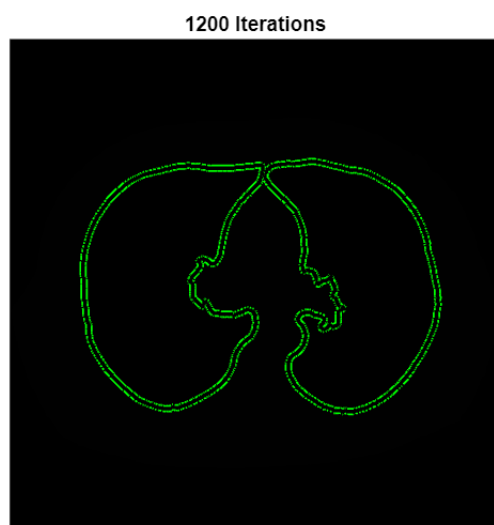
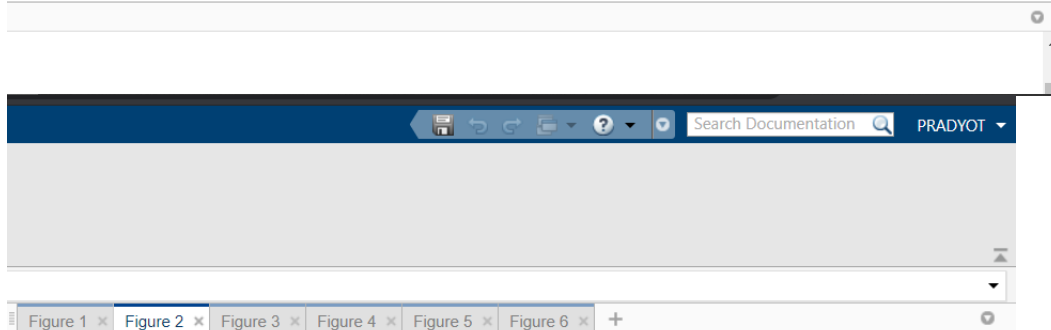
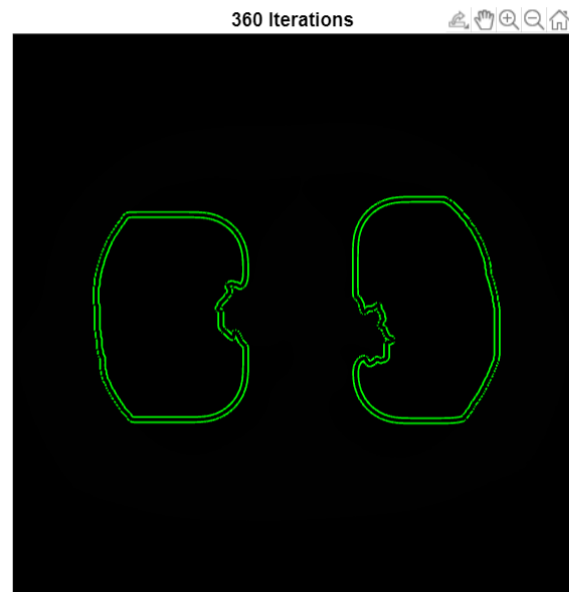
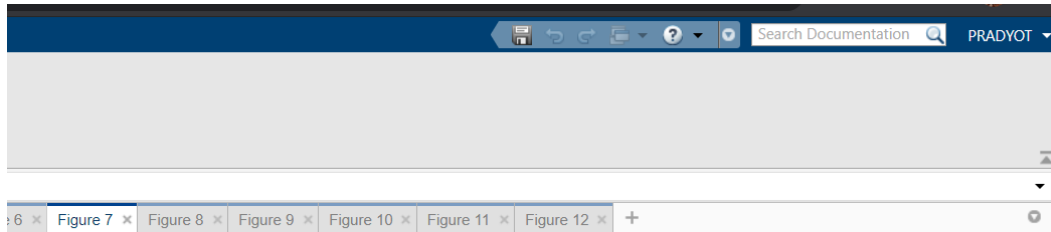


180 Iterations

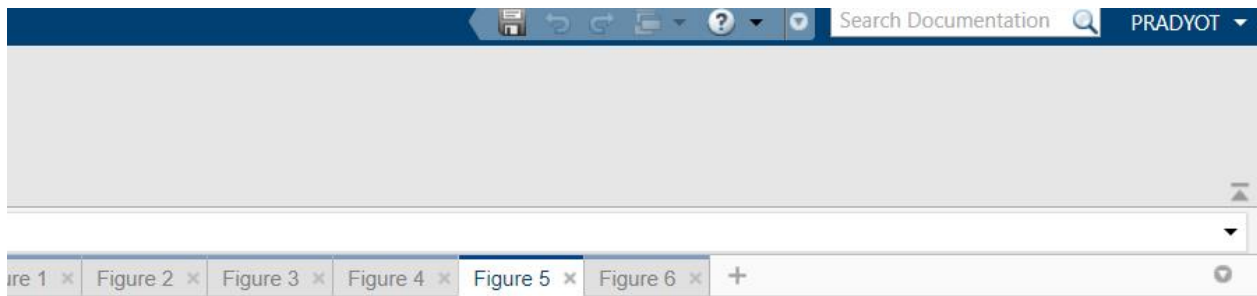


340 Iterations





Final Output:



Command Window

```
>> lung_cancer_classification  
  
threshold =  
  
    17179  
  
ans =  
  
    'lung cancer'  
  
fx >>
```

6. PROJECT DEMONSTRATION:

<https://youtu.be/6VwAfJfOhXU>

<https://github.com/pradyotsharma/Lung-Cancer-Detection.git>

7. COST ANALYSIS / RESULT AND DISCUSSION:

7.1. CONCLUSION

The methodology adopted in this project aims to develop a segmentation-based approach for lung cancer detection. Application of watershed Filter to eliminate noise in the images proved to be a success. The morphological operations also contributed towards satisfactory results in the process of segmentation. This approach aims at increasing the accuracy and speed of the lung cancer detection system. It also helps in detecting the cancer at earlier stages. This would help in curing many more patients when compared to past as the earlier we get the ailment the quicker we could start the treatment.

7.2. SCOPE

From this processed image I can create a database and use it for training an artificial neural network or deep learning algorithm which can identify even more details of tumor such as whether it is malignant or Benign (deadly or not deadly). This can change the future of identification of tumor. This scope will be a revolution in the field of medical science.

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