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```
%%Edge Detect and Region Fill to Segment SAT
%
clear all; close all; clc
%constants
%uncomment and set an absolute threshold for edge detection if use
 this
%method:
%edgedetectthreshold = 8;   %absolute threshold for edge detection
current_dir = pwd;
current_file = 'data/suc047_4_S10';
VATslice = 30;  %15 if counting from first slice, 30 if counting from
 superior end

%Load images
%input = readidf_file_pc(current_file, current_dir);
%See help for options, esp for different operating systems
%image data will be stored in input.img

Inr = read_idf_image_pc(strcat(current_file, '_In'), current_dir, 0);
Outr = read_idf_image_pc(strcat(current_file, '_Out'), current_dir,
 0);

%record image size parameters
img_size = size(Inr.img(:,:,:));
num_slices = img_size(3);

%Rotate and Flip the images to be in matlab-style format
for j=1:num_slices
    In(:,:,j) = flipud(imrotate(Inr.img(:,:,j),90));
    Out(:,:,j) = flipud(imrotate(Outr.img(:,:,j),90));
end
```

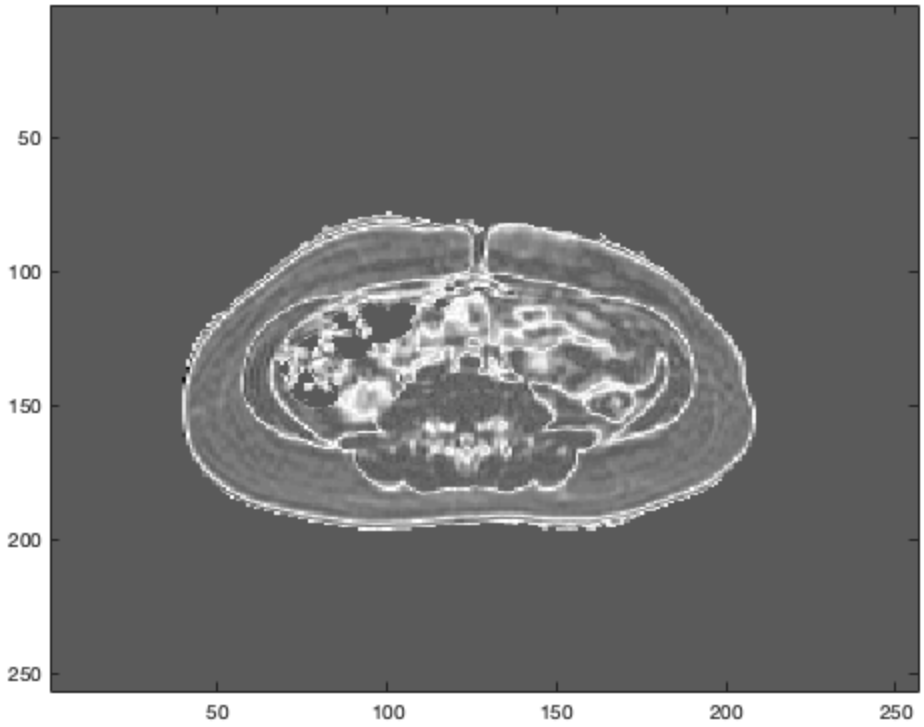
Calculate Fat Fraction Map, based on In-phase and Out-of-phase images, in [%]

```
%Calculate FF map, in [%]
%>>>>>>>>>>>>>>>
close all;
FF = (In(:,:,VATslice)-Out(:,:,VATslice))./(2*In(:,:,VATslice));
FF(isnan(FF))=0;
FF(isinf(FF))=0;
```

```
%<<<<<<<<<<<

%Remove NaN, Inf, -Inf from the map (here called FF, change if needed)
%see help isnan and help isinf
for i = 1:img_size(1)
   for j=1:img_size(2)
       for k = 1:img_size(3)

%>>>>>>>>>>>

%<<<<<<<<<<<

       end
   end
end
```

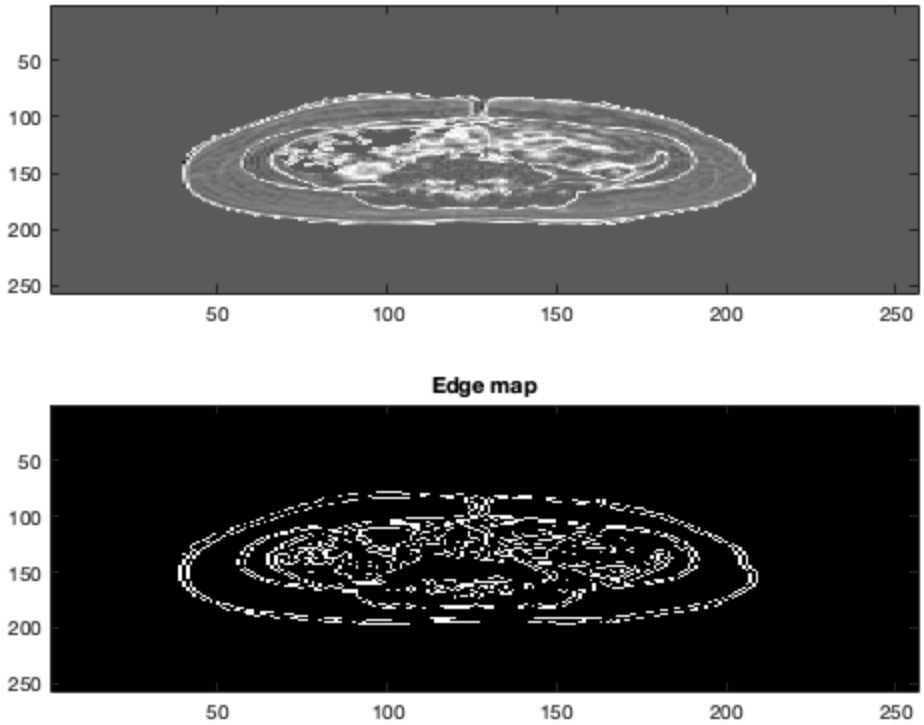
Edge Detect FF slice of interest

```
close all;
%Use Slice of Interest
%>>>>>>>>>>>
close all;
MaskIn=zeros(img_size(1));
for i = 1:img_size(1);
    for j = 1:img_size(2);
        if In(i,j,30)>100
            MaskIn(i,j)=1;
        else
            MaskIn(i,j)=0;
        end
    end
end
MaskIn=medfilt2(MaskIn);
filtFF = MaskIn.*FF;
figure('Name', 'Filtered FF')
imagesc(filtFF); colormap gray
```




```
%Edge detect, can use EdgeMap = edge(Image);
%>>>>>>>>>>>>>
[~, threshold] = edge(filtFF, 'sobel');
EdgeMap = edge(filtFF, 'sobel', 0.08);

%see help edge
%The default uses 'sobel' and find a threshold. This threshold will
 likely
%be poor.  You can modify the automatic threshold or specify one.

%One method to find a threshold based on the image data
%[~, threshold] = edge(FF30, 'sobel')
%fudgeFactor = xxx;    %make a threshold relative to the automatically
%found one
%EdgeMap = edge(FF30,'sobel', threshold * fudgeFactor);

%Or use a specific threshold (constant listed at the top of the m-
file.
%
%Edge detect FFmap (with no NaN & no Inf)
%EdgeMap = edge(FF30,'sobel', edgedetectthreshold);

%<<<<<<<<<<<<

close all;
%Display FF map and Edge detected mask
```

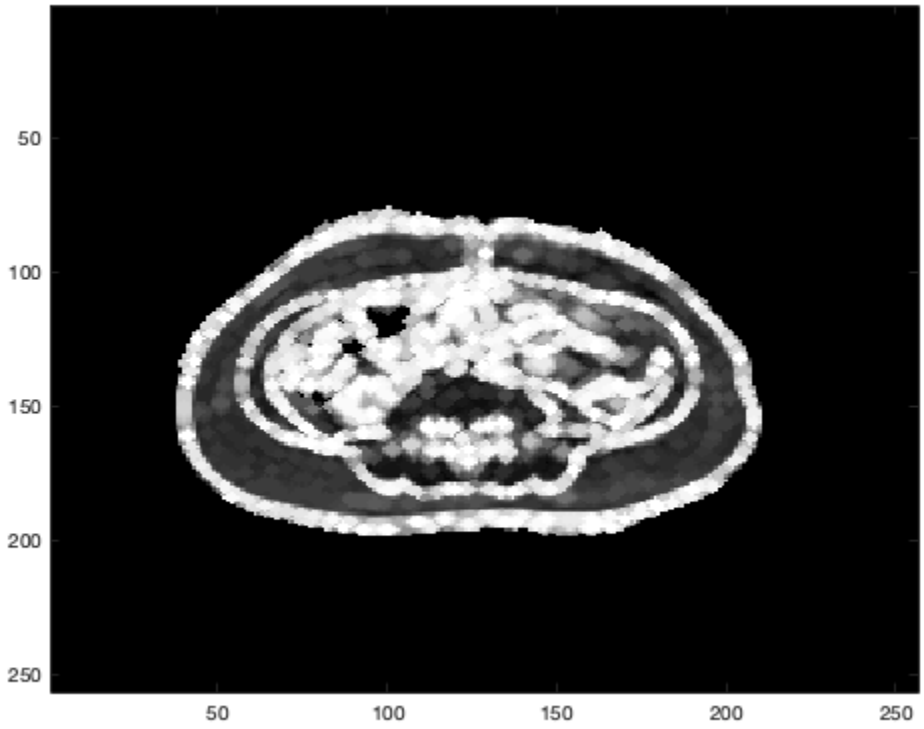
```
%>>>>>>>>>>>>>>>
figure('Name', 'FF map and Edge mask')
subplot(2,1,1)
title('Fat Fraction')
imagesc(filtFF); colormap gray
subplot(2,1,2)
imagesc(EdgeMap); colormap gray
title('Edge map')


%<<<<<<<<<<<<<<<
```



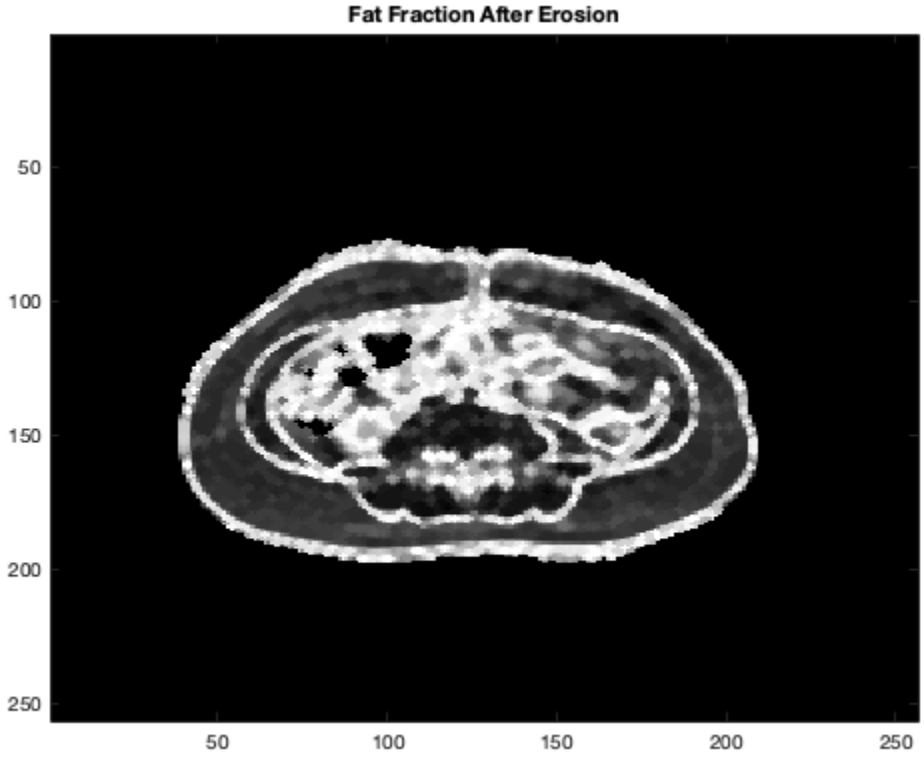

```
close all;
%Define structure elements -- basic shapes to identify in the image
%e.g. are lines, - can make vertical, horizontal, 2 diagonals (+45deg
 and -45deg)
%set the size of each element (can vary) and orientation.
%Can try other shapes, i.e. 'disk' (filled circle)

%>>>>>>>>>>>>>>>

% help strel
%format:  se90 = strel('line', size, degrees);
%e.g.  se90 = strel('line', 4, 90);
%
%
```

```
%This element is a disk = filled circle:
%sedisk = strel('disk',size);

%<<<<<<<<<<<<

%Dilate the FF slice and the edgemap using struct elements:
%>>>>>>>>>>>>>>>>>>
% help imdilate
se_dil = strel('disk', 2);
EdgeMapdil = imdilate(EdgeMap, se_dil);
se_dil_FF = strel('disk', 2);
FFdil = imdilate(filtFF, se_dil_FF);
%<<<<<<<<<<<<<<<<<<<<

%Display the dilated images
%>>>>>>>>>>>>>>>>>>
figure('Name', 'Dilated Edge Map')
imagesc(EdgeMapdil); colormap gray
figure('Name', 'Dilated FF Map')
imagesc(FFdil); colormap gray
%<<<<<<<<<<<<<

%%Erode the images and display
% help imerode;
%>>>>>>>>>>>>>>>

se_er = strel('disk', 1);
EdgeMaper = imerode(EdgeMapdil, se_er);
se_er_FF = strel('disk', 1);
FFer = imerode(FFdil, se_er_FF);

figure('Name', 'Eroded Edge Map')
imagesc(EdgeMaper); colormap gray
title('Edge Map After Erosion')
figure('Name', 'Eroded Fat Fraction Map')
imagesc(FFer); colormap gray
title('Fat Fraction After Erosion')


%<<<<<<<<<<<<<<<<<<
```


50
100
150
200
250
50
100
150
200
250

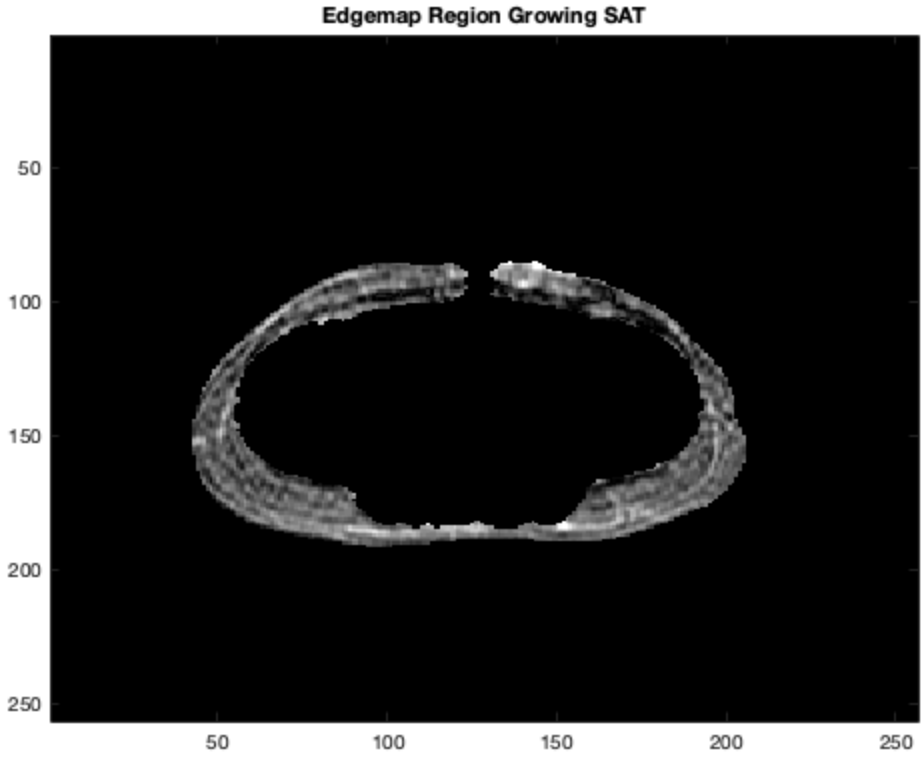

50
100
150
200
250
50
100
150
200
250

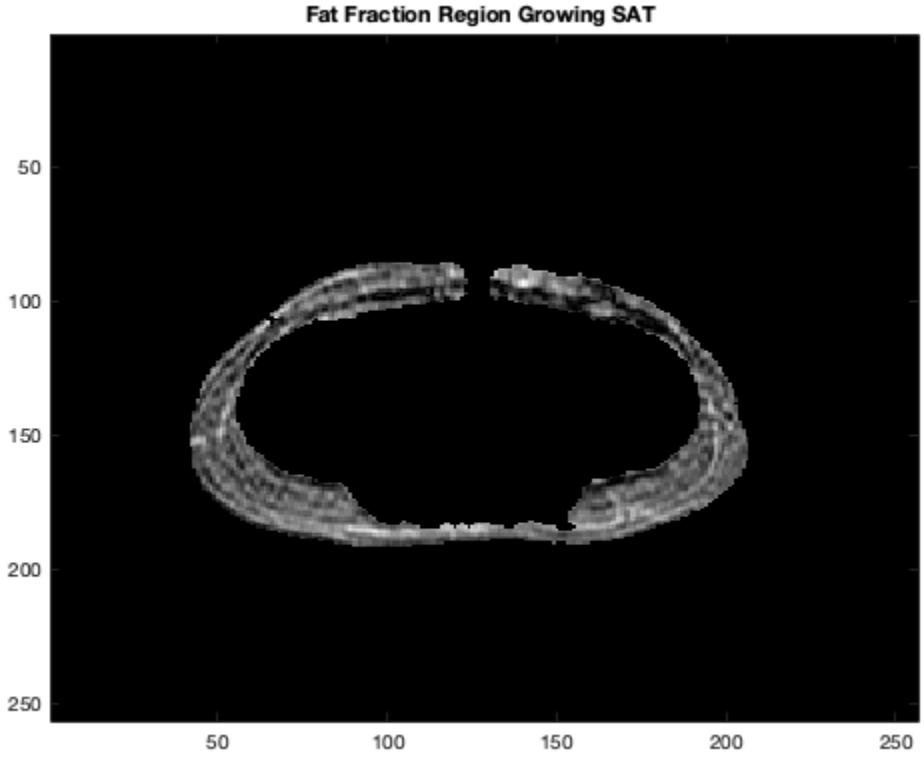

Edge Map After Erosion
50
100
150
200
250
50
100
150
200
250


Fat Fraction After Erosion
50
100
150
200
250
50
100
150
200
250

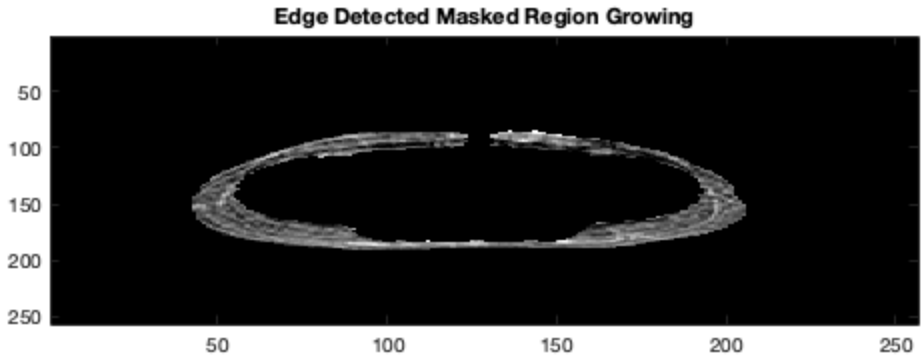
Region Grow & Display the 2 eroded, dilated images

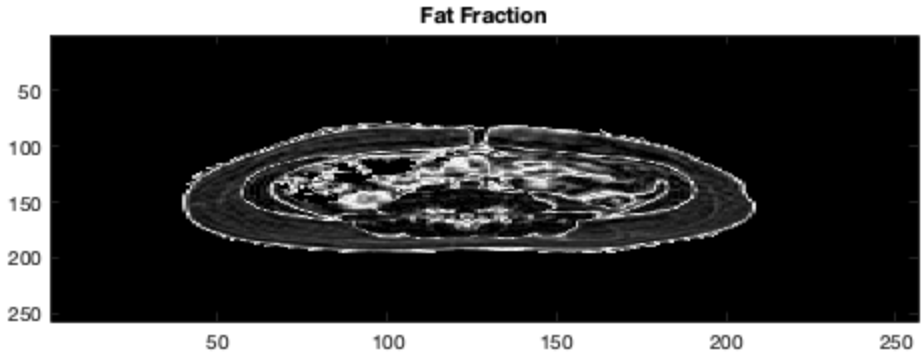
```
close all;
%format: [polygonofROI, MaskofROI] =
%regionGrowing(Im,[InitialPositionx,y],1,threshold);  %leave the FF
 type as
%'1' (3rd input)
%borderthresh = xx;  %set a value for the cutoff. This will be
 different
%for the 2 maps
%change "Image" to your mask name
[SATpoly_edge,SATmask_edge] = regionGrowing(EdgeMaper,[175,75],1, 0);
SATmask_edge = double(SATmask_edge);
SATmask_edge_rg= SATmask_edge.*filtFF;
figure('Name', 'SATmask Edgemap')
imagesc(SATmask_edge_rg, [0 0.2]); colormap gray
title('Edgemap Region Growing SAT')
[SATpoly_ff,SATmask_ff] = regionGrowing(FFer,[175,75],1, 0.172);
SATmask_ff = double(SATmask_ff);
SATmask_ff_rg = SATmask_ff.*filtFF;
figure('Name', 'SATmask FFmap')
imagesc(SATmask_ff_rg, [0 0.2]); colormap gray
title('Fat Fraction Region Growing SAT ')

RegionGrowing Opening: Initial position (175|75|1) with 0 as initial
 pixel value!
RegionGrowing Ending: Found 4944 pixels within the threshold range
 (736 polygon vertices)!
RegionGrowing Opening: Initial position (175|75|1) with 0.095588 as
 initial pixel value!
RegionGrowing Ending: Found 5237 pixels within the threshold range
 (746 polygon vertices)!
```

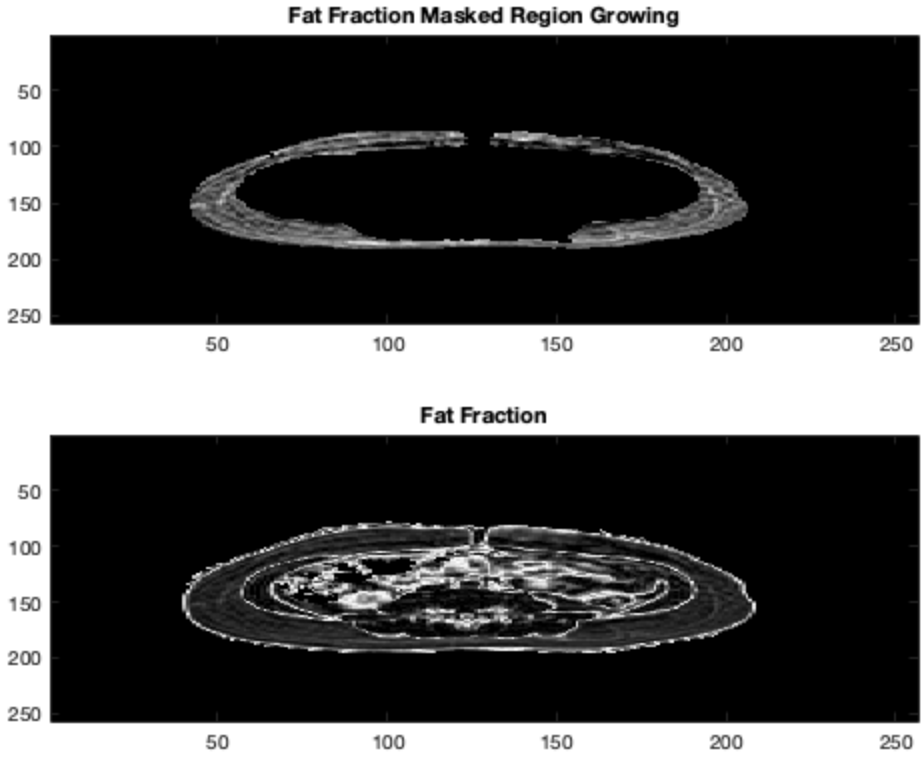

Edgemap Region Growing SAT
50
100
150
200
250
50
100
150
200
250


Fat Fraction Region Growing SAT
50
100
150
200
250
50
100
150
200
250

```
close all;
figure('Name', 'Visual Assessment of Edgemap')
subplot(2,1,1)
imagesc(SATmask_edge_rg, [0 0.2]); colormap gray
title('Edge Detected Masked Region Growing')
subplot(2,1,2)
imagesc(filtFF, [0 0.5]); colormap gray
title('Fat Fraction')

figure('Name', 'Visual Assessment of Fat Fraction')
subplot(2,1,1)
imagesc(SATmask_ff_rg, [0 0.2]); colormap gray
title('Fat Fraction Masked Region Growing')
subplot(2,1,2)
imagesc(filtFF, [0 0.5]); colormap gray
title('Fat Fraction')
```







1. Using a larger dilation and erosion radius made the region growing with the FF map difficult. Changing the threshold by a small amount made much of the image appear, including the spine. It makes the intensities less differentiable. 2. The dilation and erosion creates a smooth connected line for the region growing of the SAT. I used a disk of size 2 for the dilation and 1 for the erosion. 3. The resulting SAT missed a part of the top and was overall thinner than in the original FF map. 4. By visual examination, the edge detected mask is more faithful to the subcutaneous fat in the fat fraction map. Since I used the same dilation and erosion, I got both maps to be similar shaped. However, the edge detected mask did not have the "cuts" in the edge that were visible in the fat fraction masked.

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