HW 2: Medical Imaging Systems

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Q1

a)

b) at the given dimensions, each voxel would have dimensions of $24/192cmx24/192cmx1.0mm = 1.25mmx1.25mmx1.0mm$ giving us a volume of $1.6mm^3$ per voxel. 85% of this volume is occupied by water in our tumor. Water has a density of $1g/cm^3 = 0.001g/mm^3$ giving us $1.6mm^3 * 85\% * 0.001g/mm^3 = 0.0014g$ of water. At an atomic mass of 14 g/mole, at at a mass of 0.0014 g this gives us $\frac{0.0014g}{14g/mole} = 0.0001mole$ of water molecules. At 2 hydrogen per water molecule this gives us a total of $0.0002mole$ of hydrogen atoms or $1.2 * 10^{21}$ hydrogen nucli in water molecules. Assuming a body temperature of 310.15 K (37 Celsius), knowing that $\gamma/2 * \pi = 42.58MHz/T$ for hydrogen nuclei, with a 3 T magnet:
$M_0 = \frac{N\gamma^2h^2}{16\pi^2kT}B_0 = \frac{Nh^2}{4kT}\frac{\gamma^2}{4\pi^2}B_0 = \frac{1.2*10^{21}*(6.6*10^{-34}J/s)^2}{4*(1.4*10^{-23}J/K)*310.15K}(42.58MHz/T)^2 * 3T$

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%%
%Problem 5

%kernal a
averaging_kernal = ones(3,3)/9;

%kernal b
%orientation flipped due to matlab conventions
vertical_edge_detector = zeros(3,3);
vertical_edge_detector(:,3) = 1;
vertical_edge_detector(:,1) = -1;

%kernal c
%orientation flipped due to matlab conventions
horizontal_edge_detector = zeros(3,3);
horizontal_edge_detector(1,:) = 1;
horizontal_edge_detector(3,:) = -1;

conv1_results = ...
conv2(MRI_Image,averaging_kernal,'same');
%I use the same argument to not get increased image size
%It does however leave in zero padded edges in the calculation
   but the
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%edges are all background and I do not mind as much there

conv2_results = ...
conv2(MRI_Image,vertical_edge_detector,'same');

conv3_results = ...
conv2(MRI_Image,horizontal_edge_detector,'same');

figure(1);
subplot(2,2,1);
imagesc(MRI_Image')
axis('equal')
axis('tight')
colormap(gray);
title('Original')
subplot(222);
imagesc(conv1_results')
axis('equal')
axis('tight')
colormap(gray);
title('3x3 Average')
subplot(223);
imagesc(conv2_results')
axis('equal')
axis('tight')
colormap(gray);
title('Vertical edge detector')
subplot(224);
imagesc(conv3_results')
axis('equal')
axis('tight')
colormap(gray);
title('Horizontal edge detector')
```