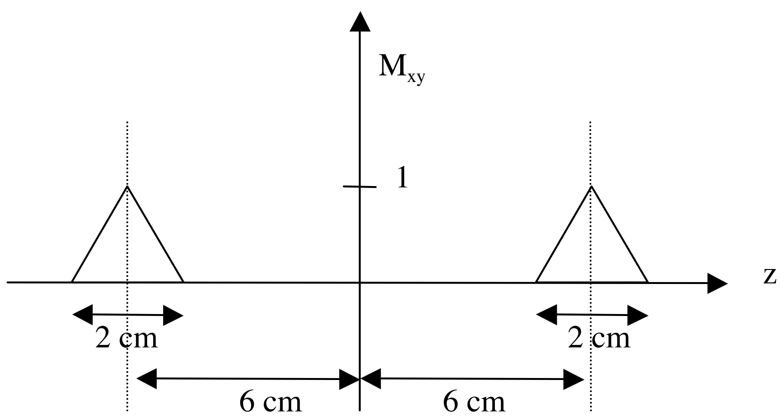
BENG280A, Principles of Biomedical Imaging 11/19/09
Fall Quarter 2009

HOMEWORK #7
Due in Class on Thursday 12/03/09

Readings:
Review Chapters 6 and 7 in Nishimura
Read Chapters 10 and 11 in Prince and Links

Problems:

1. Consider the slice profile show below. Assume that the largest B1 amplitude available is 0.3 Gauss. Calculate the B1 waveform and gradient strength required to achieve the desired slice profile. You will want to make use of the maximum B1 amplitude so that the pulse is as short as possible. Make a plot of the B1 waveform, indicating amplitudes and important features of the waveform (e.g. timing of the zeros). You may want to use MATLAB to make the plot.



2. You have been asked to design an ultrasound system for imaging of the heart. The system must be capable of acquiring 40 frames a second at a maximum depth of 15 cm.
   a) Determine how many lines per frame can be acquired. Assume that the speed of sound is 1500 m/s.
   b) Determine the highest frequency that can be used in order that the waves not be attenuated by more than 99%. Assume an attenuation of 1dB/cm/MHz.
   c) Determine the size of the detector such that the entire field of view will be in the near field. Use the frequency derived in part b.
   d) Determine the depth resolution, assuming that the temporal pulse duration is equal to 3 cycles of the acoustic wave.

3. Consider a transducer of dimensions LxL operating at a frequency of 2 MHz.
   a) Determine the size L of the transducer such that the far field region begins at 40 cm.
   b) Sketch the 2D far field pattern as a function of z.
   c) Consider two point reflectors at (d/2,0,z) and (-d/2,0,z). If the resolution is defined as the effective width of the field pattern, determine the minimum distance *d*

between the two points such that the two points can still be resolved. In other words, the distance should be equal to the effective width of the field pattern.

d) Now assume that an acoustic lens has been added to the transducer to focus the beam at a focal depth of 15 cm. What is the minimum separation of points that can be resolved at the focal depth?

MATLAB PROBLEM

1. Look up the definition of correlation coefficient (e.g. on Wikipedia) and write a program to compute the correlation coefficient between two vectors **X** and **Y** (give your function a meaningful name but do NOT name it corrcoef). Your program should also return the p-value associate with the correlation coefficient (you will want to look up how to compute the p-value). Compare your results to MATLAB's corrcoef function. You should get the same result.
2. Use your function to compute correlation maps for the fMRI dataset from the sample brain (assign1.mat on webpage). Note that this dataset is stored in the matrix **rawdata_r**, and has dimensions of 64x64x6x164. This is a 4D volume where the first 3 dimensions are the x,y, and z coordinates, and the last dimension index time. Use the reference vector **ref** from the *.mat file. Can you detect functional activation in the brain? Where in the brain is it? What happens when you apply a threshold to your maps? What p-value appears to give the best maps? Repeat this with the reference vector **ref0**.
3. Use the MATLAB etime function to see much time it takes to compute the correlation maps. Remember that using for loops in MATLAB is really inefficient. Can you come up with a faster way of computing the correlation coefficients? Hint: You will want to make judicious use of matrix multiplication.