BENG280A, Principles of Biomedical Imaging 11/19/04
Fall Quarter 2004

HOMEWORK #7
Due Monday 11/29/04

Readings:
Finish reading Seutens chapter 7. Read chapter 8

Problem 1
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.

Problem 2
Consider a transducer of dimensions LxL operating at a frequency of 5 MHz.

a) Determine the size L of the transducer such that the far field region begins at 30 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?
e) For depths away from the focal depth the acoustic lens will not completely cancel out the quadratic phase term. Define the depth of focus as the region over which the maximum residual phase error (i.e. uncanceled quadratic phase) is less than 1 radian. Estimate the beam's depth of focus assuming a focal depth of 15 cm.

Problem 3
Consider a 2D phased-array consisting of square elements of width w. The centers of the elements are separated by a distance d. You may assume that the center element is centered at the origin (x=y=0). The total size of the array is D in each direction.

a) Write an expression for the transducer function s(x,y)
b) Write down an expression for the delays that are required to focus the array at a focal depth of *f*.
c) Assume that the array is focused at a focal depth *f*. Plot the beam pattern along the diagonal line (x=y) in the focal plane. Label the plot.