Spring 2009, Aaron Lanterman

ECE 6279: Spatial Array Processing
Homework 2

Due: Wednesday 1/28/09 at the *start* of class - homeworks turned in later in the hour may be penalized at my discretion

Late due date (30% penalty): Friday 1/30/09

You are welcome to discuss approaches to the problems and solutions to difficulties you encounter with one another and with others outside the class. You can and should learn from each other as much as, and even more than, you learn from me. However, your solutions should be your own work and should be written up by yourself; feel free to discuss things, but don't be looking at someone else's paper when you are writing your solution. It's too easy to freeload that way and not learn anything. See the class website for more guidelines.

Looking at solutions to homeworks and quizzes of previous offerings of ECE6279 is expressly forbidden.

A 30% penalty will be assessed on late homeworks (even homeworks turned in later the day it is due); I will distribute solutions shortly after class on Friday, so I will not accept solutions after that. If you cannot make a class, please make arrangements to get your homework to me ahead of time.

1 Required Problems

1. Suppose we have a circularly symmetric aperture defined by $w(x, y, z) = o(x, y)\delta(z)$, where

$$o(x,y) = \begin{cases} 1, & R_1 \le \sqrt{x^2+y^2} \le R_2 \\ 0, & \text{otherwise} \end{cases}$$

   Of course, $0 < R_1 < R_2 < \infty$. Find its aperture smoothing function W as a function of $k_{xy} = \sqrt{k_x^2 + k_y^2}$. (Hint: Use *linearity* and the result in the box on p. 64.)

2. Consider an array of seven sensors located at $(x, y) = (-1, -1)$, $(1, -1)$, $(-4, 0)$, $(0, 0)$, $(4, 0)$, $(-1, 1)$ and $(1, 1)$ with uniform shading coefficients ($w_m = 1$).
   (a) Compute the array pattern as a function of k_x, k_y, and k_z. Express your answer as a sum of three terms: the first a constant, the second a product of two cosines, and the third containing a single cosine. To get the second term, you may need to employ a trigonometric identity.
   (b) Compute the array pattern as a function of the angles of incidence ϕ and azimuth θ and wavelength λ. (By "angle of incidence," I mean the wave is coming *from* an object at the ϕ, θ angles.)

3. Do Problem 4.12 on p. 192 of J & D.

4. Verify the formula in the box on p. 119 of J & D. To make your task easier, look up the "law of cosines."