Spring 2011, Aaron Lanterman

ECE 6279: Spatial Array Processing
Homework 2

Due date: Friday 2/4/11 for on-campus students, Friday 2/11/11 for distance learning students. Homeworks are due at the *start* of class; homeworks turned in significantly later in the hour may be penalized at my discretion.

Late due date (30% penalty): Monday 2/7/11 for on-campus students; Monday 2/14/11 for distance learning students. (Again, if you need to use this late option, your homeworks are due at the *start* of class.)

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 from previous offerings of ECE6279 is expressly forbidden. Look, here I am expressing how forbidden it is. Forbidden! Forbidden!!!

A 30% penalty will be assessed on late homeworks (even homeworks turned in later the day it is due); I will distribute solutions to students in the different sections (on-campus or distance learning) shortly after class on the associated "late option" due date, so I will not accept solutions after that. The "late option" turn in is available as an emergency buffer in case you get overwhelmed with life in general, but try not to rely on it. If you cannot make a class, try to make arrangements to get your homework to me ahead of time. (If you need to give your homework to a friend to deliver, please exercise judgement and caution; I have had problems in the past when the "friend" tasked with delivery directly copied from the homework they were tasked to deliver, without the original source's knowledge. This sort of thing tends to break up friendships.)

1 Required Problems

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

$$o(x,y) = \begin{cases} 1, & 3 \leq \sqrt{x^2+y^2} \leq 4 \\ 0, & \text{otherwise} \end{cases}$$

   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 $(x, y) = (0, -6)$, $(0, 0)$, $(0, 6)$, $(-1, -1)$, $(1, -1)$, $(-1, 1)$ 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.