BENG280A, Principles of Biomedical Imaging 10/04/10
Fall Quarter 2010

HOMEWORK #2
Due at the start of Class on Thursday 10/14/10

Homework policy: Late homeworks will be marked down by 20% per day. If you know that you need to turn in a homework late because of an emergency or academic travel, please let the TA know ahead of time. Collaboration is encouraged on homework assignments, however, the homework that you submit should reflect your own understanding of the material.

Readings:
Review chapters 4 and 5 in the textbook as necessary. Read Sections 2.1; 2.2.1-2.2.2; 2.2.4; 2.3.1- 2.3.3. Read Sections 6.1 and 6.2; Section 6.3 up to middle of page 198; preview remainder of section 6.3.

Problems:

1. Derive and sketch the answers for the following expressions where * denotes convolution:
   a) $m(x) = [2\delta(-x-3) + 2\delta(-x+3)] * rect(-x^2/7)$
   b) $m(x) = [2\delta(x-1003) - 2\delta(x+1003)] * \sin(\pi x)$
   c) $m(x,y) = [\delta(x,y) + \delta(x-1/2,y) + \delta(x+1/2,y) + \delta(-x,y-4) + \delta(x,y+4)] ** (rect(2x,y/4))^2$
   d) $m(x,y) = [\delta(x,y) + \delta(x-0.5,y) + \delta(x+0.5,-y)] ** [\delta(x-0.5,y+5) + \delta(-x,y+3)]$
2. Problem 2.27 (parts a and b); For part (b), also determine the response when the input signal is $f(x) = 2\delta(-x-3) + 2\delta(-x+3)$
3. Problem 5.21
4. Consider an X-ray imaging system with source distribution *s(x,y)* and object transmission function *t(x,y)*. The distance from the source to the detector is d; and the distance from the source to the object is z. Let $s(x,y) = rect(2x,y)$ and $t(x,y) = rect(2x,y)$. Write down a general expression for the intensity of the image at the detector (explicitly evaluate the convolution). Your answer should be a function of x,y, z, and d. You may define magnification variables (e.g. m and M) that are functions of z and d and use these in your answer. Sketch the answer for *z = d/2*.
5. Problem 6.2 (note that the pitch of the helix is defined as the distance traveled during a full 360 degree rotation).
6. Derive the general expression for the sinogram corresponding to a point target at location (x_0, y_0). Evaluate your expression for the following three specific locations for the point target: (a) (30, 0); (b) (0, -20); and (c) (30, -20).

Matlab Exercise:

Define a 281x281 object that is zero everywhere except for a point target at a location that you define. Treat the middle of your object as the origin. Use the **radon** function to compute the projections (use the MATLAB help feature to get more information on how to use the radon function). Compare the computed sinograms to the expressions for the three specific cases considered in problem 6.