Solve the following problems:

1. Problem 3.7 in the text
Suppose that a digital image is subjected to histogram equalization. Show that a second pass of histogram equalization (on the histogram-equalized image) will produce exactly the same result as the first pass.

2. Problem 3.11 in the text
An image with intensities in the range [0, 1] has the PDF $p_1(r)$ shown in the following diagram. It is desired to transform the intensity levels of this image so that they will have the specified $P_2(z)$ shown. Assume continuous quantities and find the transformation (in terms of $r$ and $z$) that will accomplish this.

3. Problem 3.17 in the text
Discuss the limiting effect of repeatedly applying a 3 X 3 lowpass spatial filter to a digital image. You may ignore border effects.

4. Problem 4.27 in the text
Consider a 3 X 3 spatial mask that averages the four closest neighbors of a point $(x, y)$, but excludes the point itself from the average.
(a) Find the equivalent filter, $H(u, v)$, in the frequency domain.
(b) Show that your result is a lowpass filter.

5. Problem 4.33 in the text
Consider the images shown. The image on the right was obtained by: (a) multiplying the image on the left by $(-1)^{x+y}$; (b) computing the DFT; (c) taking the complex conjugate of the transform; (d) computing the inverse DFT; and (e) multiplying the real part of the result by $(-1)^{x+y}$. Explain (mathematically) why the image on the right appears as it does.
6. In addition to the analytic solution to problem 4.27 develop a Matlab script and/or function to generate and plot \( H(u,v) \) from \( h[n,m] \). Is this system (filter) best described as low-pass? Why?

Does including the original (center) pixel in the filter make it a better low pass filter? Why? Base the following operations on whichever filter is the “better” low-pass system. Apply your system to an image of your choice 100 times as a zero-phase, spatial-frequency domain operation.

Select that image to best demonstrate the action of your filter. Explain your selection. Explain your results. Show that you have not introduced either aliasing or a displacement. Document your exercise with labeled figures of both system responses in space and spatial frequency and of the image at appropriate stages of processing. As always, be sure to follow the procedure listed below for this and all other problems. Fully document the mfile(s) used to support this problem.

**DO NOT submit your mfile!**

Due Thursday, September 21, 2017

*As with all homework, quiz, test, and exam problems include a complete problem statement, your approach to the solution of the problem, key expressions used in that approach in which all variables are defined, all the steps in the execution of your approach to the solution of the problem, the results of your solution, and, of course, an interpretation of those results or of the behavior of your design.*