EE262 **Handout # 9**

Homework # 2
Due Wednesday, January 23

1. Retrieve the file “hawaiidem” from the class web site. This is a binary byte file consisting of 927 lines, each 735 pixels, representing the topography of the Big Island of Hawaii. The vertical scale is such that each data number in the byte represents 20 m of elevation, or that a value of 255 would represent a height of 5100 m.

a. Display this image directly on your screen. Identify and count the number of large peaks on the island. The two tallest peaks on the island are the volcanoes Mauna Loa and Mauna Kea. If the pixel spacing in the image is 180 m, what is the distance between them?

b. Generate a shaded relief image of this island with illumination from the left side. Give the difference equation you use, and submit the resulting file in tiff format electronically.

c. Generate a shaded relief image with illumination from the bottom of the image. How does this change your perception of the topographic shape of the island? Again, give the difference equation you use, and submit the resulting file in tiff format.

2. Create two perspective views of the island in problem 1 using the equations in the notes for the *perspective* projection (the first option given in the notes). Choose two perspective directions 90 degrees apart from each other, and pick an elevation angle that permits you to see much of the topography. Use the shaded relief map you created in (1) as your intensity image. Submit each electronically.

3. Repeat (2) using the pinhole camera equations.

4. Write a Gaussian random number generating routine, and use it to produce a string of normally distributed random numbers with zero mean and unit variance. Do not use the built-in Matlab Gaussian function, but you may use a built-in uniform random number function. Thus your routine should start with uniformly distributed random variables and produce Gaussian draws. Combine pairs of the random variables to form complex Gaussian random variables. Measure the mean, variance, and third central moment of the real and imaginary parts of your string of complex Gaussian rvs.

a. Create a sequence of intensity values $I = | c c^* |$ from each complex Gaussian c. Plot a histogram of the intensities in the form of a probability distribution, and determine the mean and standard deviation. Plot an exponential distribution with similar parameters on top of your experimentally determined distribution, and show that the parameters for the theoretical distribution match the experimentally-inferred values from the numerical experiment.

b. Repeat (4a) but with amplitudes instead of intensities. That is, use a sequence of amplitude values $a = | c c^* |^{1/2}$. Plot a Rayleigh distribution rather than an exponential.

5. Coherent vs. incoherent imaging:

a. Using the optimally stretched image you created last week from the input image image1, calculate a simulated one-look coherent image assuming that the value at each pixel represents the power in the complex random variable draw for each image point. In other words, each of the real and imaginary parts of the complex value are normally distributed with mean 0 and variance I/2, where I is the intensity value at the given pixel. Submit the one-look image electronically.

b. Now, make multiple draws for each pixel to generate a 10-look image at the same resolution, and compare the image with the one-look image. How does it differ? Submit the resulting file to the class disk area as usual.

c. Repeat (b) but use 100 looks instead of 10 looks.

d. How many looks would be required to make the coherent image indistinguishable by eye from the original image?

6. Despeckling an image

Read in the file ‘lab2prob6data’ from the web site. This is a 2560 x 2048 image of the Stanford quad. The image was acquired with a coherent camera and is highly speckled.

a. Reduce the speckle in this image by averaging pixels, taking 2 looks in each direction. Your new image should be 1/4 the size of the original in terms of data volume. Display and submit the averaged image. Is this image of higher quality than the original? In what way?

b. Create smaller versions of the image with more looks. Choose a size that is large enough to be able to resolve details in the image, but that has enough averaging to reduce the speckle to a tolerable level. Display and submit this new image, and describe why you chose the size you did.