ECE 581 Homework 1 (Part 1 of two parts)

Due Thursday 5 AM Sept 7, 2017

Electronic Submission – Please submit PDF file via "Assignment" under Sakai

Include your analytical work, MATLAB listings, graphs and comments with your homework.

(10 points total) For this problem, model the additive uncorrelated Gaussian noise by using the appropriate Matlab random number generator utility. Use MATLAB throughout this problem. You should explain and comment on your approach and results as you proceed through the problem.

(a) (3 points) Generate a noise-free image (signal), size 1024 x 1024, which consists of one straight line that goes diagonally from corner to corner. Let each pixel along the line have equal amplitude and the value zero off the line. In particular set the total signal energy $E_s = \sum_{i,j} s_{i,j}^2 = 4$, where all the $s_{i,j}$, elements (pixels) of the matrix S, are the image. Using MATLAB, display and print out your noise-free image. Use gray scale images.

(b) (3 points) Add statistically independent Gaussian noise to the image using the random number generator for a Gaussian probability density function in MATLAB. Let the noise have zero mean and variance, $\sigma_n^2 = 1$, so that $\frac{E_s}{\sigma_n^2} = 4$. Viewing the print out of your image "normally", i.e. as you would normally view something to read on a piece of paper, can you see your image (straight line) in the noise?

(c) (2 points) If you cannot see the straight line in part (b), adjust $\frac{E_s}{\sigma_n^2}$, by changing E_s, until you can "just see" the image "with confidence". Using a MATLAB subroutine, display and print out several signal plus noise images for that case for different noise "runs". Also print out several noise alone images, for comparison. Use the MATLAB subplot command so that you can get a number of plots on one page.

(d) (2 points) Repeat (c), except tilt the print out so that you can sight along where the line would be, if it were there. Record the value of $\frac{E_s}{\sigma_n^2}$ now needed to detect the line and discuss your results.

Be ready to discuss your results in class.