

ECE 431
Digital Signal Processing
Homework 9

Due Friday, November 17, 2006

1. **Image Quantization and Digital Watermarking.** Download the Matlab data file `cam_wm.mat` from the course website. This file contains an image called `y`. The image should look familiar (the cameraman image), but it is slightly different than the image we used in class before.
 - a. There is a secret digital “watermark” in this image. The image pixels are represented by numbers between 0 and 255 (i.e., 8 bits of precision). The watermark is the pattern determined by the least significant bit (LSB) of each pixel. Determine method for extracting the LSB of each pixel, and display the LSBs as an image. You will then see the secret watermark, which is otherwise invisible.
 - b. How large of a quantization step size can you use before image quality visually degrades? Plot the image at different levels of quantization (8 bits, 6 bits, 4 bits, 2 bits).
2. Prove that convolution in time corresponds to multiplication in the z-transform domain.
3. Consider a system described by the following transfer function:

$$H(z) = \frac{(z + 1)^2}{(z - 1/2)(z + 3/4)}$$

- a. Find the difference equation representation of the time-domain filter that implements this system.
- b. Sketch the pole/zero plot and possible ROCs (there may be more than one).