CSE166 – Image Processing – Midterm

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`http://www-cse.ucsd.edu/classes/fa07/cse166`

11:00am-12:20pm Tuesday Nov. 6, 2007.

On this exam you are allowed to use a calculator and one 8.5" by 11" sheet of notes. The total number of points possible is 25. In order to get full credit you must **show all your work**. Good luck!

1. (10 pts) Consider the system $g(x) = \frac{1}{2}[xf(x-1) + (x-1)f(x)]$.
   (a) Is this system linear? If it is linear, what is the impulse response?
   (b) Is this system shift invariant?
2. (12 pts) Let $h(x)$ denote a piecewise continuous function that is equal to $1/a$ for $x \in [-a/2, a/2]$ and zero elsewhere, and let $H(u)$ denote its Fourier transform.
   (a) What type of filter is $h(x)$: lowpass, bandpass, or highpass?
   (b) What is $H(u)$? Give its name and functional form.
   (c) Sketch $h(x)$ and $H(u)$ for $a = 1$ and $a = 2$ in four separate plots, arranged in a 2×2 grid. Indicate the DC component and the locations of the zero crossings on the u axis in each of the Fourier transform plots.
   (d) What is $\lim_{a \to 0} h(x)$ and $\lim_{a \to 0} H(u)$?
3. (8 pts) Suppose you are given an image $f(x, y)$ and you produce a new image $g(x, y)$ by subtracting $f(x, y)$ from a copy of itself shifted one pixel up and one pixel to the left.
   (a) Is this operation on f linear? Is it shift invariant?
   (b) Writing this operation in the form $g = f * h$, what choice of h will produce the desired g?
   (c) Let f represent an image of a white square on a black background. Sketch f and $\|g\|$.
4. (5 pts) Write down the expression for the χ^2 distance between a pair of K-bin histograms $h_i(k)$ and $h_j(k)$. What advantage does this have over simply computing the squared Euclidean distance between $h_i(k)$ and $h_j(k)$?