CSE166 – Image Processing – Midterm

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`http://www-cse.ucsd.edu/classes/fa10/cse166`

2:00-2:50pm Friday Oct. 29, 2010.

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 30. In order to get full credit you must **show all your work**. Good luck!

1. (10 pts) Clearly write **T** for True or **F** for False in the blank for each question.
   (a) The Laplacian of a Gaussian is a Gaussian. _____
   (b) $f(x) * h(x) = F(u)H(u)$. _____
   (c) The convolution of an $M \times M$ image with itself is of size $(M-1) \times (M-1)$. _____
   (d) The binomial kernel is a discrete approximation to a Gaussian. _____
   (e) The Fourier Transforms of $\cos(2\pi u_o x)$ and $\sin(2\pi u_o x)$ have the same magnitude. _____
   (f) If $f(x)$ is a narrow box, then $F(u)$ is a wide box. _____
   (g) Luminance is 1D and Chrominance is 2D. _____
   (h) The first step of Canny edge detection is convolution with an LoG filter. _____
   (i) The Fourier Transform of a delta function is a constant. _____
   (j) If W is a DFT Matrix, then W multiplied by itself is diagonal. _____
2. (10 pts) Consider the following kernel:

$$h(x) = e^{-x^2/2\sigma^2} \cos(2\pi u_o x)$$

   Assume in this problem that x is continuous.
   (a) Give the name of this kernel and specify what kind of symmetry it has.
   (b) What type of filter is $h(x)$: lowpass, bandpass, or highpass?
   (c) If you filter an image with this kernel, will the DC component of the result be zero?
   (d) Name another type of filter that can be used in place of this filter with approximately the same effect.
3. (10 pts) Let X denote a continuous random variable representing pixel brightness in an image, and let $X \sim p_X(x)$.
   (a) Write down the transformation $T(\cdot)$ for which the random variable $Y = T(X)$ has a uniform distribution on $[0, 1]$.
   (b) Write down the version of $T(\cdot)$ used in the discrete case.
   (c) What is the name of this image processing operation?
   (d) Why does this operation sometimes not produce a uniform distribution in the discrete case? Illustrate your answer with an example.