EECS 4422/5323: Computer Vision
Example Midterm Exam Questions

- Consider a pinhole camera, as governed by ideal perspective projection. Suppose that the image plane is 0.5 cm behind the pinhole and that a 1.5 meter tall object is imaged 10 meters in front of the camera. How tall will the object appear in the image? Provide your answer in cm.

- Derive the radiometric relationship between scene radiance, L, and image irradiance, E, i.e., the fundamental equation of radiometric imaging.

- Suppose that an image, $E(x,y)$, is convolved with a Gaussian point spread function,

  $$h(x,y) = \frac{1}{2\pi\sigma^2}\exp\left(-\frac{1}{2}\frac{x^2+y^2}{\sigma^2}\right).$$

  Beyond which frequencies will the amplitudes of the frequencies in the resulting image be reduced by one half what they were in the original image, E?

- Derive the Gabor filter as an instance of a windowed Fourier transform. Calculate its modulation transfer function.

- Let $E(x,y)$ be an image. Calculate the Fourier transform of

  $$E(x,y)\cos(a\,x + b\,y).$$

  Based on what you find, *briefly* state how taking the product of the image with the cosinusoid has altered its structure. You might find it useful to note that

  $$\cos(ax+by) = \frac{1}{2}\left(\cos(ax+by) + i\sin(ax+by) + \cos(ax+by) - i\sin(ax+by)\right)$$

- Given a spatially quantized image, $E(i,j)$, of dimensions NxM and a quantized template, $h(i,j)$, of dimensions nxm, give a pseudo-code implementation for convolution of E and h. You may assume that $n<N$ and $m<M$.

- The gradient squared of an image, $E(x,y)$, is given as

  $$\left(\frac{\partial E}{\partial x}\right)^2 + \left(\frac{\partial E}{\partial y}\right)^2$$

  and can be used to enhance edges for edge detection. Calculate the response of this operation to an ideal step edge at an arbitrary orientation.

- Letting $E(x,y)$ represent an image and subscripts denote partial differentiation, discuss how the eigenvalues of the following matrix are related to the local image orientation structure in the region W over which information is accumulated

  $$C = \begin{pmatrix} \sum_W E_x^2 & \sum_W E_x E_y \\ \sum_W E_y E_x & \sum_W E_y^2 \end{pmatrix}$$