Computational Vision
Psy 5036, Fall 2010

Mid-semester Exam Study Guide

To prepare for the exam, you should read both the lecture notes and the assigned readings.

Definitions of key concepts. You will be asked to write a short paragraph on each concept discussing its definition and relationship to vision. On the exam, you will answer 8 from a selection of 12. 3 points each for a total of 24 points.

eigenfunction	contrast	Gabor function	scene vs. image descriptions
Rods & cones	diffraction limit	Point spread function (PSF)	Nyquist rate & aliasing
hypercolumn	spatial frequency	fovea	d', hit rate, false alarm rate
visual angle	Noise, secondary variables	statistical efficiency	ROC
kurtosis	$1/f^2$	Poisson distribution	zero-crossing
scotopic/photopic	Superposition & homogeneity	receptive field	$\nabla^2 G$
orientation selectivity	shift-invariant	linear system	predictive coding
Modulation transfer function (MTF)	Fourier transform	Convolution & lateral inhibition	Maximum a posteriori estimation (MAP)
histogram equalization	autocorrelation function	Signal-known-exactly (SKE) & cross-correlation	Difference of Gaussians (DOG)
$\nabla I(x,y)$, spatial gradient	Contrast normalization	Conditional probability	"Explaining away"
Image pyramid	Graphical model	Band-pass filter	Multiple spatial frequency channels

Long essay questions. On the exam, you will be asked to answer 2 questions. 12 points each for a total of 24 points for this section.

1. Explain the experiment of Hecht, Schlaer and Pirenne and discuss its significance.

2. Describe and compare the MTF and the CSF of the human visual system. Relate the optical quality of the eye, as characterized by the MTF, to the sampling resolution of the foveal and peripheral receptor mosaic.

3. Discuss the contributions of psychophysics, neurophysiology, information theory (i.e. efficient coding), and computer vision (e.g. edge detection) approaches to our understanding of lateral inhibition. Illustrate your answer with one contribution from each of the four fields.

4. Discuss the contributions of psychophysics, neurophysiology and computational theory (i.e. image basis sets and sparse, efficient coding) to our understanding of the organization of spatial neural receptive fields in primate visual cortex. Illustrate your answer with one contribution from each of the three fields.

5. How can intensity statistics in natural images be exploited to improve neural coding?

6. Describe how visual decisions or estimates about scene properties can be modeled using Bayesian decision theory, including the concepts of likelihood, prior, and utility (or loss). Give an example.

7. Summarize the key points from *one* of the following themes/papers on your reading list:
   a) Campbell and Green, (1965)
   b) Contrast normalization and natural image statistics,
      (See relevant sections of Simoncelli & Olshausen, 2001 and Geisler, 2008)
   c) Burgess et al. (1981)
   d) The cost of cortical computation, Lennie (2003)