Computational Vision
Psy 5036, Fall 2006

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
visual angle  spatial frequency  fovea  d’, hit rate, false alarm rate
kurtosis  Noise, secondary variables  statistical efficiency  ROC
scotopic/photopic  1/f²  Poisson distribution  zero-crossing
orientation selectivity  Superposition & homogeneity  linear system  predictive coding
Modulation transfer  shift-invariant  receptive field  Maximum a posteriori estimation
function (MTF)  Fourier transform  Convolution & (MAP)
histogram equalization  autocorrelation function  Signal-known-exactly
                      (SKE) & cross-correlation  Difference of Gaussians (DOG)

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.

Early Vision

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 papers on your reading list:
   a) Albrecht et al., (1980)
   b) Meister et al., (1999)
   c) Burgess et al. (1981)