Exam 1 Review

- One hour to complete
- Closed book, closed notes, no calculator necessary
- One 8.5 by 11 sheet with anything you want on it
- Covers chapters (1), 2, 3, and 4
- Total of 10 questions
  - ~4 short answer and/or minor calculations
  - ~1 requires a short proof
  - ~3 routine calculations
  - ~2 somewhat more challenging

Chapter 2: Digital Image Fundamentals

- Visual perception
  - Cornea, iris, pupil, lens, retina, blind spot, fovea
  - Brightness adaptation, Mach bands, simultaneous contrast
  - Focal length, size of image on retina
- Image acquisition
  - Illumination, reflectance, transmissivity \( f(x,y) = i(x,y)r(x,y) \)
- Sampling and quantization
  - False contouring
  - Aliasing \( \Delta x < \frac{1}{2w_{max}} \) \( \Delta y < \frac{1}{2v_{max}} \)

Chapter 2: Pixel relationships

- Neighbors, adjacency, paths
- Regions, boundaries
- Distance measures: Euclidean, \( D_x \), \( D_y \)

Chapter 2: Linear & non-linear systems

- Homogeneity
- Additivity

Chapter 3: Enhancement in Spatial Domain

- Point processing, gray level transformations
  - Contrast stretching, gamma correction, log transformations
  - Look up tables
  - Cumulative probability distribution function, probability distribution function
- Histograms, normalized histograms
- Histogram equalization, histogram matching

\[
s = T(r) = F^{-1}(F_s(F(r)) = \int_{-\infty}^{\infty} p_s(\alpha) d\alpha \]
Chapter 3: Enhancement in Spatial Domain

- Local enhancement
  - Local mean and standard deviation
- Image subtraction
- Filter masks and convolution
  - Know how to calculate a 2-d convolution!
  - Image edge effects
  - Symmetric and anti-symmetric masks
- Image blurring, low pass filter, box filter
- Order statistics filter, median filter
- Linear convolution
  - Identity element
  - Series and parallel systems

Chapter 4: Enhancement in Spatial Domain

- Image sharpening, high pass filters
  - Second derivative & Laplacian
  - First derivative & gradient operators
  - High boost filtering

Chapter 4: Enhancement in the Frequency Domain

- Properties of the DFT
  - Symmetry properties
  - Periodicity
  - Centered & uncentered, frequency shifting
  - Spatial shifting
  - Scaling
  - Reciprocal relationship with spatial domain
  - DC sample
- Basic general filtering algorithm
- Low pass filters
  - “ideal” (ripples, artifacts)
  - Butterworth
  - Gaussian

Chapter 4: Enhancement in the Frequency Domain

- High pass filters - “ideal,” Butterworth, Gaussian
- Laplacian in frequency domain
- High frequency emphasis
- Homomorphic filtering
- Sampling
- Convolution theorem
  - Convolution with the DFT
  - Masking/windowing vs. convolution
- Linear vs. circular convolution
  - Length of result
  - no wrap-around vs. wrap-around
Chapter 4: Enhancement in the Frequency Domain

- Zero padding
  - Why do we need it?
  - How much do we need?
- Separable convolution kernels
- Spectrum of a 2-d periodic signal
- Know how to find $H(u,v)$ from either $h(x,y)$ or a mask!
- Know how to find magnitude & phase of the DFT!