CS/ECE 545
(Digital Image Processing)
Midterm Review

Prof Emmanuel Agu

Computer Science Dept.
Worcester Polytechnic Institute (WPI)
Exam Overview

- Wednesday, March 5, 2014 in-class
- Will cover up to lecture 5 (Harris Corner Detection)
  - Includes today’s class
- Can bring:
  - One page cheat-sheet, hand-written (not typed)
  - Calculator
- Will test:
  - Theoretical concepts
  - Mathematics
  - Algorithms
  - Programming
  - ImageJ knowledge (program structure and some commands)
What am I Really Testing?

- Understanding of
  - concepts (NOT only programming)
  - programming (pseudocode/syntax)

- Test that:
  - you can plug in numbers by hand to check your programs
  - you did the projects
  - you understand what you did in projects
General Advise

- **Read your projects** and refresh memory of what you did
- **Read the slides**: worst case – if you understand slides, you’re more than 50% prepared
- Focus on **Mathematical results, concepts, algorithms**
- Plug numbers: calculate by hand
- Try to **predict subtle changes** to algorithm.. What ifs?..
- **Past exams**: One sample midterm is on website
- All lectures have references. Look at refs to focus reading
- Do all readings I asked you to do on your own
Grading Policy

- I try to give as much partial credit as possible
- In time constraints, laying out outline of solution gets you healthy chunk of points
- Try to write something for each question
- Many questions will be easy, exponentially harder to score higher in exam
Introduction to Image Processing

- What is an Image?
- Imaging system (parts)
- Digital image: an approximation
- What is image processing?
- Examples image processing operations: know what each type of operation does
  - Noise removal, contrast adjustment, segmentation, edge detection, image compression, etc
- Applications of image processing
  - Face recognition, fingerprinting, law enforcement, etc
Introduction to Image Processing

- Relationships with other fields (computer vision, image analysis)
- The key stages in image processing: know the stages and what each stage does
- Light, the electromagnetic spectrum & Image processing
- Structure of the human eye (rods, cones, fovea, etc)
- Image formation (in the eye & pinhole camera)
- Brightness adaptation and discrimination
Introduction to Image Processing

- Image acquisition
- Spatial sampling
- Image quantization
- Image as a discrete function
- Representing images
- Image resolutions:
  - spatial resolution vs intensity level resolution
- Saturation & noise
- Image File formats
ImageJ

- ImageJ parts
- Key features
  - Interactive tools, plugin mechanism, macro language + interpreter
- Software architecture
- Writing plugins
Histograms

- What is a histogram?
- Uses, interpretation of histograms
- Image issues easily identified using histogram
- Histograms: image brightness, contrast and dynamic range
- Computing histograms and binning
Histograms

- Color histograms
- Cumulative histograms
- What is a point operation?
- Point operations
  - Clamping, inverting images, thresholding, etc
  - Gray level transformations
  - Intensity windowing
- Contrast adjustment
- Histogram equalization
Operations on Histograms

- Histogram specification
- Histogram matching
- Gamma correction
- Alpha blending
Image Enhancement & Filters

- What is image enhancement?
- What is a filter
- Spatial filtering
- Smoothing using averaging filters
- Weighted smoothing filters
- Dealing with out of range image coordinates
  - Crop, pad, extend, wrap
- Linear filters vs non-linear filters
Filters

- Linear smoothing, gaussian filters
- Difference filters
- Convolution
  - Properties, separability, etc
- Noise
  - What is noise
  - Noise types: speckle noise, salt-and-pepper noise, etc
  - Best filter types to clean types of noise
Filters, Edge Detection

- Non-linear filters: min, max, median, weighted median filters
- Outlier method for cleaning noise
- Edge detection
  - What is an edge, characteristics
  - Edge operators
  - Gradient-based edge detection
  - Prewitt, Sobel, Roberts, Compass edge detection filters
Edge Detection

- Edge detection using 2nd derivatives
- Canny edge detection
- Contours and edge maps
- Image sharpening
  - Edge sharpening using Laplace operator
  - Edge sharpening using unsharp masking
- Harris corner detection