CS 474/674 Image Processing and Interpretation

Fall 2018 – Dr. George Bebis

Midterm Exam Study Guide

- ## Image Processing/Intro
  - Goal of Image Processing and related fields (Computer Vision/Computer Graphics)
  - Key processes in image processing
  - Applications of Image Processing and Computer Vision
  - Light and EM spectrum
  - Image formation and representation
  - Image digitization (sampling and quantization)
  - Image file formats, read/write PGM images

- ## Intensity Transformation
  - Point processing transformations vs mask processing transformations
  - Contrast stretching, contrast compression, intensity level slicing, bit-level slicing, log/exp transformations.
  - Histograms and their properties, Histogram equalization. ***You should know how to apply the steps of histogram equalization in the discrete case.*** **(Graduate Students Only): *need to know the steps in the continuous case as well as the theory behind it.***
  - Histogram specification. ***You should know how to apply the steps of histogram specification in the discrete cases.*** **(Graduate Students Only): *need to know the steps in the continuous case as well as the theory behind it.***
  - Local histogram processing, histogram statistics

- ## Arithmetic and Geometric Transformations
  - Addition, averaging, subtraction
  - Scaling, Rotation, Translation, Shear, Affine
  - Forward vs Inverse transformation

- Interpolation (zero-order, first-order, bilinear, bicubic etc. - how does it work?)
- Image registration (why is it useful? - how does it work?)

- **Spatial Filtering**
  - Mask processing (neighborhood + operation)
  - Linear vs non-linear filters
  - Main linear filters: correlation and convolution
  - How do we choose the mask weights? How do we deal with image boundaries?
  - Properties of smoothing and sharpening filters
  - Smoothing filters: averaging, Gaussian, and median filtering
  - Sharpening filters: unsharp masking, high boost filter, derivatives
  - Properties of gradient, approximation using finite differences; implementation using masks.
  - Laplacian (2^{nd} derivative), comparison with gradient

- **Fourier Transform**
  - Complex numbers, sin/cos functions, Euler's formula
  - FT definition and equations. ***You should be able to explain the FT both in mathematical and non-mathematical terms.***
  - Why is FT useful? What are the main filtering steps using FT?
  - FT magnitude and phase
  - FT pairs of common functions (e.g., square, δ(x), sin(x), cos(x) etc.) ***You should know how to derive them.***
  - Discrete Fourier Transform (DFT), DFT equations (both 1D and 2D). ***You should know how to compute the DFT of a discrete function.***
  - DFT properties (i.e., separability, periodicity, symmetry, translation, rotation, distributive, scale, average value). ***You should know how to prove them, especially the separability property.***
  - Magnitude/Phase – which one is most important and why?

- **Fast Fourier Transform**
  - Complexity of DFT and FFT ***You should know how to prove it.***
  - What is the main idea behind FFT? (**Graduate Students Only)*: need to know how to derive the FFT equations.***

- **Convolution**
  - Definition and equations (both in the continuous and discrete 1D/ and 2D cases). ***You should be able to explain the convolution both in mathematical and non-mathematical terms. Also, you should know how to compute it in the discrete case.*** (**Graduate Students Only)*: need to know how to compute it in the continuous case too.***
  - Convolution theorem. ***You should know how to prove it.*** Why is it important?
  - When does the convolution theorem hold true in the discrete case? NOT INCLUDED in Midterm
  - What is the reason for padding a signal or an image with zeroes when computing the discrete convolution? NOT INCLUDED in Midterm

Comments

The midterm exam will be closed-books, closed-notes. It will include True/False questions (i.e., answers must be justified) and problems similar to the ones we have done in class and in the homework. Also, there will be 1-2 proofs.