CS474/674 Image Processing and Interpretation

Fall 2011 – Dr. George Bebis

Mideterm Exam Study Guide

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- ## Image Processing/Intro
  - Image processing/Computer Vision/Computer Graphics
  - Image formation, sampling, quantization
  - Image representation, file formats

- ## Intensity Transformation
  - Point processing transformations versus mask processing transformations
  - Simple transformations, contrast stretching, contrast compression, intensity level slicing, log/exp transformations.
  - 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 for the continuous case as well as the theory behind it.***

- ## Arithmetic/Logic Operations
  - Addition, averaging, subtraction, multiplication, division, AND, OR
    - What are they useful for?

- ## Geometric Transformations
  - Scaling, Rotation, Translation, Shear, Affine
  - Forward vs Inverse transformations
  - Interpolation (zero-order, first-order, bilinear, bicubic etc. – know how to apply them)
  - Image registration (how does it work? why is it useful? – know how to apply it)

- **Spatial Filtering**
  - Mask processing, weight normalization, 2D correlation/convolution, linear vs non-linear filters
  - Definition and properties of low-pass, high-pass, and band-pass filters.
  - Smoothing filters based on averaging, Gaussian, and median filtering.
  - Sharpening filters based on high-pass filters, unsharp masking, derivatives
  - Properties of gradient, approximation of gradient using finite differences; implementation using masks.

- **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 the FT useful? What are the main steps in filtering 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, Complexity of FFT ***You should know how to prove them.***
  - What is the main idea behind FFT? (**Graduate Students Only)*: need to know how to derive the FFT equations.***

- **Convolution**
  - Definition, convolution 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? What is the reason for padding a signal or an image with zeroes when computing the discrete convolution?

- **Sampling**
  - What is the problem of sampling? Why it important?
  - Definition and properties of band-limited functions.
  - Expressing sampling mathematically (i.e., using a train of impulses)
  - What is the spectrum of a sampled function? How does the sampling step affect the spectrum of a sampled function? (both in 1D and 2D)
  - What is aliasing? Nyquist theorem ***You should know how to prove it.***
  - Practical issues (i.e., cannot sample an infinite duration signal)

- **Frequency Filtering**
  - Low-pass, high-pass, and band-pass filters – how do they look like in the time/frequency domain?
  - How do we specify a filter in the frequency domain?
  - What are the **main steps** of filtering in the frequency domain? (page 263)
  - Why low-pass filters cause blurring? What is the “ringing” effect?
  - How does high emphasis filtering work?
  - How does homomorphic filtering work? What are the main assumptions?

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.