CS474/674 Image Processing and Interpretation

Fall 2009 – 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 both in the continuous and discrete cases.*** **(Graduate Students Only):** ***need to know the theory behind it (i.e., what main result from probability theory supports the theory behind histogram equalization?).***
  - Histogram specification. ***You should know how to apply the steps of histogram specification both in the continuous and discrete cases.*** **(Graduate Students Only):** ***need to know 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, second-order etc. – know how to compute them)
- Image registration (how does it work? What is it useful for?)

- **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, Euler's formula
  - Definition, FT 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 definitions (i.e., magnitude, power, 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?

- **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, both in the continuous and discrete cases.

- 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?
- How is the discrete convolution implemented in 2D?

• 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)

• 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.***

• Frequency Filtering

- Frequency domain representation of low-pass, high-pass, and band-pass filters. How do they look like in the frequency domain?
- How do we specify a filter in the frequency domain?
- What are the main steps of filtering in the frequency domain?
- Why low-pass filters cause blurring? What is the “ringing” effect?
- High emphasis filtering and homomorphic filtering: main ideas and steps.

Comments

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