

COURSE TITLE

DIGITAL IMAGE PROCESSING I (1051.361)

INSTRUCTOR INFORMATION

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COURSE DESCRIPTION

This course is an introduction to the basic concepts of digital image processing. The student will be exposed to image capture and image formation methodologies, sampling and quantization concepts, statistical descriptors and enhancement techniques based upon the image histogram, point processing, neighborhood processing, and global processing techniques based upon kernel operations and discrete convolution as well as the frequency domain equivalents, geometrical operations for scale and rotation, and grey-level resampling techniques. The student will be introduced to the computation of the discrete and fast Fourier transforms for one- and two-dimensional functions and the techniques of frequency domain filtering. Emphasis is placed on applications and efficient algorithmic implementation using the IDL programming language. (1016-305, 1051-211 or equivalent) Class 4, Credit 4

LEARNING OUTCOMES/METHOD OF EVALUATION

- Ability to use basic digital image processing concepts to perform enhancements to grey-level data (HOMEWORK ASSIGNMENTS / EXAMS)
- Ability to use the IDL environment as an interactive problem solving tool and visualization system (HOMEWORK ASSIGNMENTS)

MEETING TIMES

Tuesday, Thursday / 2:00-3:50PM / Room 76:1230

READING MATERIALS

- Gonzalez, R.C. and R.E. Woods, Digital Image Processing, Second Edition, Prentice Hall, Upper Saddle River, New Jersey, 2002 (ISBN: 0-201-18075-8)

COURSE MECHANICS

60% Programming Assignments

10% Homework Assignments

15% Oral Examination 1

15% Oral Examination 2

TOPICAL OUTLINE

Digital Image Processing - Introduction

- Definition
- Topical areas to be covered
- Grey level quantization
 - Uniform
 - IGS

Image Acquisition Systems

- Types of systems
 - Single detector
 - Linear detector
 - Array detector
 - Color
 - Spectrometers
- Trade-offs between systems

Geometric Manipulation of Images

- Concept of image mapping
- Affine transforms
 - Rotation
 - Scale
 - Matrix representations
- Resampling
 - Nearest neighbor
 - Bilinear interpolation
 - Cubic convolution
- Image-to-image registration
 - Polynomial mapping functions
 - Linear least squares regression

Image Enhancement

- Lookup tables (LUT)
- Histograms as a descriptor

- Histogram equalization
- Histogram specification
- Histogram-based statistics

Spatial Filtering

- Mechanics
- Smoothing
- Order-statistics filters
 - Minimum
 - Midpoint
 - Maximum
 - Median
- Sharpening
 - First derivative
 - Second derivative
 - Conceptual approach
 - Laplacian operator
 - Unsharp masking
- Gradient
 - Roberts Cross
 - Sobel
 - Prewitt
 - Noise considerations

ORAL EXAMINATION 1

Point/Line Detection

- Cascaded operations
 - Smoothing
 - Laplacian
 - Grey-level thresholding
- Specific filters

Frequency Domain

- Review of complex number arithmetic
- Fourier series
- One-dimensional discrete Fourier transform
- Concept of physical dimensionality
- Two-dimensional Fourier transform
 - Computational tricks
- Amplitude and phase representations
 - Mathematical definition
 - Physical meaning
 - Phase dominance/substitution

Fast Fourier Transform

- Derivation
- "Butterfly" diagrams

Frequency Domain Filtering

- Convolution theorem
- Mechanics of filtering in the frequency domain
- Filter types
 - Notch
 - Lowpass
 - Highpass
- Filter shapes
 - Ideal
 - Gaussian
 - Butterworth
- Laplacian filtering in the frequency domain
- Composite Laplacian filtering
- High-boost filtering

ORAL EXAMINATION 2