Image Processing With Applications

Spring 2009, Math563/CSCI567

Instructor: Dr. Nikolay Metodiev Sirakov
Department of Computer Science and Information Systems
Department of Mathematics, TAMU-Commerce
Day and Time: T 7:20-10:00PM **Room:** STC 123
Meets 1/20/2008 through 5/15/2009

Please pay attention that a new edition is in use this semester

Text: Digital Image Processing, 3nd Edition, by Rafael C. Gonzalez, Richard E. Woods, Prentice Hull, 2008, 0-13-168728-x, 978-0-13-168728-8

A book which provides IP algorithms: Digital Image Processing Using Matlab, by Rafael C. Gonzalez, Richard E. Woods, Steven L. Eddins, Prentice Hull, 2004, ISBN 0-13-008519-7

Useful Image Analysis book, not a subject of study under this course: S.T. Acton, N. Ray, Biomedical Image Analysis: Tracking, Morgan and Claypool Publishers, 2006.

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URL: http://www.tamu-commerce.edu/coas/math/FACULTY/SIRAKOV/

OBJECTIVES:

Main Objective:

To develop the theoretical foundation of: Image enhancement in the spatial and frequency domains; Image Restoration; Transformation; to introduce the main practical fields; to teach students develop skips in working with image processing algorithms; to teach students develop and code image processing algorithms; to teach students write research reports and papers as well as to present them.

Objectives:

1. Classification of the areas in the field, introduction to the main definitions, problems and new technologies in the field. To teach students the main image processing modalities. Perception, presentation of digital images, methods for zooming;
2. To teach students the basic image transformation methods: arithmetic, logic, averaging, log, power, histogram processing;
3. To teach students about image statistics, convolution, smoothing, sharpening- using Laplacian, Gradient and their derivatives, Fuzzy logic;
4. To develop Frequency domain; 1D and 2D Fourier transforms, properties, Fast Fourier transform, inverse, main algorithm, Laplacian in frequency domain, The Convolution and Correlation Theorems;
5. To teach students about Filtering, sharpening unsharpening in the frequency domain;
6. To develop the foundations of Image Degradation/Restoration. Noise Modeling, Basic color models; color image processing and transformation;
7. Intro to wavelets: main definitions, functions, transforms and problems to solve.

As an additional activity (out of the course) for the interested and best prepared students an introduction may be given to the most recent Image Analysis methods as well as Image Databases, Features Extraction, Indexing and retrieval.

Requirements: *Integral and Differential Calculus of two variables;*
C++, Java or Computer algebra programming

List of Lectures

1. Intro to IP: Definitions, Main Problems, New Technologies, Imaging Modalities.
2. Visual Perception, Image Sensing and Acquisition.
3. Representing Digital Images. Zooming. Bilinear and Bi-cubic interpolations. Basic relationships, connectivity, regions and boundaries.
4. Arithmetic/Logic Operations: Image Subtraction; Image Averaging.
5. Transformations: Gray Level; Log; Power-Law; Piecewise-Linear.
6. Histograms: Processing; Equalization; Matching.
7. Local statistics for enhancement. Image averaging.
8. Spatial Filters. Convolution. Smoothing. Sharpening.
9. Use of Second Derivative for Image Enhancement – The Laplacian.
10. Use of First Derivative for Image Enhancement – The Gradient.
11. Fuzzy sets and membership functions to IP.
12. The 1D Fourier Transform and its Inverse.
13. The 2D Fourier Transform and its Inverse. Properties- shifting, periodicity.
14. Filtering in the Frequency Domain. Correspondence between Filtering in the Frequency and Spatial Domains.
15. Ideal, Butterworth, and Gaussian Lowpass Filters. Ideal, Butterworth, and Gaussian Highpass Filters.
16. The Laplacian in the Frequency Domain. Unsharp Masking.
17. Additional Properties of the 2D Fourier Transform. Computing the Inverse Fourier Transform using Forward Transform Algorithm.
18. The Convolution and Correlation Theorems.
19. The Fast Fourier Transform. Calculation complexity.
20. Image Degradation/Restoration. Noise Models. Restoration in the Presence of Noise. Filters.
21. Periodic Noise reduction by Frequency Domain Filtering.
22. Linear, Position-Invariant Degradation. Estimating the degradation function by Modeling.
23. Minimum Mean Square Error Filtering. Constrained Least Square Filtering.
24. Introduction to Color Image Processing. RGB Color Models. HIS Color Models. Converting colors from HIS to RGB. **New- RGBA model and alpha channel.**
25. Pseudo-color Image Processing.
26. Color transformations. Smoothing and Sharpening. Colors Segmentation.
27. Color Edge Detection. Noise in Color Images.
28. Wavelets. Image pyramids, Sub-band Coding and Haar Transform.
29. Scaling and Wavelet functions.

NOTE: Lectures 27 and 28 will be given upon time permission.
Some of the lectures will include Lab work, algorithms design and performing experiments with real images and existing software tools.

COURSE EVALUATION

Basis for Evaluation:

Mid Term Exam	- 22%
Final Exam	- 28%
HW	- 18%
Project	- 22%
Lab, and In class problems	- 10%

Grading Policy: ***A:*** 100%- 90%
B: 89% - 80%
C: 79% - 70%
D: 69% - 60%
F: Less than 59 %

The professor reserves the rights to reward students for continuous hard work.

Additional Activities: Experiments; Home Practice Problems**;** Extra Credit Problems

Final Test **Section:** Math563/CSCI567 **Date:** Tuesday, May 12,09 **Time:** 7:30PM-10PM

COURSE POLICIES

In-class activity: *Problems to be solved during the class period.*

HW: *large problems, which involve theoretical and practical skills above the average level. Some of the HW could be assigned as team works.*

Mid term comprehensive exam: *Is to be given around mid semester. It will take 2/3 of a class period.*

Makeup: *Except in the case of a formal institutional excuse, no individual makeup test will be permitted.*

Project (most likely group): *closed itself innovative problem, whose development includes: survey of the present state of the art; development of a theoretical model; numerical analysis of the implementation; algorithm design; and coding; performing experiments. and deriving conclusions.*

Students requesting accommodations for disabilities must go through the Academic Support Committee. For more information, please contact the Director of Disability Resources & Services, Halladay Student Services Bldg., Room 303D, 903 886 5835.

All students enrolled at the University shall follow the tents of common decency and acceptable behavior conducive to a positive learning environment (See Student's Guide Handbook, Polices and Procedures, Conduct).

Commerce, Texas
January 19.2009 **Dr. Nikolay Metodiev Sirakov**

Elaborated objectives and lectures' titles April 07, 2009