Image Processing With Applications

Spring 2013, Math563/489/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:** Bin 301
Meets 1/14/2013 through 5/10/2013

Text: Digital Image Processing, 3rd 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

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Student Learning Outcomes (SLO): Students will be able to learn, understand and perform Image enhancement applying mathematical methods in the spatial (1st 2nd derivatives, laplacian and the gradient) and frequency domains (Fourier transformations); Image Restoration; Transformation; the students will learn the fields of application; the students will develop skills for working with image processing (IP) algorithms and tools; the students will know how to develop and code IP algorithms; students will learn how to write research reports and papers as well as how to present them.

Objectives:

1. Classification of the areas in the field, problems and new technologies. To teach students the main IP modalities. Digital image formats, methods for zooming and their mathematical and computer science basis;
2. To teach students the basic image transformation methods: arithmetic, averaging, log, power, histogram processing, statistical, logic (including fuzzy logic);
3. To teach students about image statistics, correlation, convolution, smoothing, sharpening, Gradient and Laplacian operators, and derivatives for objects edge detection;
4. 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, ***automatic tracking objects in video, automatic human activities recognition in video.***

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

List of Lectures

1. Intro to IP: Definitions, Main Problems, Advanced Technologies, Imaging Modalities. Visual Perception, Image Sensing and Acquisition.
2. Representing Digital Images. Zooming. Bilinear and Bi-cubic interpolations. Basic relationships, connectivity, regions and boundaries.
3. Arithmetic/Logic Operations: Image Subtraction; Image Averaging.
4. Gray Level transformations: Log; Power-Law; Piecewise-Linear.
5. Histograms: Processing; Equalization; Matching.
6. Local statistics for enhancement. Image averaging.
7. Spatial Filters. Convolution, Correlation, Smoothing, Sharpening.
8. Use of Second Derivative for Image Enhancement – The Laplacian.
9. Use of First Derivative for Image Enhancement – The Gradient.
10. Fuzzy sets and membership functions to IP.
11. The 1D Fourier Transform and its Inverse.
12. The 2D Fourier Transform and their Inverse. Properties- shifting, periodicity.
13. Filtering in the Frequency Domain. Correspondence between Filtering in the Frequency and Spatial Domains.
14. Ideal, Butterworth, and Gaussian Lowpass and Highpass Filters.
15. The Laplacian in the Frequency Domain. Unsharpening Masking.
16. Additional Properties of the 2D Fourier Transform. Computing the Inverse Fourier Transform using Forward Transform Algorithm.
17. The Convolution and Correlation Theorems.
18. The Fast Fourier Transform. Calculation complexity.
19. Noise Models. Restoration in the Presence of Noise. Filters. Periodic noise reduction.
20. Minimum, Mean Square Error Filtering. Constrained Least Square Filtering.
21. Introduction to Color Image Processing. Color Models and conversion from one to another.
22. Pseudo-color Image Processing. Basics of full color image processing.
23. Wavelets. Image pyramids. Scaling and Wavelet functions.
24. The wavelet series expansion. The Discrete Wavelet Transform.

NOTE: Lectures 23 and 24 will be given upon time permission.
Some assignments will include Lab work, algorithms design and performing experiments with real images and existing software tools.

COURSE EVALUATION
Basis for Evaluation:

Mid Term Exam	- 24%
Final Exam (Project Presentation)	- 22%
HW	- 20%
Project	- 22%
Lab, and in class problems	- 12 %

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 **:** Math563/489CSCI567 **Date:** Tuesday - May 08	**Time:** 7:30PM-10PM

COURSE POLICIES

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

HW: *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 experiment 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).

The road that will lead you to find a good job is the road of learning and writing a very good project.

Commerce, Texas
January 11, 2013 **Dr. Nikolay Metodiev Sirakov**