Image Processing With Applications

Spring 2015, 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:** Bin 301
Meets 1/20/2015 through 5/15/2015

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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Additional by appointment

For class enhancement materials and lectures, please visit:

http://faculty.tamuc.edu/nsirakov/Teaching/Teaching_2014.html

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) Students will be able to recognize main definitions, metrics, image statistics, and new technologies in the field.
(2) Students will be able to utilize basic image transformation methods: arithmetic, geometric, order and local statistics, logic, averaging, log, power, histogram processing;
(3) Students will be able to utilize Image Enhancement Methods for smoothing/sharpening space domain: convolution, correlation, Laplacian, Gradient and their derivatives, Fuzzy logic.
(4) Students will be able to utilize Fourier transforms, properties, Fast Fourier transform, inverse, main algorithm, the Convolution and Correlation Theorems, Laplacian and low pass/high pass, band pass/band reject filters in frequency domain.
(5) Students will be able to utilize Image Degradation/Restoration, noise modeling, Basic color models; color image processing and transformation.
(6) Students will conduct independent project development, which encompasses: survey, theoretical work, coding, writing and presenting reports.
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.

Requirements: *Calculus of two variables;*
Any of the languages: C, C++, C#, Java, MathLab, Mathematica

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

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/CSCI567 **Date:** Tuesday - May 12	**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 19, 2015 **Dr. Nikolay Metodiev Sirakov**