



# ***Image Processing With Applications***

## **Spring 2018, Math563 cross-listed with CSCI567**

**Instructor:** Dr. Nikolay Metodiev Sirakov  
Department of Computer Science and Information Systems  
Department of Mathematics, TAMU-Commerce  
**Day and Time:** T 7:20-10:30PM    **Room:** Bin BA244  
**Meets 2/1/2018 through 5/11/2018**

**Instructor:** Dr. Nikolay Metodiev Sirakov  
**Office Hours:** M 4PM-5:30PM  
W 10AM-12AM  
F 10AM-11:30AM  
Additional by appointment

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**Text Book:** Digital Image Processing, 3<sup>rd</sup> Edition, by Rafael C. Gonzalez, Richard E. Woods, Prentice Hall, 2008, 0-13-168728-x, 978-0-13-168728-8

**A book which provides IP algorithms (not a text book):** Digital Image Processing Using Matlab, by Rafael C. Gonzalez, Richard E. Woods, Steven L. Eddins, Prentice Hall, 2004, ISBN 0-13-008519-7

**For class enhancement materials and lectures, please visit:**

<http://faculty.tamuc.edu/nsirakov/Teaching/Image%20Processing%20With%20Applications.aspx>

**Objectives:** Students will be able to learn, understand and perform Image enhancement applying mathematical methods in the spatial (1<sup>st</sup> 2<sup>nd</sup> 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.

### **Student Learning Outcomes (SLO):**

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

**Required Skills:** *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 Low-pass and High-pass Filters.
15. The Laplacian in the Frequency Domain. Un-sharpening 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.** Introduction to Color Image Processing. Color Models and conversion from one to another.
21. Pseudo-color Image Processing. Basics of full color image processing.

**Tentative Calendar:** *1<sup>st</sup> week*-Lectures 1 and 2; *2<sup>nd</sup> week*- Lectures 3 and 4; *3<sup>rd</sup> week*- Lecture 5; *4<sup>th</sup> & 5<sup>th</sup> weeks* - Lectures 5, 6 and 7; *6<sup>th</sup> and 7<sup>th</sup> weeks* - Lectures 8 and 9; *8<sup>th</sup> weeks* - Lectures 10 and 11; *9<sup>th</sup> week*- Lecture 12; *10<sup>th</sup> week*- Lectures 13 and 14; *11<sup>th</sup> week* - Lectures 15 and 16; *12<sup>th</sup>* – Lecture 17, Guides for writing report and designing a presentation; *13<sup>th</sup> week*- Lecture 18; *14<sup>th</sup> week*- Lectures 19, 20, 21; *15<sup>th</sup> week* – Giving back the report revisions, Lecture 20, Guides for writing report and designing a presentation.

## COURSE EVALUATION

### Basis for Evaluation:

Mid Term Exam	- 26%
HW	- 20%
Project	- 22%
Lab Work	- 12 %
Project Presentation and revision	- 20%

**Grading Policy:**

<b>A:</b>	100%- 90%
<b>B:</b>	89% - 80%
<b>C:</b>	79% - 70%
<b>D:</b>	69% - 60%
<b>F:</b>	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 8

**Time:** 7PM-9:30PM

## **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.*

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

**Lab Work** – conducting experiments with given software and images by the teacher. Short report will be required.

**Makeup:** *Except in the case of a formal institutional excuse, no individual makeup test or HW or Lab Work 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.*

**Cheating:** *test and quizzes results will be canceled in case of cheating, extra credit grades may be taken off as well.*

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**Office of Student Disability Resources and Services; Texas A&M University-Commerce; Halladay Student Services Building; Room 132 A/D; Phone (903) 886-5150 or (903) 886-5835; Fax (903) 468-8148**  
[StudentDisabilityServices@tamuc.edu](mailto:StudentDisabilityServices@tamuc.edu)

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<http://www.tamuc.edu/aboutUs/policiesProceduresStandardsStatements/rulesProcedures/34SafetyOfEmployeesAndStudents/34.06.02.R1.pdf> *and/or consult your event organizer). Pursuant to PC 46.035, the open carrying of handguns is prohibited on all TAMUC campuses. Report violations to the University Police Department at 903-886-5868 or 9-1-1.*

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**The road that will lead you to find a good job is the road of coding, learning, developing and writing a very good project/report.**

Commerce, Texas  
December 14, 2017

**Dr. Nikolay Metodiev Sirakov**