CS659 - IMAGE PROCESSING AND ANALYSIS
Spring 2023

INSTRUCTOR: Dr. Frank Y. Shih
Office: Room 4205, GITC Building
Office hours: Thursday 1:00~2:30 pm. In addition, you can see me by appointment or send me an e-mail (shih@njit.edu).
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WebEx Virtual Classroom: **https://njit.webex.com/meet/shih**

COURSE DESCRIPTION:

This course is an intensive study of image processing, analysis, understanding, and applications. Topics to be covered include: mathematical tools, human visual perception, image enhancement, restoration, image geometric transformation, matching, segmentation, feature extraction, representation and description, pattern recognition and interpretation, digital watermarking and steganography, face image recognition, document image analysis, solar image processing, and so on.

COURSE OBJECTIVES

The objectives of this course include:
1. Cover the fundamental theory and algorithms that are widely used in image processing and analysis
2. Expose students to current technologies and applications related to image processing
3. Develop hands-on experiences using computers to process images
4. Familiarize with MATLAB or Python image processing toolboxes
5. Develop creative thinking on solving problems of image processing

GRADING:

Homework (20%), Exam 1 (20%), Exam 2 (20%), Paper 1 (20%), Paper 2 (20%)

A. The course schedule (subject to change):

2/2, 11:00PM: Homework 1 Due (Lecture 1, 2, 3, 4)
2/16, 11:00PM: Homework 2 Due (Lectures 5, 6, 7, 8)
2/23, Exam 1, (Section 002 in-classroom 2:30~4:30pm; Section 852 online 7~11pm)
3/2, Oral Presentation of Research Paper 1, (Section 002 in-classroom 2:30~5:20pm; Section 852 online 7~10pm)
3/5, 11:00PM, Research Paper 1 Due
3/23, 11:00PM: Homework 3 Due (Lectures 9, 10, 11, 12, 13)
4/6, 11:00PM: Homework 4 Due (Lectures 14, 15, 16, 17, 18, 19, 20)

4/13, Exam 2, (Section 002 in-classroom 2:30~4:30pm; Section 852 online 7~11pm)
4/27, Oral Presentation of Research Paper 2, (Section 002 in-classroom 2:30~5:20pm; Section 852 online 7~10pm)
5/2, 11:00PM: Research Paper 2 Due

B. Lecture-3rd Edition Book Correspondance

Notes	Textbook1
Lecture 1	Ch 1
Lecture 2	Ch 2
Lecture 3	Ch 4, pp. 199-254
Lecture 4	Ch 3
Lecture 5	Ch 4, pp. 255-310
Lecture 6	Supplement
Lecture 7	Ch 10 & Supplement
Lecture 8	Ch 11 & Supplement
Lecture 9	Ch 9 & Supplement
Lecture 10	Ch 12, pp. 861-882
Lecture 11	Ch 12, pp. 882-902
Lecture 12	Ch 12, pp. 903-906 & Supplement
Lecture 13~20	Supplement

The following programming languages are allowed: Matlab, Python, C++, and Java.
There will be a total of 100 points. For your reference, the grade assign is based on the following criterion; however, the real grade can be adjusted lower or higher based on the overall class scores distribution.

A: 85 – 100 points
B+: 75 – 84 points
B: 65 – 74 points
C+: 55 – 64 points
C: 45 – 54 points
D: 40 – 44 points
F: 0 – 39 points

COURSE WEBSITE:

This course adopts "Canvas" for homework submission. Please submit your homework solution in Microsoft Word format to **https://njit.instructure.com** before each deadline. Absolutely, no late submission is accepted. Write the answers in your own words individually. Any plagiarism will cause a "FAIL" grade and report to Dean of Students.

The course lecture and power-point files are available free of charge through NJIT website at **https://njit.instructure.com**.

TEXTBOOKS:

1. R. Gonzalez and R. Woods, *Digital Image Processing*, Pearson Education, fourth edition, 2018, ISBN 9780133356724.
2. F. Y. Shih, *Image Processing and Pattern Recognition: Fundamentals and Techniques*, Wiley-IEEE Press, ISBN 0-470-40461-2, 2010.

REFERENCE BOOKS:

1. A. McAndrew, *Introduction to Digital Image Processing with Matlab*, Thomson Course Technology, 2004.
2. F. Y. Shih, *Digital Watermarking and Steganography: Fundamentals and Techniques*, Taylor & Francis Group, CRC Press, Boca Raton, FL, ISBN 1-4200-4757-4, 2008.
3. F. Y. Shih, *Image Processing and Mathematical Morphology: Fundamentals and Applications*, Taylor & Francis Group, CRC Press, Boca Raton, FL, ISBN 1-4200-8943-9, 2009.
4. F. Y. Shih (Editor), *Multimedia Security: Watermarking, Steganography, and Forensics*, CRC Press, Boca Raton, FL, 2013, ISBN: 978-1-4398-7331-1.

COURSE CONTENT:

LECTURE 1. INTRODUCTION
LECTURE 2. DIGITAL IMAGE FUNDAMENTALS
LECTURE 3. IMAGE TRANSFORMS
LECTURE 4. IMAGE ENHANCEMENT IN THE SPATIAL DOMAIN
LECTURE 5. IMAGE ENHANCEMENT IN THE FREQUENCY DOMAIN
LECTURE 6. IMAGE MATCHING
LECTURE 7. IMAGE SEGMENTATION
LECTURE 8. MATHEMATICAL MORPHOLOGY
LECTURE 9. IMAGE REPRESENTATION
LECTURE 10. FEATURE EXTRACTION
LECTURE 11. MINIMUM DISTANCE CLASSIFIER
LECTURE 12. NEURAL NETWORKS CLASSIFIER
LECTURE 13. SYNTACTIC PATTERN CLASSIFIER
LECTURE 14. FUZZY CLASSIFIER
LECTURE 15. DIGITAL WATERMARKING
LECTURE 16. WATERMARKING ATTACKS AND TOOLS
LECTURE 17. DIGITAL STEGANOGRAPHY
LECTURE 18. FACE IMAGE PROCESSING AND ANALYSIS
LECTURE 19. DOCUMENT IMAGE PROCESSING AND CLASSIFICATION
LECTURE 20. SOLAR IMAGE PROCESSING AND ANALYSIS

Academic Honor Code

The NJIT academic honor code (http://www.njit.edu/academics/honorcode.php)applies in full to

this class. Note in particular that copying programs, in full or in part, is forbidden. You may discuss ideas and concepts with your fellow students, but you may NOT copy any code.