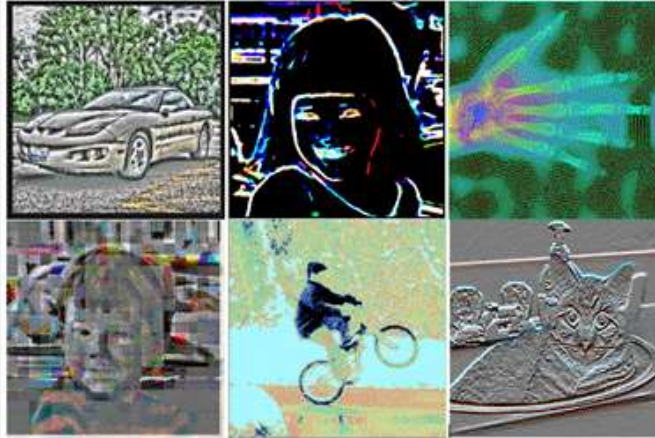


ECE 439 DIGITAL IMAGE PROCESSING SYLLABUS



Professor: [Dr. Scott E Umbaugh](#) **Office:** Engineering Building, Room EB3037

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Textbook: [DIPA: Digital Image Enhancement, Restoration and Compression, 4th Edition](#), SE Umbaugh, Taylor&Francis/CRC Press, 2023; Supplementary documents are available at the publisher's web site as [Support Material](#)

Prerequisite: ECE 351 and programming experience, or consent of instructor

Class Format: Two lectures and 1 lab per week, two tests, and term project

Web Site Imaging Examples: [CVIPtools Imaging Examples](#)

Goals and Objectives: Introduce the student to analytical tools and methods which are currently used in digital image processing as applied to image information for human viewing. Then apply these tools in the laboratory in image enhancement, image restoration and an introduction to image compression.

COURSE OUTLINE

- Image Sensing and Representation, 2 Lectures, Chapter 1
- Image Processing Development tools, CVIPlab, 2 Lectures, Chapter 2
- Human Visual Perception, 2 Lectures, Chapter 3
- Discrete Transforms, 4 Lectures, Chapter 4
- Transform and Spatial Filters, Wavelet transform, 2 Lectures, Chapter 5

TEST #1

- Image Enhancement, 5 Lectures, Chapter 6

- Image Restoration, 6 Lectures, Chapter 7
- Image Compression, 2 Lectures, Chapter 8

TEST #2

PROJECT DUE -- 16th week

GRADING: Test #1 - 25%, Test #2 - 25%, Lab Exercises - 25%, Project - 25%

HOMEWORK is not collected, but it is highly recommended to work through the problems, as many test problems are based on the homework. The Solutions Manual is available below with the lecture slides.

ECE 439 LECTURE SCHEDULE

WEEK	TOPICS	READING	HOMEWORK & LAB
1	Overview, Computer imaging systems	Chapter 1 Chapter 2	Chap 1: 1-4,7,20,22-25,29,30 Chap 2: Programming: Introduction to CVIPlab
2	Image analysis, preprocessing, CVIPlab	Chapter 2 Chapter 3	Chap 2: Programming: Introduction to CVIPlab Chap 3:1-9
3	Human visual system, image model	Chapter 3	Chap 3:11-16,18,19,23,25,26,28 Program: Objective Fidelity Measures
4	Discrete transforms, Fourier	Chapter4: Sections 4.1, 4.2	Chap 4: 1-11, 19 Suppl Exercises: 1,2 Program: Fourier transform
5	discrete cosine, Walsh-Hadamard, Haar, PCT, filtering	Chapter 4: Sections 4.3-4.8 Chapter 5: Sections 5.1,5.2,5.3	Chap 4: 12-16,18,20,21; Supplementary Exercises: 3,4,5 Program: Ideal Filters
6	filtering, wavelet transform, Intro image enhancement	Chapter 5: Sections 5.4-5.8 Chapter 6: Section 6.1,6.2.1	Chap 5: 1-15, Suppl Exercises: 1,4,5 Chap 6: 1-7,9,10
7	Review and TEST #1, Study Guide, 439SAMPLEtst1.docx , Sample Test KEY		

8	Image enhancement, gray scale mods, histogram mod, pseudocolor	Chapter 6: Section 6.2	Chap 6:11-14,16,18,20-24 Programing (Chap 5): Lowpass and Highpass spatial Filters
9	Image enhancement, sharpening, smoothing	Chapter 6: Sections 6.3, 6.4 6.5	Chap 6: 30-42, Suppl Exer: 2,4 Program: Unsharp masking
10	Image restoration, overview, system model, noise removal: order filters	Chapter 7: Sections 7.1, 7.2, 7.3.1 Project: Chap2, Section 2.7	Chap. 7: 1-10
11	Image restoration: noise removal: mean & adaptive filters, degradation model, inverse filter <i>Project Proposal Due Must be approved by Professor</i>	Chapter 7: Sections, 7.3.2, 7.3.3, 7.4, 7.5.1	Chap 7: 11-18, Suppl Exer: 1,3 Project
12	Freq. filters, geometric transforms	Chapter 7: Sections 7.5.2, 7.5.3, 7.5.4, 7.5.4, 7.5.7, 7.6	Chap 7: 19,20,21,23,27,28,33 Project
13	image compression: system model, lossless methods	Chapter 8: Sections 8.1, 8.2.1, 8.2.2	Chap 8: 1-7,10-14 Project
14	Lossy/JPEG; Work on project, Oral Presentations.pptx	Section 8.3: pages 413-414, 439-443 (JPEG)	Project
15	<i>Review and TEST #2</i> , Study Guide , 439SAMPLEtst2.docx , Sample Test Key		Project
16	Presentation of term project to class, professor and TA <i>Project Paper Due</i>		

ECE 439 Digital Image Processing PowerPoint Lecture Slides

[Chapter1_IERC_Ed4](#)

[Chapter2_IERC_Ed4](#)

[Chapter3_IERC_Ed4](#)

[Chapter4_IERC_Ed4](#)

[Chapter5_IERC_Ed4](#)

[Chapter6_IERC_Ed4](#)

[Chapter7_IERC_Ed4](#)

[Chapter8_IERC_Ed4](#)

[Homework_Lab_Solutions_Manual](#)

ECE 439 [Digital Image Processing Lab](#) Outline

- Students will work in pairs, with a partner of their choice. Labs can be performed using CVIPlab in either C or Matlab
- Labs are due on Friday by noon, on weeks 5 and 10; Late lab work is worth 50% up until 2 days late, after that it is worth 10%
- Useful document for those familiar with C++, but not C programming: [C for C++ Programmers.htm](#)

Weeks	TOPICS - reading: Chapter 2, <u>CVIPtools</u>
1-5	Chapter 2: Introduction to CVIPlab. <u>Lab1_C</u> or <u>Lab1_Matlab</u> Chapter 3: Objective Fidelity Measures, RMS error and Peak SNR (p. 125) <i>Extra credit:</i> Root-mean-square SNR Chapter 4: Fourier Transform (p.172). <i>Extra credit:</i> supplemental Fourier Transform (p. 173)
6-10	Chapter 5: Ideal Filters, lowpass and highpass with FFT (p. 207), <i>Extra credit:</i> DCT, bandpass filter Chapter 6: Unsharp masking (p. 291)
11-15	Term project, see section 2.7, pp. 84-85 for ideas <ul style="list-style-type: none">• Create project proposal• Run experiments and analyze results• Write report and develop presentation/demo
16	Present project to the class

ECE 439 Digital Image Processing - Semester Project

Semester Project: The project will consist of designing experiments, implementing algorithms, and analyzing the results for an image processing problem. You will work with a partner. The project will be selected by the students, ***subject to approval by the professor***. The proposal, due week 11, will include: 1) topic, 2) algorithms to be explored, 3) number and type of images to be used, 4) method of evaluation of results

A paper will be written describing the project and discussing what was learned during the project. The final paper should be *about* 10 to 15 pages, typed and double-spaced; include images ! In the paper include an appendix containing program listing(s). The students will give a **5 minute** presentation of their project in the lab to the class, the professor, and the lab instructor. ***Do NOT go over 5 minutes and do not have more than 10 PowerPoint slides!*** Also, an [evaluation](#) for each group member will be handed in or emailed with the report.

- You do NOT need to hand in a paper copy of the report, *email me a soft copy of the Word file*. Before you send the file ***give it a meaningful name that includes your last name(s) and the project title***.

Grading: The project is worth 25% of your term grade, broken down as follows:

- Overall Project.. 15%
- Paper..... 5%
- Presentation..... 5%

Suggested Project Process:

- 1) Find an area of interest from the lab or from class; see Section 2.7 in textbook for project ideas.
 - 2) Design experiment(s) you wish to pursue
 - 3) Design algorithms/C function(s)/Matlab code to implement related to project
 - 4) Code and debug your function(s), or use CVIPtools
 - 5) Test your functions on some real images
 - 6) Process images/do the experiments
 - 7) Compare and contrast your results to other similar results from using CVIPtools functions, or research results in library from similar experiments - Analyze results using appropriate metrics, tabulate or plot, etc. Use the objective and subjective fidelity measures in Chapter 2 to compare images. Design your subjective measure experiments carefully as outlined in Chapter 2.
 - 8) Write report, include images
 - 9) Present/demo to the class
- NOTE: If you do not have any specific images that you want to use, take a look at the image databases on the Internet, such as: [DIP Image Databases](#) ; <http://www.imagescience.org/>

Project Paper Format Outline

- 1. Title page (project title, names, course number, date, etc.)
- 2. Table of contents with page numbers for: different sections, figures, appendices, etc.
- 3. Abstract - 1 page or less. Concise description of what is contained in the paper.
- 4. Introduction/Project overview
- 5. Body of paper. Broken down into sections as required for you project. For example: Background/theory, experimental methods, discussion and analysis of results, program descriptions, etc. Present results using graphs, images, etc.,
- 6. Summary and conclusions. Summarize any results and draw conclusions as based on these results.

- 7. Suggestions for future work. Include any ideas you have based on your work and conclusions about follow-up experiments and/or research.
- 8. References. Be sure your references are complete. Avoid web sites as references – these come and go – find the source, which is usually a published paper.
- 9. Appendices - related background information, program listings, etc.

General: reports should be typed, double spaced, pages numbered starting with abstract. Number of pages?- do what is necessary, but keep it concise, extra stuff can go in an appendix. DO NOT put in plastic folder, simply staple in upper left hand corner.

Class Attendance Policy: Based on University Class Attendance Policy 119: It is the responsibility of students to ascertain the policies of instructors with regard to absence from class, and to make arrangements satisfactory to instructors with regard to missed course work. Failure to attend the first session of a course may result in the student's place in class being assigned to another student.

Class Policies: If you have a documented disability that requires academic accommodations, please go to Disability Support Services for coordination of your academic accommodations. DSS is located in the Student Success Center, Room 1270; you may contact them to make an appointment by calling (618) 650-3726 or sending an email to disabilitysupport@siue.edu. Please visit the DSS website located online at: www.siue.edu/dss for more information. Students are expected to be familiar with and follow the Student Academic Code. It is included in the SIUE Policies and Procedures under Section 3C2.2.

Brief Bibliography

Books

- 1. Digital Image Processing - R.C.Gonzalez & P.Wintz
- 2. Robot Vision - B.K.P.Horn
- 3. Computer Vision - D.H.Ballard & C.M.Brown
- 4. Syntactic Pattern Recognition : An introduction -R.C.Gonzalez and M.G.Thomason
- 5. Pattern Recognition - A Statistical Approach - P.A. Devijver and J. Kittler
- 6. Digital Image Processing - W. K. Pratt
- 7. Fundamentals of Digital Image Processing - A.K. Jain
- 8. Digital Picture Processing - A. Rosenfeld and A.C. Kak
- 9. Pattern Classification and Scene Analysis - R.O. Duda and P.E. Hart
- 10. Object Recognition by Computer - W.E.L. Grimson
- 11. Digital Pictures - A.N. Netravali and B.G. Haskell
- 12. Vision in Man and Machine - M.D. Levine
- 13. Pattern Recognition Statistical, Structural and Neural Approaches, R.J Schalkoff, John Wiley & Sons NY
- 14. Digital Image Processing and Computer Vision, R.J. Schalkoff, Wiley
- 15. Artificial Intelligence: An Engineering Approach, R.J. Schalkoff, McGraw-Hill
- 16. Algorithms for Graphics and Image Processing, Theo Pavlidis, Computer Science Press, call no.: T385.P381982
- 17. Handbook of Pattern Recognition and Image Processing, K.S. Fu and T.Y. Young, Academic Press
- 18. The Image Processing Handbook, John C. Russ, CRC Press SIUE Library call #: TA1632.R881992 (reference)

Journals

- 1. IEEE Transactions on Pattern Analysis and Machine Intelligence
- 2. IEEE Transactions on Computers

- 3. Pattern Recognition
- 4. Computer Vision, Graphics and Image Processing
- 5. IEEE Transactions on Medical Imaging
- 6. Computerized Medical Imaging and Graphics
- 7. IEEE Transactions on Image Processing
- 8. IEEE Engineering in Medicine and Biology
- 9. IEEE Transactions on Signal Processing
- 10. IEEE Transactions on Neural Networks
- 11. IEEE Transactions on Geoscience and Remote Sensing
- 12. Photogrammetric Engineering and Remote Sensing
- 13. International Journal of Remote Sensing
- 14. Journal of Visual Communication and Image Representation

Numerous Conference Proceedings from the following professional groups:

- IEEE - Institute of Electrical and Electronic Engineers
- SPIE - Society of Photographic and Instrumentation Engineers, The International Society for Optical Engineering
- SMPTE - The Society of Motion Picture and Television Engineers
- PRS - Pattern Recognition Society