GINA CODY
SCHOOL OF ENGINEERING
AND COMPUTER SCIENCE

COMP 478/6771
Image Processing
Department of Computer Science and Software Engineering
Fall 2023

Course Instructor: *Dr Yiming Xiao*
Email: yiming.xiao@concordia.ca

Office Hours: *Thursday, 16:00 –17:00 at ER 953 (2155 Rue Guy)*

Tutorials: N/A

Labs: COMP 478/6771 DDDI: Tuesday 20:30 – 22:00
COMP 478/6771 DDDJ: Tuesday 20:30 – 22:00

Lab Demonstrators:
Soorena Salari (soorena.salari374@gmail.com)
Kiana Nezami (nezami.kiana@gmail.com)

Course Calendar Description:

Digital image fundamentals, image transforms (Fourier, Walsh, Haar, Hotelling, wavelet), image enhancement (histogram processing, spatial filtering, high- and low-pass filtering), image restoration, image compression (elements of information theory, image compression models, error-free compression, lossy compression), image segmentation (line detection, Hough transform, edge detection and linking, thresholding, region splitting and merging), representation and description (skeletons, shape descriptors, moments, texture).

Prerequisites: N/A
Co-requisites: N/A

Specific Knowledge and Skills Needed for this Course:
Students taking this course are expected to have sufficient knowledge of the following topics. Should you have difficulties in any of these topics, you are strongly encouraged to review them before the DNE deadline.

- *Probability distributions (Histogram, PDF, and CDF)*
- *Fourier Transform*

Course materials
Required Textbook: *Digital Image Processing, 4th Edition, by R. C. Gonzalez, R. E. Woods, Prentice Hall.*
Other course materials: *all materials will be made available on Moodle.*

Grading Scheme

Assessment Tool	Weight
4 assignments (each assignment is worth 5%)	20%
Midterm exam	20%
Final project	30%
Final exam	30%
Total	100%

Passing Criteria:

- Assignments are due strictly on the due date. No submissions will be accepted three days after the due date; and in that period there is a penalty of 30% for each day late.
- If plagiarism is detected for any assignment, project, and exams, a grade of zero will be given.

Tentative Course Schedule

Lecture time: *Tuesday 2:45 pm ~ 5:30 pm*
Lecture location: *LS 205 SGW*

Week	Topic
Week 1 (Sep 5 ~ Sep 10)	*Introduction to Image processing*
Week 2 (Sep 11 ~ Sep 17)	*Review of matrix, vectors, probability theory, and linear system*
Week 3 (Sep 18 ~ Sep 24)	*Image enhancement I: pixel-wise operation* *Assignment 1 (due Oct 3)*
Week 4 (Sep 25 ~ Oct 1)	*Image enhancement II: image filtering*
Week 5 (Oct 2 ~ Oct 8)	*Image transformation in 2D: Fourier transformation* *Assignment 2 (due Oct 17)* *Course project announcement*
Week 6 (Oct 9 ~ Oct 15)	*Thanksgiving & mid-term break*
Week 7 (Oct 16 ~ Oct 22)	*Filtering in frequency domain: homomorphic filtering, image reconstruction*
Week 8 (Oct 23 ~ Oct 29)	*Midterm Exam*
Week 9 (Oct 30 ~ Nov 5)	*Image restoration: Denoising, sharpening, deblurring* *Assignment 3 (due Nov 14)*
Week 10 (Nov 6 ~ Nov 12)	*Edge detection*
Week 11 (Nov 13 ~ Nov 19)	*Hough transformation, edge, Otsu's method* *Assignment 4 (due Dec 5)*
Week 12 (Nov 20 ~ Nov 26)	*Morphological operations*
Week 13 (Nov 27 ~ Dec 3)	*Wavelet transformation*

Lab Details

During each lab section, lab instructors will demonstrate the algorithms and MATLAB software tools that are relevant to the learning materials from the lecture of the week. The lab manuals will be made available on the course Moodle page each week.

Week	Topic
Week 1 (Sep 5 ~ Sep 10)	*Introduction to MATLAB*
Week 2 (Sep 11 ~ Sep 17)	*Introduction to MATLAB image processing toolbox*
Week 3 (Sep 18 ~ Sep 24)	*Image manipulation and histogram operation; spatial filtering (smoothing)*
Week 4 (Sep 25 ~ Oct 1)	*Spatial filtering (sharpening and edge detection)*
Week 5 (Oct 2 ~ Oct 8)	*Fourier transformation*
Week 6 (Oct 9 ~ Oct 15)	*Thanksgiving & mid-term break*
Week 7 (Oct 16 ~ Oct 22)	*Frequency domain filtering*
Week 8 (Oct 23 ~ Oct 29)	*Review & exercise*
Week 9 (Oct 30 ~ Nov 5)	*Image restoration*
Week 10 (Nov 6 ~ Nov 12)	*Edge detection*
Week 11 (Nov 13 ~ Nov 19)	*Edge and line detection*
Week 12 (Nov 20 ~ Nov 26)	*Hough transform and morphological operation*
Week 13 (Nov 27 ~ Dec 3)	*Wavelet transformation*

Engineering Tools

The class materials and tutorials will use MATLAB with the associated Image Processing Toolbox, Signal Processing Toolbox, and Wavelet Toolbox. However, for the assignments and projects, the students are welcome to use any software libraries that have the same functionalities as the mentioned MATLAB toolboxes.

Details on assessment tools

- **Assignments:**
  There will be four assignments in total. Students must complete their own assignments. Each assignment will be made of a theoretical component and a programming component.

- **Midterm & Final exam:**
  The midterm and final exams will be closed-book exams. More details will be announced in class.

- **Project description:**
  This course includes a final project. The students can form a group of two to complete the project although individual project is preferred. The details of the project will be provided in Week 5.

Other information

Markers for the course
Bahar Jahani (baharjahani98@gmail.com)
Arash Harirpoush (aharirpoosh@gmail.com)
Christopher Neves (christopher.neves@hotmail.ca)

You are responsible for frequently checking the course webpage to obtain new information and assignments on Moodle. You are encouraged to discuss homework assignments with other students, and of course with the TAs. However, you must do each assignment by yourself. Academic honesty requires you to adhere to this policy. Also note that there is no relationship between the total numerical marks and the final letter

grades. In the event of extraordinary circumstances beyond the University's control, the content and/or evaluation scheme in this course is subject to change.

Graduate Attributes:

The following is the list of graduate attributes (skills) that students use, learn and/or apply throughout the term.

Graduate attribute	Indicator	Level of coverage
Knowledge base for engineering	• Digital image fundamentals, image transforms (Fourier, Haar, wavelet) • Image enhancement (histogram processing, spatial filtering, high- and low-pass filtering) • Image restoration • Image segmentation (line detection, Hough transform, edge detection and linking, thresholding) • Image representation and feature description	Intermediate/Advanced
Problem analysis	• Problem identification and formulation • Problem solving • Analysis	Intermediate
Use of engineering tools	• Use of Engineering tools: Use of image processing software and libraries.	Intermediate
Individual and teamwork	• Cooperation and work ethics • Initiative and leadership • Delivery results	Intermediate

Course Learning Outcomes (CLOs):

By the end of this semester, students are expected to master the following computer science and software engineering concepts.

Course learning outcomes	Related graduate attributes
Knowledge base of mathematics (matrix operations, probability and statistics, numerical solutions, regression, sets and relations)	• Knowledge base for engineering
Knowledge base in a specific domain (image processing and its applications)	• Knowledge base for engineering • Problem analysis
Ability to use appropriate tools, techniques and resources (use image processing software and libraries)	• Knowledge base for engineering • Use of engineering tools

Ability to select appropriate tools, techniques, and resources	• Use of engineering tools • Problem analysis
Awareness of limitations of tools, ability to create and extend tools as necessary	• Knowledge base for engineering • Problem analysis • Use of engineering tools
Supporting softwares: MATLAB, Image Processing Toolbox, Signal Processing Toolbox, Wavelet Toolbox	• Use of engineering tools

Health and Safety Guidelines

All health and safety rules specific to this course can be found in the lab manual. General health and safety instructions and available health and safety trainings can be found at:
Safety Programs - Concordia University (https://www.concordia.ca/campus-life/safety/general-safety.html)

On Campus Resources

Please visit Student services at Concordia University for the services available Gina Cody School students.