THE UNIVERSITY OF WINNIPEG

APPLIED COMPUTER SCIENCE

Course Number: **GACS-7205-001**
Course Name: **Digital Image Processing**
Course Webpage: https://www.acs.uwinnipeg.ca/liu-qi/GACS7025DIP.html

Instructor Information

Instructor: Qian Liu
E-mail: qi.liu@uwinnipeg.ca
Office Hours: Thursdays   1:00 - 2:00 pm   3C07

Class meeting time: Monday/Wednesday   4:00 - 5:15 pm   3C13

Important Dates

1. First Class: Wednesday, September 6, 2023
2. No Class (Reading Week):   Wednesday, October 11, 2023
3. Project Proposal Presentation Day: Monday, October 23, 2023
4. Final Withdrawal Date w/o academic penalty*:   Monday, November 13, 2023
5. Last Class: Wednesday, November 29, 2023
6. Project Presentation Day: Monday, December 11, 2023
7. University closures: Truth and Reconciliation Day   Saturday, September 30, 2023
                           Thanksgiving   Monday, October 9, 2023
                           Remembrance Day   Saturday, November 11, 2023

*A minimum of 20% of the work on which the final grade is based will be evaluated and available to the student before the voluntary withdrawal date.

Course Objectives / Learning Outcomes

This course offers students a comprehensive exploration of Digital Image Processing and its practical applications. Image processing is extensively employed in both our daily lives and a multitude of research domains, encompassing areas such as healthcare, geography, environmental science, and digital agriculture, among others. The curriculum delves into the core principles of visual perception and image acquisition, essential methods for image manipulation, segmentation, coding, and introduces the basics of Computer Vision. By

successfully completing the course, students will acquire the capability to conduct image manipulations and analyses across diverse fields.

Computer system administrator

The system administrator:

Mr. Nischal Ghorasaini (n.ghorasaini@uwinnipeg.ca).

Evaluation Criteria

- Assignments (20%)
  - 2 assignments, worth 10% each.
  - All assignments are to be completed individually.
  - Individual due dates will be posted on course website.
  - Assignments will be accepted up to 1 day late with a 20% penalty.

- Project (60%)
  - The project aims to acquaint students with at least one practical application of image processing. It involves selecting a specific problem within the field of image processing and organizing it into a research proposal (within 3 pages). Then, conduct the proposed research by reviewing relevant literatures on the chosen topic, implementing a solution, and documenting the entire process into a comprehensive report (10-15 pages).
  - Project proposal (10%)
  - Project final report (50%)
  - Individual due dates will be posted on course website.
  - Proposal and report will be accepted up to 1 day late with a 20% penalty.

- Presentations (20%)
  1. Project proposal presentation (5%)
  2. Project final presentation (15%)

Students should contact the instructor as soon as possible if extenuating circumstances require missing a lab, assignment, test or examination. A medical certificate from a practicing physician may be required before any adjustments are considered.

Students with documented disabilities, temporary or chronic medical conditions, requiring academic accommodations for tests/exams (e.g., private space) or during lectures/laboratories (e.g., note-takers) are   encouraged to contact Accessibility Services (AS) at 204-786-9771 or accessibilityservices@uwinnipeg.ca to discuss appropriate options. All information about a student's disability or medical condition remains confidential. https://www.uwinnipeg.ca/accessibility-services.

Students may choose not to attend classes or write examinations on holy days of their religion, but they must notify their instructors at least two weeks in advance. Instructors will then provide opportunity for students to make up work examinations without penalty. A list of religious holidays can be found in the 2019-20 Undergraduate Academic Calendar online at http://uwinnipeg.ca/academics/calendar/docs/important-notes.pdf

Final Letter Grade Assignment

Historically, numerical percentages have been converted to letter grades using the following scale. However, instructors can deviate from these values based on pedagogical nuances of a particular class, and final grades are subject to approval by the Department Review Committee.

A+	90 – 100%	B+	75 – 79%	C	60 – 64%
A	85 – 89 %	B	70 – 74%	D	50 – 59%
A-	80 – 84%	C+	65 – 69%	F	below 50%

Required Text Book

- Digital Image Processing (Forth Edition) by R.C. Gonzalez and R.E. Woods (ISBN 978-0131687288)
- PDF version of Class Notes will be available on course website.

Prerequisite and Restriction Information

This course assumes that students have strong programming skill in MATLAB, and a working knowledge of Intermediate Calculus, Linear Algebra, basic estimation techniques, and some statistical topics on the level of introductory courses in Statistics.

Regulations, Policies, and Academic Integrity

Students are encouraged to familiarize themselves with the Academic Regulations and Policies found in the University Academic Calendar at:
https://uwinnipeg.ca/academics/calendar/docs/regulationsandpolicies.pdf
Particular attention should be given to subsections 8 (Student Discipline), 9 (Senate Appeals) and 10 (Grade Appeals).

Avoiding Academic Misconduct: Academic dishonesty is a very serious offense and will be dealt in accordance with the University's policies.

Detailed information can be found at the following:

- Academic Misconduct Policy and Procedures: https://www.uwinnipeg.ca/institutional-analysis/docs/policies/academic-misconduct-policy.pdf and

- https://www.uwinnipeg.ca/institutional-analysis/docs/policies/academic-misconduct-procedures.pdf
- About Academic Integrity and Misconduct, Resources and FAQs: https://library.uwinnipeg.ca/use-the-library/help-with-research/academic-integrity.html

Uploading essays and other assignments to essay vendor or trader sites (filesharing sites that are known providers of essays for use by others who submit them to instructors as their own work) involves "aiding and abetting" plagiarism. Students who do this can be charged with Academic Misconduct.

Academic Integrity and AI Text-generating Tools: Students must follow principles of academic integrity (e.g., honesty, respect, fairness, and responsibility) in their use of material obtained through AI text-generating tools (e.g., ChatGPT, Bing, Notion AI). If an instructor prohibits the use of AI tools in a course, students may face an allegation of academic misconduct if using them to do assignments. If AI tools are permitted, students must cite them. According to the MLA (https://style.mla.org/citing-generative-ai/), writers should
- cite a generative AI tool whenever you paraphrase, quote, or incorporate into your own work any content (whether text, image, data, or other) that was created by it
- acknowledge all functional uses of the tool (like editing your prose or translating words) in a note, your text, or another suitable location
- take care to vet the secondary sources it cites

If students are not sure whether or not they can use AI tools, they should ask their professors.

Non-academic misconduct: Students are expected to conduct themselves in a respectful manner on campus and in the learning environment irrespective of platform being used. Behaviour, communication, or acts that are inconsistent with a number of UW policies could be considered "non-academic" misconduct. More detailed information can be found here:

- Respectful Working and Learning Environment Policy https://www.uwinnipeg.ca/respect/respect-policy.html,
- Acceptable Use of Information Technology Policy https://www.uwinnipeg.ca/institutional-analysis/docs/policies/acceptable-use-of-information-technology-policy.pdf
- Non-Academic Misconduct Policy and Procedures: https://www.uwinnipeg.ca/institutional-analysis/docs/student-non-academic-misconduct-policy.pdf and https://www.uwinnipeg.ca/institutional-analysis/docs/student-non-academic-misconduct-procedures.pdf.

Copyright and Intellectual Property: Course materials are the property of the instructor who developed them. Examples of such materials are course outlines, assignment descriptions, lecture notes, test questions, and presentation slides—irrespective of format. Students who upload these materials to filesharing sites, or in any other way share these materials with others outside the class without prior permission of the instructor/presenter, are in violation of copyright law and University policy. Students must also seek prior permission of the instructor/presenter before, for example, photographing, recording, or taking screenshots of slides, presentations, lectures, and notes on the board. Students found to be in violation of an

instructor's intellectual property rights could face serious consequences pursuant to the Academic Misconduct or Non-Academic Misconduct Policy; such consequences could possibly involve legal sanction under the Copyright Policy: https://copyright.uwinnipeg.ca/basics/copyright-policy.html

Privacy

Students have rights in relation of the collecting of personal data the University of Winnipeg
- Student Privacy: https://www.uwinnipeg.ca/privacy/admissions-privacy-notice.html
- Zoom Privacy: https://www.uwinnipeg.ca/privacy/zoom-privacy-notice.html

Class Cancellation, Correspondence with Students and Withdrawing from Course

When it is necessary to cancel a class due to exceptional circumstances, the course instructor will make every effort to inform students via uwinnipeg email and Nexus.

Students are reminded that they have a responsibility to regularly check their uwinnipeg e-mail addresses to ensure timely receipt of correspondence from the University and/or the course instructor.

Please let course instructor know if you plan on withdrawing from the course. Note that withdrawing before the VW date does not necessarily result in a fee refund.

Topics to be covered (tentative)

1. Introduction to Digital Image Processing
2. Digital Image Fundamentals
   - Elements of Visual Perception
   - Light and the Electromagnetic Spectrum
   - Image Sensing and Acquisition
   - Image Sampling and Quantization
   - Some Basic Relationships between Pixels
   - An Introduction to the Mathematical Tools Used in Digital Image Processing
3. Intensity Transformations and Spatial Filtering
   - Some Basic Intensity Transformations
   - Histogram Processing
   - Fundamentals of Spatial Filtering
   - Smoothing Spatial Filters
   - Sharpening Spatial Filters
   - Combining Spatial Enhancement Methods
4. Filtering in the Frequency Domain
   - Preliminary Concepts
   - Sampling and the Fourier Transform of Sampled Functions

- ➢ The Discrete Fourier Transform of One Variable
- ➢ Extension to Functions of Two Variables
- ➢ Some Properties of the 2-D Discrete Fourier Transform
- ➢ The Basic of Filtering in the Frequency Domain
- ➢ Image Smoothing and Sharpening Using Frequency Domain Filters
- ➢ Selective Filtering
- ➢ Implementation

5. Image Restoration and Reconstruction
- ➢ A Model of the Image Degradation/Restoration Process
- ➢ Noise Models
- ➢ Restoration in the Presence of Noise Only – Spatial Filtering
- ➢ Periodic Noise Reduction by Frequency Domain Filtering
- ➢ Linear, Position-Invariant Degradations
- ➢ Estimating the Degradation Function
- ➢ Inverse Filtering
- ➢ Minimum Mean Squares Filtering
- ➢ Geometric Mean Filter
- ➢ Image Reconstruction from Projections

6. Advanced Topics in Digital Image Processing
- ➢ Image segmentation
- ➢ Feature extraction
- ➢ Deep Convolutional Neural Networks

Note that all topics listed may not be covered and can be offered in a different time order.