Western University
Faculty of Engineering
Department of Electrical & Computer Engineering

ECE9202b/ BME9519b/BIOPHYS 9519b

COURSE OUTLINE 2022-2023

DESCRIPTION

Digital image processing has various applications ranging from remote sensing and entertainment to medical applications. This course explores a few major areas of digital image processing at an advanced level, with a primary emphasis on medical applications. Topics covered include image segmentation, image registration, and other image processing operations using the Image Processing Toolbox in MATLAB and 3D Slicer. Examples will be presented to give students exposure to real-world applications.

PREREQUISITES

ECE 4445A or MEDBIO 4445A or ECE9201A or BME9509A or BIOPHYS9509A

ENROLLMENT RESTRICTIONS

Enrollment in this course is restricted to graduate students in Electrical & Computer Engineering, as well as any student that has obtained special permission to enroll in this course from the course instructor as well as the Graduate Chair (or equivalent) from the student's home program.

INSTRUCTOR: Dr. Yimin Yang

519-661-2111 ext. 87385, yimin.yang@uwo.ca
Consultation hours: Thursday from 9:30 am to 10:30 am at TEB 245

COURSE FORMAT

Face-to-face

Lecture days/times/locations:

- Thursday from 8:30 am to 9:30 am in Health Sciences Building, Room 11
- Friday from 11:30 am to 1:30 pm in Spencer Engineering Building, Room 1056

Required Textbook:

Gonzalez, R.C., & Woods, R.E. (2018). *Digital Image Processing*, 4th ed. Pearson.

Other Required References:

1. Class notes
2. Documentation on Matlab and the Image Processing Toolbox can be found on the Mathworks' Web site at https://www.mathworks.com/help/
3. Documentation on the 3D Slicer software can be found at https://www.slicer.org/

Evaluation

Course Component	Weight
Assignments	20%
Quizzes	30%
Final Examination	50%

To obtain a passing grade in the course, a mark of 50% or more must be achieved on the final examination as well as on the laboratory. A final examination or laboratory mark < 50% will result in a final course grade of 48% or less.

TOPICS

Week	Topics
Week 1	Introduction to course, Boundary preprocessing
Week 2	Boundary feature descriptors, Region feature descriptors
Week 3	Object recognition with prototype matching

Week 4-6	Deep Learning for object recognition
	    - Deep convolutional neural networks
	    - Deep autoencoders
	    - Transfer Learning, whole image features
	    - Deconvolutional layers for segmentation, object detection
	Image reconstruction and augmentation with deep autoencoders

Week 7	Reading Week
Feb. 16	Quiz 1 (no class)

Week 8	Basic Image Segmentation
	    - point, line, and edge detection
	    - region segmentation using clustering
	    - Gradient-based methods

Week 9	Image Segmentation with Deep Learning
Week 10-11	Morphological image processing
Mar. 16	Quiz 2 (no class)
Week 11-12	image registration, 3D image processing
Week 13	Case study, review

SPECIFC LEARNING OUTCOMES

Degree Level Expectation	Weight	Assessment Tools	Outcomes
Depth and breadth of knowledge	40%	• Assignments • Examinations	• Understanding of advanced concepts and theories • Awareness of important current problems in the field of study

			• Understanding of computational and/or empirical methodologies to solve related problems
Research & scholarship	20%	• Assignments • Examinations	• Ability to conduct critical evaluation of current advancements in the field of specialization • Ability to conduct coherent and thorough analyses of complex problems using established techniques/principles and judgment
Application of knowledge	30%	• Assignments • Examinations	• Ability to apply knowledge in a rational way to analyze a particular problem • Ability to use coherent approach to design a particular engineering system using existing design tools
Communication skills	5%	• Assignments • Examinations	• Ability to communicate (oral and/or written) ideas, issues, results and conclusions clearly and effectively
Awareness of limits of knowledge	5%	• Assignments	• Awareness of the need of assumptions in complex scientific analyses and their consequences • Understanding of the difference between theoretical and empirical approaches • Ability to acknowledge analytical limitation due to complexity of practical problems

Assignments:

Assignment	Distribution date	Due date
#1	Mon., Jan. 23, 2023	Mon., Feb. 6, 2023
#2	Mon., Feb. 6, 2023	Mon., Feb. 27, 2023
#3	Mon., Feb. 27, 2023	Mon., Mar. 13, 2023
#4	Mon., Mar. 13, 2023	Mon., Mar. 27, 2023

Students may work in groups of two (2). If so, one report can be submitted by each group. Most of the assignments will involve programming in MATLAB. All assignments will be distributed via OWL. All assignments are expected to be submitted via OWL by 11:55 pm on the due date. Each assignment is worth 5% of your overall grade.

Quizzes: There will be 2 quizzes to ensure that you are keeping up with the material being taught. They will each take place during the normal lecture hour. Each quiz will last 50 minutes. Quiz dates are as

follows:

- **Quiz #1:** Thursday, Feb. 16, 2023
- **Quiz #2:** Thursday, Mar. 16, 2023

All quizzes will be closed book. Only non-programmable calculators will be allowed.

Final Examination: The final examination will be take place during the regular examination period. The final examination will be closed book. Only non-programmable calculators will be allowed.

Late Submission Policy: Late assignments will be accepted up to 2 days past the stated due date, but a late penalty of 5% per day will be applied. Assignments will not be accepted more than 2 days past the due date.

Use of English: In accordance with Senate and Faculty Policy, students may be penalized up to 10% of the marks on all assignments, tests, and examinations for improper use of English. Additionally, poorly written work with the exception of the final examination may be returned without grading. If resubmission of the work is permitted, it may be graded with marks deducted for poor English and/or late submission.

Attendance: Any student who, in the opinion of the instructor, is absent too frequently from class, laboratory, or tutorial periods will be reported to the Dean (after due warning has been given). On the recommendation of the department, and with the permission of the Dean, the student will be debarred from taking the regular final examination in the course.

Absence Due to Illness or Other Circumstances: Students should immediately consult with the instructor or department Chair if they have any problems that could affect their performance in the course. Where appropriate, the problems should be documented (see the attached "Instructions for Students Unable to Write Tests or Examinations or Submit Assignments as Scheduled"). The student should seek advice from the instructor or department Chair regarding how best to deal with the problem. Failure to notify the instructor or department Chair immediately (or as soon as possible thereafter) will have a negative effect on any appeal.

For more information concerning medical accommodations, see the relevant section of the Academic Handbook: http://www.uwo.ca/univsec/pdf/academic_policies/appeals/accommodation_medical.pdf

For more information concerning accommodations for religious holidays, see the relevant section of the Academic Handbook:

http://www.uwo.ca/univsec/pdf/academic_policies/appeals/accommodation_religious.pdf

Missed Quizzes: If a student misses a quiz, she or he must follow the Instructions for Students Unable to Write Tests and provide documentation to Undergraduate Services Office within 24 hours of the missed quiz. If accommodation is granted, the department will decide whether to provide a make-up quiz or allow reweighting of the quiz, where reweighting means the marks normally allotted for the quiz will be added to the final exam. If no reasonable justification for missing the quiz can be found, then the student will receive a mark of zero for the quiz.

If a student is going to miss the quiz for religious reasons, they must inform the instructor in writing

within 48 hours of the announcement of the quiz date or they will be required to write the quiz.

Course Delivery with Respect to the COVID-19 Pandemic: Although the intent is for this course to be delivered in-person, the changing COVID-19 landscape may necessitate some or all of the course to be delivered online, either synchronously (i.e., at the times indicated in the timetable) or asynchronously (e.g., posted on OWL for students to view at their convenience). The grading scheme will not change. Any assessments affected will be conducted online as determined by the course instructor.

When deemed necessary, tests and examinations in this course will be conducted using a remote proctoring service. By taking this course, you are consenting to the use of this software and acknowledge that you will be required to provide personal information (including some biometric data) and the session will be recorded. Completion of this course will require you to have a reliable internet connection and a device that meets the technical requirements for this service. More information about this remote proctoring service, including technical requirements, is available on Western's Remote Proctoring website at: https://remoteproctoring.uwo.ca.

Cheating and Plagiarism: Students must write their essays and assignments in their own words. Whenever students take an idea or a passage from another author, they must acknowledge their debt both by using quotation marks where appropriate and by proper referencing such as footnotes or citations. University policy states that cheating, including plagiarism, is a scholastic offence. The commission of a scholastic offence is attended by academic penalties, which might include expulsion from the program. If you are caught cheating, there will be no second warning.

All required papers may be subject to submission for textual similarity review to commercial plagiarism-detection software under license to the University for the detection of plagiarism. All papers submitted will be included as source documents on the reference database for the purpose of detecting plagiarism of papers subsequently submitted to the system. Use of the service is subject to the licensing agreement, currently between the University of Western Ontario and Turnitin.com (http://www.turnitin.com).

Scholastic offences are taken seriously and students are directed to read the appropriate policy, specifically, the definition of what constitutes a Scholastic Offence, in the relevant section of the Academic Handbook:
http://www.uwo.ca/univsec/pdf/academic_policies/appeals/scholastic_discipline_undergrad.pdf

Use of Electronic Devices: Students may use laptops, tablet computers, or smart phones *only* to access the course OWL site during lectures and tutorials. Use of *nonprogrammable* calculators *only* is permitted during quizzes and examinations. No other electronic devices may be used at any time during lectures, tutorials, or examinations.

Policy on Repeating All Components of a Course: Students who are required to repeat an Engineering course must repeat all components of the course. No special permissions will be granted enabling a student to retain laboratory, assignment, or test marks from previous years. Previously completed assignments and laboratories cannot be resubmitted by the student for grading in subsequent years.

Internet and Electronic Mail: Students are responsible for regularly checking their Western e-mail and the course web site (https://owl.uwo.ca/portal/) and making themselves aware of any information

that is posted about the course.

Accessibility: Please contact the course instructor if you require material in an alternate format or if any other arrangements can make this course more accessible to you. You may also wish to contact Services for Students with Disabilities (SSD) at 519-661-2111 ext. 82147 for any specific question regarding an accommodation.

Support Services: Office of the Registrar, http://www.registrar.uwo.ca/
Student Development Centre, http://www.sdc.uwo.ca/
Engineering Undergraduate Services, http://www.eng.uwo.ca/undergraduate/ USC
Student Support Services, http://westernusc.ca/services/

Students who are in emotional/mental distress should refer to Mental Health @ Western, http://www.health.uwo.ca/mental_health/, for a complete list of options about how to obtain help.