

**Western University
Faculty of Engineering
Department of Electrical and Computer Engineering**

**ECE 9202B/BIOMED 9519B:
Advanced Image Processing and Analysis
Course Outline, Winter 2020**

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 primary emphasis on medical applications. Topics covered include image segmentation, image registration, and image processing using Image Processing Toolbox in MATLAB and 3D Slicer. Examples will be presented to give the students exposure to real-world applications.

Instructor: Dr. Reza Jafari
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Consultation hours: By appointment

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Consultation hours: By appointment

Academic Calendar Copy: This course explores a few major areas of digital image processing at an advanced level, with primary emphasis on medical applications. Topics covered include image filtering and enhancement, visualization, image segmentation and image registration. Examples will be presented to give the students exposure to real-world applications in medicine and other applications.

Contact Hours: 3 lecture hours/week, 0.5 course.

Prerequisites: ECE 4445A/B or MBP 4445A/B or BIOPHYS 9509 or BME 9509.

Unless you have either the requisites for this course or written special permission from your Dean to enroll in it, you will be removed from this course and it will be deleted from your record. This decision may not be appealed. You will receive no adjustment to your fees in the event that you are dropped from a course for failing to have the necessary prerequisites.

CEAB Academic Units: Engineering Science 75%, Engineering Design 25%

Required Textbook: None

Recommended References:

1. R. C. Gonzalez, R. E. Woods, "Digital Image Processing," 3rd edition, Prentice-Hall, 2008.
2. A. M. Haidekker, "Advanced Biomedical Image Analysis," John Wiley & Sons, 2011.
3. G. Shengrong *et al.*, "Advanced Image and Video Processing Using MATLAB," Springer International Publishing, 2018.
4. J. Hajnal *et al.*, "Medical Image Registration," CRC Press, Boca Raton, 2001.

General Learning Objectives (CEAB Graduate Attributes)

Knowledge Base	3/3	Use of Engineering Tools	3/3	Impact on Society and the Environment	
Problem Analysis	3/3	Individual and Team Work		Ethics and Equity	
Investigation		Communication Skills	3/2	Economics and Project Management	
Design		Professionalism		Life-Long Learning	

Notation: x/y , where x is the cognitive level (1: Remember, 2: Understand, 3: Apply) at which the attribute is assessed and y is the academic level (1: Beginner, 2: Intermediate, 3: Advanced) at which the attribute is assessed.

Topics and Specific Learning Objectives

1. 3D Slicer

At the end of this section, students will be able to:

- a. describe how to load and visualize 3D volumetric images in 3D Slicer
- b. apply segmentation and registration algorithms as taught in class
- c. successfully apply segmentation and registration algorithms beyond those taught in class

2. Segmentation algorithms

At the end of this section, students will be able to:

- a. identify broad categories of segmentation algorithms
- b. describe in detail specific segmentation algorithms taught in class
- c. describe at a high level related segmentation algorithms not covered during lectures
- d. identify appropriate segmentation algorithm for a defined task
- e. appropriately configure/task the algorithm according to the task
- f. write a program in MATLAB to implement a segmentation algorithm taught in class
- g. implement segmentation algorithms beyond those taught in class

3. Object recognition

At the end of this section, students will be able to:

- a. identify appropriate object recognition algorithm for a defined task
- b. describe supervised and unsupervised pattern classifications
- c. describe a template matching algorithm taught in class
- d. describe in detail a specific object recognition algorithms taught in class
- e. implement an object recognition algorithm taught in class
- f. implement object recognition algorithms beyond those taught in class

4. Registration algorithms

At the end of this section, students will be able to:

- a. identify broad categories of registration algorithms
- b. describe in detail the specific registration algorithms taught in class
- c. describe at a high level related registration algorithms not covered during lectures
- d. to identify appropriate registration algorithm for a defined task

- e. appropriately configure/task the algorithm according to the task
- f. implement a registration algorithm taught in class
- g. implement registration algorithms beyond those taught in class

Evaluation

Course Component	Weight
Homework Assignments	20%
Midterm Test	20%
Final Examination	25%
Course Project	35%

For MSc and PhD students to obtain a passing grade in the course, a mark of 50% or more must be achieved on the course project; such a mark < 50% will result in a final course grade of 48% or less. Moreover, to obtain a passing grade in the course, a mark of 50% or more must be achieved on the final examination. A final examination < 50% will result in a final course grade of 48% or less.

Homework Assignments: The course will include about four homework assignments, submitted online through the OWL system.

Midterm Exam: There will be one closed-book midterm test scheduled lecture time slot. Only non-programmable calculators will be permitted; no other materials or electronic devices will be allowed.

Final Examination: A closed-book final examination will take place during the regular examination period. Only non-programmable calculators will be permitted; no other materials or electronic devices will be allowed.

Course Project: The project topic and scope will be selected in consultation with the instructor and will involve algorithm implementation. The deliverables will consist of a written report, an oral presentation, and the software implementation.

Late Submission Policy: Late assignments will be penalized at a rate of 20% per 24 hours overdue, **with no exceptions.**

Any reason for late submission of an assignment must be brought to the attention of the instructor for consideration prior to the assignment deadline. Documented evidence of the reason for such requests must be provided for such requests to be considered. No requests for accommodation of late submission of assignments will be considered by the instructor after assignment deadlines.

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 Midterm Examinations: If a student misses a midterm examination, 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 test. If accommodation is granted, the department will decide whether to provide a make-up test or allow reweighting of the test, where reweighting means the marks normally allotted for the midterm will be added to the final exam. If no reasonable justification for missing the test can be found, then the student will receive a mark of zero for the test.

If a student is going to miss the midterm examination for religious reasons, they must inform the instructor in writing within 48 hours of the announcement of the exam date or they will be required to write the exam.

Cheating and Plagiarism: The course instructor will seek the maximum penalty for any student committing a scholastic offence on the first and all subsequent offences. Students must complete all assignments and examinations independently (i.e. not with partners or in groups). 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 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.