



ENGG*4660 Medical Image Processing

01

Winter 2023

Section(s): C01

School of Engineering

Credit Weight: 0.50

Version 1.00 - January 03, 2023

1 Course Details

1.1 Calendar Description

This course covers the fundamentals of medical image processing. Image processing topics covered include: fundamentals of resolution and quantization; linear systems as applied to multi-dimensional continuous and discrete systems; point operations such as contrast enhancement and histogram equalization; geometric operations for distortion correction, including interpolation methods; linear filtering in both the spatial and spatial-frequency domains; and image restoration and inverse filtering. Image segmentation is covered in the framework of pattern recognition using single and multiple dimensional features, and includes the fundamental Bayes classifier as well as machine learning methods for both supervised and unsupervised learning.

Pre-Requisites: ENGG*3390

1.2 Course Description

Medical imaging is a rapidly developing field within biomedical engineering. There is a demand both within the research community and in clinical support for people with knowledge of digital image processing techniques for enhancing, restoring, manipulating, and interpreting digital images.

1.3 Timetable

Lectures:

Tuesday 16:00-17:20 ANNU 002

Thursday 16:00-17:20 ANNU 002

Laboratory:

Wednesday 11:30-13:20 THRN 2336

1.4 Final Exam

Date: April 19, 2022

Time: 8:30-10:30

Location: TBD

2 Instructional Support

2.1 Instructional Support Team

Instructor:	Bob Dony Ph.D., P.Eng
Email:	rdony@uoguelph.ca
Telephone:	+1-519-824-4120 x53458
Office:	THRN 2341
Office Hours:	By appointment

2.2 Teaching Assistants

Teaching Assistant (GTA):	Peyman Tahghighi
Email:	ptahghig@uoguelph.ca

3 Learning Resources

3.1 Required Resources

Course Website (Website)

Course material, news, announcements, and grades will be regularly posted to the ENGG*4660 Courselink site. You are responsible for checking the site regularly.

3.2 Additional Resources

Digital Image Processing using MATLAB (Textbook)

Gonzalez, Woods, Eddins, Pearson Prentice Hall, 2004

Digital Image Processing (Textbook)

Gonzalez, Woods, Addison-Wesley, 1992

Digital Image Processing (Textbook)
 Castleman, Prentice Hall, 1996

Medical Imaging: Signals and Systems (Textbook)
 Prince, Links, Pearson Prentice Hall, 2006

Fundamentals of Medical Imaging (Textbook)
 Suetens, Cambridge, 2002

4 Learning Outcomes

4.1 Course Learning Outcomes

By the end of this course, you should be able to:

1. Relate the point spread function to image resolution both in terms of spatial and spatial-frequency measurements.
2. Perform filtering operations in both the spatial and spatial-frequency domains.
3. Explain the effects and uses of the various image processing techniques on digital images.
4. Given a corrupted image, justify a choice of image processing operators to restore or enhance the image, design and implement the operators, and evaluate both qualitatively and quantitatively the results.
5. Describe the components of pattern recognition and explain their limitations.
6. Justify the choice of segmentation technique given an end-use application.
7. Implement various segmentation techniques as appropriate.

4.2 Engineers Canada - Graduate Attributes (2018)

Successfully completing this course will contribute to the following:

#	Outcome	Learning Outcome
1	Knowledge Base	1, 2, 3, 4, 5, 6, 7

#	Outcome	Learning Outcome
1.4	Recall, describe and apply program-specific engineering principles and concepts	1, 2, 3, 4, 5, 6, 7
2	Problem Analysis	1, 2, 3, 4, 5, 6
2.2	Identify, organize and justify appropriate information, including assumptions	5
2.3	Construct a conceptual framework and select an appropriate solution approach	1
2.4	Execute an engineering solution	2
2.5	Critique and appraise solution approach and results	3, 4, 6
3	Investigation	3, 4, 5, 6, 7
3.1	Propose a working hypothesis	5
3.2	Design and apply an experimental plan/investigative approach (for example, to characterize, test or troubleshoot a system)	7
3.3	Analyze and interpret experimental data	7
3.4	Assess validity of conclusions within limitations of data and methodologies	3, 4, 6, 7
4	Design	4, 6
4.4	Evaluate alternative design solutions based on problem definition	6
4.5	Develop and refine an engineering design solution, through techniques such as iteration, simulation and/or prototyping	4
5	Use of Engineering Tools	2, 4, 5, 7
5.1	Select appropriate engineering tools from various alternatives	4, 5, 7
5.2	Demonstrate proficiency in the application of selected engineering tools	2, 4, 7
5.3	Recognize limitations of selected engineering tools	4, 7

4.3 Relationships with other Courses & Labs

Previous Courses:

ENGG*3390: Provides a background in linear systems theory and signal processing.

5 Teaching and Learning Activities

5.1 Lecture

Lecture Schedule

Topics:

Day	Lecture Topic
Jan 10	2D Signals and Systems
Jan 12	2D Systems and Fourier
Jan 17	Fourier and Sampling
Jan 19	Reconstruction Filtering
Jan 24	Filtering
Jan 26	Optimal Filtering
Jan 31	Optimal Filtering cont'd
Feb 2	Human Visual System
Feb 7	Point Operations The Histogram
Feb 9	Histogram Equalization Algebraic Operations
Feb 14	Geometric Operations
Feb 16	Image Registration
	Reading Week
Feb 28	Segmentation Edge Detection
Mar 2	Midterm
Mar 7	<i>Iron Ring</i>
Mar 9	Pattern Classification
Mar 14	Multi-dimensional Gaussian
Mar 16	Multi-dimensional cont'd
Mar 21	Unsupervised Learning
Mar 23	Supervised Learning
Mar 28	Gradient Descent
Mar 30	Neural Networks
Apr 4	Neural Networks cont'd
Apr 6	

5.2 Lab

Lab Schedule

Topics:

Week	Dates	Activity	Due
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Week 2	Jan 18	Introduction to MATLAB	
Week 3-4	Jan 25-Feb 1	Filtering	Feb 8
Week 5-6	Feb 8-Feb 15	Optimal Filtering	Mar 1
Week 7	Mar 1	Greylevel Operations	Mar 8
Week 8-9	Mar 8-Mar 15	Image Registration	Mar 22
Week 10- 12	Mar 22-Apr 5	Segmentation	Apr 10

5.3 Other Important Dates

Monday, January 9, 2023: First day of classes

Monday, February 20 - Friday, February 24, 2023: Winter Break

Friday, April 7, 2023: Holiday

Monday, April 10, 2023: (Friday schedule) drop date and last day of classes

6 Assessments

6.1 Assessment Details

Computer Labs/Assignments (40%)

Learning Outcome: 1, 2, 3, 4, 5, 6, 7

See lab schedule for due dates.

Midterm (25%)

Date: Thu, Mar 2, In Class

Learning Outcome: 1, 2, 3, 4

Final Exam (35%)

Date: Wed, Apr 19, 8:30 AM, TBA

Learning Outcome: 1, 2, 3, 4, 5, 6, 7

7 Course Statements

7.1 Course Grading Policies

Missed Assessments: If you are unable to meet an in-course requirement due to medical, psychological, or compassionate reasons, please email the course instructor. See the undergraduate calendar for information on regulations and procedures for Academic Consideration.

Accommodation of Religious Obligations: If you are unable to meet an in-course requirement due to religious obligations, please email the course instructor within two weeks of the start of the semester to make alternate arrangements. See the undergraduate calendar for information on regulations and procedures for Academic Consideration of Religious Obligations.

Passing grade: As per University policy, the minimum passing grade is 50%.

Missed midterm tests: If you miss a test due to grounds for granting academic consideration or religious accommodation, the weight of any missed test will be added to the final exam weight. There will be no makeup midterm tests.

Late Assignments: Late submission of assignments will not be accepted.

8 School of Engineering Statements

8.1 Instructor's Role and Responsibility to Students

The instructor's role is to develop and deliver course material in ways that facilitate learning for a variety of students. Selected lecture notes will be made available to students on Courselink but these are not intended to be stand-alone course notes. Some written lecture notes will be presented only in class. During lectures, the instructor will expand and explain the content of notes and provide example problems that supplement posted notes. Scheduled classes will be the principal venue to provide information and feedback for tests and labs.

8.2 Students' Learning Responsibilities

Students are expected to take advantage of the learning opportunities provided during lectures and lab sessions. Students, especially those having difficulty with the course content, should also make use of other resources recommended by the instructor. Students who do (or may) fall behind due to illness, work, or extra-curricular activities are advised to keep the instructor informed. This will allow the instructor to recommend extra resources in a timely manner and/or provide consideration if appropriate.

8.3 Lab Safety

Safety is critically important to the School and is the responsibility of all members of the School: faculty, staff and students. As a student in a lab course you are responsible for taking all reasonable safety precautions and following the lab safety rules specific to the lab you are working in. In addition, you are responsible for reporting all safety issues to the laboratory supervisor, GTA or faculty responsible.

9 University Statements

9.1 Email Communication

As per university regulations, all students are required to check their e-mail account regularly:

e-mail is the official route of communication between the University and its students.

9.2 When You Cannot Meet a Course Requirement

When you find yourself unable to meet an in-course requirement because of illness or compassionate reasons please advise the course instructor (or designated person, such as a teaching assistant) in writing, with your name, id#, and e-mail contact. The grounds for Academic Consideration are detailed in the Undergraduate and Graduate Calendars.

Undergraduate Calendar - Academic Consideration and Appeals

<https://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-ac.shtml>

Graduate Calendar - Grounds for Academic Consideration

<https://www.uoguelph.ca/registrar/calendars/graduate/current/genreg/index.shtml>

Associate Diploma Calendar - Academic Consideration, Appeals and Petitions

<https://www.uoguelph.ca/registrar/calendars/diploma/current/index.shtml>

9.3 Drop Date

Students will have until the last day of classes to drop courses without academic penalty. The deadline to drop two-semester courses will be the last day of classes in the second semester. This applies to all students (undergraduate, graduate and diploma) except for Doctor of Veterinary Medicine and Associate Diploma in Veterinary Technology (conventional and alternative delivery) students. The regulations and procedures for course registration are available in their respective Academic Calendars.

Undergraduate Calendar - Dropping Courses

<https://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-drop.shtml>

Graduate Calendar - Registration Changes

<https://www.uoguelph.ca/registrar/calendars/graduate/current/genreg/genreg-reg-regchg.shtml>

Associate Diploma Calendar - Dropping Courses

<https://www.uoguelph.ca/registrar/calendars/diploma/current/c08/c08-drop.shtml>

9.4 Copies of Out-of-class Assignments

Keep paper and/or other reliable back-up copies of all out-of-class assignments: you may be asked to resubmit work at any time.

9.5 Accessibility

The University promotes the full participation of students who experience disabilities in their academic programs. To that end, the provision of academic accommodation is a shared responsibility between the University and the student.

When accommodations are needed, the student is required to first register with Student

Accessibility Services (SAS). Documentation to substantiate the existence of a disability is required; however, interim accommodations may be possible while that process is underway.

Accommodations are available for both permanent and temporary disabilities. It should be noted that common illnesses such as a cold or the flu do not constitute a disability.

Use of the SAS Exam Centre requires students to make a booking at least 14 days in advance, and no later than November 1 (fall), March 1 (winter) or July 1 (summer). Similarly, new or changed accommodations for online quizzes, tests and exams must be approved at least a week ahead of time.

For Guelph students, information can be found on the SAS website
<https://www.uoguelph.ca/sas>

For Ridgetown students, information can be found on the Ridgetown SAS website
<https://www.ridgetownc.com/services/accessibilityservices.cfm>

9.6 Academic Integrity

The University of Guelph is committed to upholding the highest standards of academic integrity, and it is the responsibility of all members of the University community—faculty, staff, and students—to be aware of what constitutes academic misconduct and to do as much as possible to prevent academic offences from occurring. University of Guelph students have the responsibility of abiding by the University's policy on academic misconduct regardless of their location of study; faculty, staff, and students have the responsibility of supporting an environment that encourages academic integrity. Students need to remain aware that instructors have access to and the right to use electronic and other means of detection.

Please note: Whether or not a student intended to commit academic misconduct is not relevant for a finding of guilt. Hurried or careless submission of assignments does not excuse students from responsibility for verifying the academic integrity of their work before submitting it. Students who are in any doubt as to whether an action on their part could be construed as an academic offence should consult with a faculty member or faculty advisor.

Undergraduate Calendar - Academic Misconduct
<https://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-amisconduct.shtml>

Graduate Calendar - Academic Misconduct
<https://www.uoguelph.ca/registrar/calendars/graduate/current/genreg/index.shtml>

9.7 Recording of Materials

Presentations that are made in relation to course work - including lectures - cannot be recorded or copied without the permission of the presenter, whether the instructor, a student, or guest lecturer. Material recorded with permission is restricted to use for that course unless further permission is granted.

9.8 Resources

The Academic Calendars are the source of information about the University of Guelph's procedures, policies, and regulations that apply to undergraduate, graduate, and diploma programs.

Academic Calendars
<https://www.uoguelph.ca/academics/calendars>

9.9 Disclaimer

Please note that the ongoing COVID-19 pandemic may necessitate a revision of the format of course offerings, changes in classroom protocols, and academic schedules. Any such changes will be announced via CourseLink and/or class email.

This includes on-campus scheduling during the semester, mid-terms and final examination schedules. All University-wide decisions will be posted on the COVID-19 website (<https://news.uoguelph.ca/2019-novel-coronavirus-information/>) and circulated by email.

9.10 Illness

Medical notes will not normally be required for singular instances of academic consideration, although students may be required to provide supporting documentation for multiple missed assessments or when involving a large part of a course (e.g.. final exam or major assignment).

9.11 Covid-19 Safety Protocols

For information on current safety protocols, follow these links:

- <https://news.uoguelph.ca/return-to-campus/how-u-of-g-is-preparing-for-your-safe-return/>
- <https://news.uoguelph.ca/return-to-campus/spaces/#ClassroomSpaces>

Please note, these guidelines may be updated as required in response to evolving University, Public Health or government directives.
