1. Course Information

MBP/ECE 4445a: Introduction to Digital Image Processing
Fall Term 2018

The aim of this introductory course is to provide a solid background in the fundamentals of digital image processing. The course covers many of the major topics in the field, including image representation, 2D linear systems theory and Fourier analysis, digital filtering, registration and segmentation. The course concentrates on those techniques that have proven most useful in practice. A major aim of this course is to expose students to real-world applications of image processing in industry, science and medicine. Through assignments, students will become familiar with the image processing facilities available in the popular MATLAB numeric computation and visualization environment.

Lectures:
Lecture days/times/locations:
- Mondays from 5:30 pm to 6:20 pm in Spencer Engineering Building, Room 1200
- Thursdays from 9:30 am to 10:20 am in Spencer Engineering Building, Room 1059
- Fridays from 10:30 am to 11:20 am in University Community Centre, Room 146

Starting date: Thursday, September 6, 2018

Requisites:
Prerequisite(s): The former Medical Biophysics 3302E or 3503G; Medical Biophysics 3303E; Calculus 2303A/B or 2503A/B; 1.0 course from Medical Biophysics 2128A/B and 2129A/B, or Physics 2128A/B and 2129A/B, or Physics 2101A/B and 2102A/B, or the former Physics 200; or permission of the department.

Antirequisite(s): The former MBP 445A/B and ECE 4445 A

Senate regulation regarding the student's responsibility regarding requisites:
Unless you have either the requisites for this course or written special permission from your Dean to enroll in it, you may 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.

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 661-2111 x 82147 for any specific question regarding an accommodation.

2. Instructor Information
Instructor: Hanif M. Ladak, Ph.D., P.Eng.
Email: hladak@uwo.ca
Office: Medical Sciences Building, Room M 403

Phone: 519-661-2111 ext. 86551
Office Hours: Tuesdays from 1:30 pm to 3:30 pm

OWL:
Students with OWL issues should contact the Computer Support Centre at 519 661-3800 or send e-mail to owl@uwo.ca

3. Course Materials

Textbook:
K.R. Castleman, Digital Image Processing, Prentice-Hall, Inc., Englewood Cliffs, 1996.

Supplemental Information:
1. R. Jain, R. Kasturi, B.G. Schunck, Machine Vision, McGraw-Hill, New York, 1995.
2. A.K. Jain, Fundamentals of Digital Image Processing, Prentice-Hall, Inc., Englewood Cliffs, 1989.
3. M. Sonka, V. Hlavac, R. Boyle, Image Processing, Analysis, and Machine Vision, Brooks/Cole Publishing Co., Pacific Grove, 1999.
4. T.M. Peters and J. Williams, editors, The Fourier Transform in Biomedical Engineering, Birkhäuser, Boston, 1998.
5. Documentation on Matlab and the Image Processing Toolbox can be found on the Mathworks' Web site at http://www.mathworks.com/help/?s_cid=global_nav

4. Evaluation:

Component	Date	% of Final Mark
Assignment 1	Distributed on Sept. 24, 2018 Due on Oct. 4, 2018	5%
Assignment 2	Distributed on Oct. 4, 2018 Due on Oct. 18, 2018	5%
Assignment 3	Distributed on Oct. 18, 2018 Due on Nov. 1, 2018	5%
Assignment 4	Distributed on Nov. 1, 2018 Due on Nov. 15, 2018	5%
Quiz 1	Fri., Oct. 19, 2018	15%
Quiz 2	Fri., Nov. 9, 2018	15%
Final Examination	TBA	50%

Assignments: Students will work in groups of two (2) to four (4) individuals. One report can be submitted by each group. Most of the assignments will involve programming in MATLAB.

Quizzes: Quizzes will be done during class time, so there is 50 min available for each quiz. They will be based on lecture material, homework, assignments and any assigned reading. Questions

will involve problem solving, calculations, and writing code in MATLAB. Both quizzes are closed book. Non-programmable calculators will be allowed.

Final examination: Material from the entire course will be covered. As with the quizzes, the final examination will be based on lecture material, homework, assignments and any assigned reading. Questions will involve problem solving, calculations, and writing code in MATLAB. The final examination is closed book. Non-programmable calculators will be allowed. The examination will be 3 hours long.

Absence from course commitments

A. Absence for medical illness:
Students must familiarize themselves with the Policy on Accommodation for Medical Illness:
http://www.uwo.ca/univsec/pdf/academic_policies/appeals/accommodation_medical.pdf

Statement from the Dean's Office, Faculty of Science
If you are unable to meet a course requirement due to illness or other serious circumstances, you must provide valid medical or other supporting documentation to the Dean's office as soon as possible and contact your instructor immediately. It is the student's responsibility to make alternative arrangements with their instructor once the accommodation has been approved and the instructor has been informed. In the event of a missed final exam, a "Recommendation of Special Examination" form must be obtained from the Dean's Office immediately. For further information please see:
http://www.uwo.ca/univsec/pdf/academic_policies/appeals/accommodation_medical.pdf

A student requiring academic accommodation due to illness, should use the Student Medical Certificate when visiting an off-campus medical facility or request a Record's Release Form (located in the Dean's Office) for visits to Student Health Services.
The form can be found at:
http://www.uwo.ca/univsec/pdf/academic_policies/appeals/medicalform.pdf

For medical illness affecting work worth less than 10% of the total course grade, evaluation may be re-weighted.

B. Absence for non-medical reasons:
Material submitted for evaluation (assignments, lab reports) after the due date will be subjected to a late penalty of 10%/day but will not be accepted after marked material has been returned to the class. Missed quizzes will be given 0% unless accommodation is made through the Office of the Dean of Science.

C. Special Examinations
A Special Examination must be written at the University or an Affiliated University College no later than 30 days after the end of the examination period involved. To accommodate unusual circumstances, a date later than this may be arranged at the time permission is first given by the Dean of the Faculty. The Dean will consult with the instructor and Department Chair and, if a

later date is arranged, will communicate this to Registrarial Services. If a student fails to write a scheduled Special Examination, permission to write another Special Examination will be granted only with the permission of the Dean in exceptional circumstances and with appropriate supporting documents. In such a case, the date of this Special Examination normally will be the scheduled date for the final exam the next time the course is offered.

D. Support Services:
Registrarial Services: http://www.registrar.uwo.ca/

Academic Counselling (Science and Basic Medical Sciences):
https://www.uwo.ca/sci/counselling/

Student Development Centre: http://www.sdc.uwo.ca/

Student Health Services: http://www.shs.uwo.ca/

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

5. Course Syllabus

Specific Learning Outcomes:
1. You will gain knowledge in a broad range of digital image processing techniques, including histogram-based methods, point operations, algebraic operations, geometric operations, convolution, frequency analysis, filtering and segmentation.
2. You will be expected to understand and derive the mathematical formulation for each algorithm, and this specific knowledge will enable you to quantitatively critique and compare various algorithms, Moreover, you will be able to extend the theoretical framework to adapt and optimize algorithms to new problems.
3. You will become a literate programmer of image processing algorithms in the MATLAB computation environment, which will enable you to translate mathematical algorithms into practice.
4. You will be able to describe and solve interdisciplinary image processing problems in industry, science and medicine.

The following topics will be covered in the lectures:

Date(s)	Topics
Sept. 6	Introduction to course
Sept. 7, 10	The digital image and its properties
Sept. 13, 14, 17, 20	Review of MATLAB and introduction to image processing toolbox
Sept. 21	Researching digital image processing topics

Sept. 24, 27, 28; Oct. 1, 4, 5	The gray-level histogram and point operations
	    - Computation of the histogram
	    - Histogram equalization

	- Histogram matching
	- Photometric calibration
Oct. 8-12	**Fall Reading Week (no classes)**
Oct. 15, 18	Algebraic operations
	- Applications in noise reduction, motion detection, and background removal
Oct. 19	**Quiz 1 (in class)**

Oct. 22, 25, 26, 29;
Nov. 1
	Geometric operations
	      - Gray-level interpolation
	      - Spatial transformations
	      - Applications in geometric calibration, image rectification and registration

Nov. 2, 5	Review of 1-D linear systems theory; extension to 2-D
	      - Definitions
	      - Harmonic signals and complex signal analysis
	      - Convolution filters
	Order-statistic and homomorphic filters

Nov. 8, 12	Review of the 1-D Fourier Transform; extension to 2-D
	      - Definition and properties of the Fourier Transform
	      - Linear systems and the Fourier Transform
	      - Frequency-based filters

Nov. 9	**Quiz 2 (in class)**

Nov. 15, 16	Image segmentation
	      - Thresholding and binary image processing
	      - Gradient-based methods
	      - Edge-detection and linking
	      - Region growing

Nov. 19, 22, 23, 26, 29, 30; Dec. 3, 6	Case studies
Dec. 7	Review

Lecture dates listed above are approximate, although every attempt will be made to adhere to this schedule.

Students are expected to attend all lectures and complete all assignments, homeworks, quizzes and examinations.

6. Additional Information/Statements

Statement on Use of Electronic Devices
Electronic devices other than non-programmable calculators are not allowed during the quizzes and final examination. Such devices will be confiscated at the beginning of each quiz or final examination and returned to the student at the end of the session.

Academic Offences
Scholastic offences are taken seriously and students are directed to read the appropriate policy, specifically, the definition of what constitutes a Scholastic Offence, at the following Web site:
http://www.uwo.ca/univsec/pdf/academic_policies/appeals/scholastic_discipline_undergrad.pdf .

All required papers may be subject to submission for textual similarity review to the commercial plagiarism detection software under license to the University for the detection of plagiarism. All papers submitted for such checking will be included as source documents in 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 Western University and Turnitin.com (http://www.turnitin.com).

If computer-marked multiple-choice quizzes and/or exams will be given, and software might be used to check for unusual coincidences in answer patterns that may indicate cheating, the following statement must be included in the course outline: