

Course Syllabus

CMPT 819: Image Processing and Computer Vision

1 Catalogue Description

An introduction to image processing and computer vision, including coverage of topics such as the basics of image representation and manipulation, edge detection, image segmentation, photometric stereo and shape from shading, optical flow, and pattern recognition.

- Prerequisite(s):** No formal prerequisite
- Class Time and Location:** Monday/Wednesday/Friday, Arts 109
- Website:** [CS Moodle Page \(http://moodle.cs.usask.ca\)](http://moodle.cs.usask.ca)

2 Instructor Information

- Instructor** Mark Eramian
- Contact:** Email: eramian@cs.usask.ca
- Office Hours:** Location: Spinks Undergraduate Lab
Hours: To be announced.
or by appointment (arrange by email) in SPINKS S422.

3 Course Objectives

The successful student in this class should:

- understand the typical steps for solution of image processing/vision problems: pre-processing, segmentation, description, and recognition;
- possess knowledge and understanding of basic and some advanced methods for each step in the process;
- be able to choose appropriate methods and implement solutions to small-scale image processing and vision problems; and
- have acquired in-depth, state-of-the-art knowledge of the research frontier on a chosen topic of interest.

4 Student Evaluation

4.1 Grading Scheme

Assignments	
Assignment 0	2.5%
Assignments 1–5	3.5% each
Assignment sub-total:	20%
Project and Presentation	35%
Midterm Exam	10%
Final Exam	35%
Total	100%

4.2 Assignment Due Dates (tentative)

- Assignment 0: September 18, 10:00pm
- Assignment 1: October 2, 10:00pm
- Assignment 2: October 16, 10:00pm
- Assignment 3: November 6, 10:00pm
- Assignment 4: November 20, 10:00pm
- Assignment 5: December 3, 10:00pm

In the unlikely event that an assignment must be cancelled, the remaining assignment grades will be pro-rated to 25% of the final grade.

4.3 Examination Schedule (tentative)

- Mid-Term Examination: October 24, 2014 (in class)

4.4 Final Exam Scheduling

The Registrar schedules all final examinations, including deferred and supplemental examinations. Students are advised not to make travel arrangements for the exam period until the official exam schedule has been posted.

Note: All students must be properly registered in order to attend lectures and receive credit for this course.

5 Textbook Information

5.1 Required Text

- R. Gonzalez, R. Woods, and S. Eddins, *Digital Image Processing Using Matlab* (second edition), Gatesmark Publishing, 2009.

- Alternative: R. Gonzalez, R. Woods, and S. Eddins, *Digital Image Processing Using Matlab* (first edition), Prentice-Hall, 2003.

5.2 Recommended/Supplementary Texts

- R. Gonzalez and R. Woods, *Digital Image Processing (third edition)*, Prentice-Hall, 2008
 or
 (second edition) Prentice-Hall, 2002.

6 Lecture Topics (tentative)

Topic	Subtopics
Introduction	<ul style="list-style-type: none"> • Overview of Applications of Vision and Image Processing
Image Formats	<ul style="list-style-type: none"> • Digital Image Formats • Colour Models
Matlab Basics	<p>Video Lecture – To be watched outside class time.</p> <ul style="list-style-type: none"> • Data Types • Operators • Manipulating Matrices • File I/O • The Image Processing Toolbox
Grayscale Transforms and Filtering	<ul style="list-style-type: none"> • Thresholding • Histogram Equalization • Linear Filtering (convolution) • Noise Reduction • Nonlinear Filtering
Edge Detection	<ul style="list-style-type: none"> • Gradients, Edge Magnitude and Direction • Finite Difference Filters • Laplacian of Gaussian Filter • Canny Edge Detector

Colour Image Processing	<ul style="list-style-type: none"> • Colour Transformations • Colour Histogram Equalization • Colour Median Filtering. • Colour Gradient and Edge Detection
Thresholding and Region Processing	<ul style="list-style-type: none"> • Thresholding as a form of Segmentation • Basic Global Thresholding • Optimal Global Thresholding • Techniques to improve global thresholding • Region Labeling • Boundary Tracing
Segmentation	<ul style="list-style-type: none"> • Edge Based Segmentation • Region-based Segmentation • Hybrid Methods
Segmentation Validation	<ul style="list-style-type: none"> • Boundary-based measures of accuracy. • Region-based measures of accuracy. • Measuring Reproducibility.
Description	<ul style="list-style-type: none"> • Boundary Descriptors • Region and Shape Descriptors • Texture Description • SIFT Features and Bags of Words
Classification	<ul style="list-style-type: none"> • Supervised and Unsupervised Clustering • Nearest Neighbor Classifiers • Bayesian Classification • Training and Testing Methodologies
Other Topics (time permitting)	<ul style="list-style-type: none"> • Morphological Image Processing • Frequency Domain Filtering

7 Other Course Information

- **Class Project:** Students will complete a class project. The class project is an independent study of an area of image processing/computer vision. This project can take the form of an implementation project, where you research and implement an algorithm or algorithms for a computer-vision-related task and demonstrate its correctness/effectiveness. It may also take the form of a term paper – a survey paper in which you review the state of the art in research in a particular area of computer vision. Regardless of the form the project takes, students will be required to make an in-class presentation of their projects at a time to be arranged with the instructor. Students who choose an implementation project must also submit a written report on the results of their work. All project topics must be approved by the instructor. Projects are expected to be completed with about 2 months of work, so it is anticipated that topics should be selected and approved by late September or very early October. More details about the project, and suggestions for topics, will be made available later in September.
- Important course announcements regarding assignments and examinations, as well as other information will be communicated to the class via the course website on Moodle. Students are responsible for reading this website regularly.
- Programming assignments for this course will be in Matlab. Matlab is available on the most of the departmental undergraduate lab machines under all operating systems. Matlab is also available on the Windows Terminal Server, `skynet.usask.ca` and the Linux terminal server `tuxworld.usask.ca`.
- Submission instructions for assignments will be given in the descriptions of individual assignments. Assignments will be submitted through the Moodle class page.
- Computer software may be used to assist in the detection of academic misconduct. See Section 8.6 for more information on academic honesty and academic misconduct.

8 Policies

8.1 Late Assignments

Absolutely no late assignments will be accepted.

8.2 Assignment Extensions

Extensions will be granted only by the course instructor. If you have serious medical or compassionate grounds for an extension, the student must contact their instructor by email **before or on** the due date of the assignment explaining their situation and to make arrangements to provide the appropriate documentation. Upon receipt of this documentation the instructor will consider whether to grant an extension. **Requests for extensions received after the due date of an assignment will not be considered.**

8.3 Missed Assignments

Students who do not submit anything for an assignment by the due date will receive a grade of zero and the assignment will be considered “complete” with respect to incomplete coursework (see Section 8.5).

8.4 Missed Examinations

1. "Students who have missed an exam or assignment must contact their instructor as soon as possible. Arrangements to make up the exam may be arranged with the instructor. Missed exams throughout the year are left up to the discretion of the instructor if a student may make up the exam or write at a different time. If a student knows prior to the exam that she/he will not be able to attend, they should let the instructor know before the exam."
2. "Final exams - a student who is absent from a final examination through no fault of his or her own, for medical or other valid reasons, may apply to the College of Arts and Science Dean's office. The application must be made within three days of the missed examination along with supporting documentary evidence. Deferred exams are written during the February mid-term break for Term 1 courses and in early June for Term 2 and full year courses."

(2007/08. <http://www.arts.usask.ca/students/transition/tips.php>)

8.5 Incomplete Course Work and Final Grades

When a student has not completed the required course work, which includes any assignment or examination including the final examination, by the time of submission of the final grades, they may be granted an extension to permit completion of an assignment, or granted a deferred examination in the case of absence from a final examination. Extensions for the completion of assignments must be approved by the Department Head, or Dean in non-departmentalized Colleges, and may exceed thirty days only in unusual circumstances. The student must apply to the instructor for such an extension and furnish satisfactory reasons for the deficiency. Deferred final examinations are granted as per College policy.

In the interim, the instructor will submit a computed percentile grade for the course which factors in the incomplete course work as a zero, along with a grade comment of INF (Incomplete Failure) if a failing grade. In the case where the instructor has indicated in the course outline that failure to complete the required course work will result in failure in the course, and the student has a computed passing percentile grade, a final grade of 49% will be submitted along with a grade comment of INF (Incomplete Failure).

If an extension is granted and the required assignment is submitted within the allotted time, or if a deferred examination is granted and written in the case of absence from the final examination, the instructor will submit a revised computed final percentage grade. The grade change will replace the previous grade and any grade comment of INF (Incomplete Failure) will be removed. For provisions governing examinations and grading, students are referred to the University Council Regulations on Examinations section of the Calendar.

(2011 University of Saskatchewan Calendar/Academic Courses Policy)

8.6 Academic Honesty

The University of Saskatchewan is committed to the highest standards of academic integrity and honesty. Students are expected to be familiar with these standards regarding academic honesty and to uphold the policies of the University in this respect. Students are particularly urged to familiarize themselves with the provisions of the Student Conduct & Appeals section of the University Secretary Website and avoid any behaviour that could potentially result in suspicions of cheating, plagiarism, misrepresentation of facts and/or participation in an offence. Academic dishonesty is a serious offence and can result in suspension or expulsion from the University.

All students should read and be familiar with the Regulations on Academic Student Misconduct, <http://www.usask.ca/secretariat/student-conduct-appeals/StudentAcademicMisconduct.pdf>,



as well as the Standard of Student Conduct in Non-Academic Matters and Procedures for Resolution of Complaints and Appeals,

<http://www.usask.ca/secretariat/student-conduct-appeals/StudentNon-AcademicMisconduct.pdf>.

Academic honesty is also defined and described in the Department of Computer Science Statement on Academic Honesty:

<http://www.cs.usask.ca/undergrad/honesty.php>.

For more information on what academic integrity means for students see the Student Conduct & Appeals section of the University Secretary Website at:

<http://www.usask.ca/secretariat/student-conduct-appeals/forms/IntegrityDefined.pdf>

8.7 Examinations with Disability Services for Students (DSS)

Students who have disabilities (learning, medical, physical, or mental health) are strongly encouraged to register with Disability Services for Students (DSS) if they have not already done so. Students who suspect they may have disabilities should contact DSS for advice and referrals. In order to access DSS programs and supports, students must follow DSS policy and procedures. For more information, check <http://www.students.usask.ca/disability/>, or contact DSS at 966-7273 or dss@usask.ca.

Students registered with DSS may request alternative arrangements for mid-term and final examinations. Students must arrange such accommodations through DSS by the stated deadlines. Instructors shall provide the examinations for students who are being accommodated by the deadlines established by DSS.