Course Syllabus

Computer Vision (CSCI 4220U)

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Computer Science, Faculty of Science
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Winter 2019

Instructor

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Lectures

- Monday, 8:10-11 am, UA2220 (*First day of lectures, Monday, January 7, 2018.*)

Labs

In case the course has multiple lab sections. Each student will be assigned to one of these lab sections. All labs cover the same material. Each lab section is limited to 24 students, and these are filled on a first-come bases.

Please check mycampus for up to date information about course scheduling.

Office hours

Friday, 2-3 pm in UA4032, or by appointment.

Course Slack channel

We will use Slack as a way for online communication.

- uoit-csci-4220u-w19.slack.com

If you aren't on the course Slack channel yet, please let the professor or one of the TAs know. Your uoit.net email address will be used to add you to the course slack channel.

Course Description

This course introduces students to computer vision – the science and technology to make computers "see". The goal of computer vision is to develop computational machinery to extract useful information from images and videos. The course will study various steps of the overall image analysis pipeline. Topics covered will include: image formation, image representation, segmentation, feature extraction, motion analysis, object detection, camera calibration, and 3D visual reconstruction. A secondary focus of this course will be to focus applications computer vision, including mobile vision, which rely heavily upon the fundamental theory and techniques covered in this course.

Topics

Week 1

- Why computer vision?
- Image formation
    - Pinhole camera model
    - Projective geometry

- – Vanishing points
  - – Homogeneous coordinates
  - – Perspective projection
  - – Orthographic projection
- Lights and materials (self study)
  - – Absorption
  - – Diffusion
  - – Reflection
  - – Transparency
  - – Refraction
  - – Flourescence
  - – Subsurface scattering
  - – Phosphorescence
  - – Inter-reflection

Week 2

- Image representations
- Image filtering
  - – Convolution
  - – Guassian filter
  - – Average filter
  - – Separable filters

Week 3

- Image filtering (contd.)
  - – Integral images
  - – Bilateral filtering
- Template matching
  - – Cross-correlation
- Laplacian filtering
- Image pyramids

Week 4

- Model fitting
  - – Line fitting
  - – Least squares
  - – Robust least squares
- RANSAC
- Hough transform

Week 5

- Image derivatives
- Difference of Gaussians
- Edge detection
  - – Canny edge detector
- Image histograms

Week 6

- **Midterm 1**
- Local image features
- Interest point detection
  - Corner detection
  - Harris corner detectors

Week 7

- SIFT descriptor
- Multi-view geometry
  - Homography
- Image stiching

Week 8

- Stereo estimation
- Motion analysis
- Optical flow

Week 9

- Machine learning
  - A 10,000 km high view of deep learning
- K-nearest neighbours
- Naive Bayes classifier
- Linear classifiers
  - Bias and variance

Week 10

- Mixture of Gaussians
- Dimensionality reduction
  - Principle Component Analysis (PCA)
  - Eigen faces

Week 11

- **Midterm 2**
- Clustering
  - Meanshift clustering
  - Agglomerative clustering
  - Image segmentation

Week 12

- *Project presentations*

Course material

We will use the following textbook for this course. I will be assigning reading assignments from this textbook:

- *Computer Vision: Algorithms and Applications* by Szelski.

Students are encouraged to take their own notes during lectures.

Programming resources

We will primarily use Python + OpenCV in this course. I recommend that you install Anaconda Python Distribution, which comes prepackaged with all the necessary packages.

Grading

- Class participation, quizzes, and exercises 10%
- Lab participation and completion 30%
- Midterm exams 20%
- Course project 40%

A student must get 50% in the course project to pass the course.

Important dates

- Midterm 1 (70 minutes) on Feb 11
- Midterm 2 (70 minutes) on Mar 25
- Project selection due by Mar 4
- Project final presentations during last lecture
- Project report due on Apr 5

UOIT academic calendar that lists important dates (and deadlines) is available at here.

Class Participation and Inclass Exercises

Student participation in lectures and laboratories is strongly recommended. It is often difficult to assign a class participation mark. At the same time; however, I feel that it is important to reward students who make lectures lively and interesting for everyone. In order to assign class participation marks, I will provide in-class exercises during the last 20 to 30 minutes during most lectures. Theses exercises will require programming and will cover the topic currently under discussion. These exercises are due before the end of the lecture. When grading these exercises, I will focus more on the attempt rather then the correct solution. Paying attention during lectures and taking your own notes is one way to successfully complete these exercises.

Course Project

The students will work in teams of up to 2 and work on a course project. The topic of the project will be decided in consultation with the instructor. Students teams and course projects will be finalized before Feb 22. Course projects will require students to develop a computer vision system. Each team will be required to submit the project before the last week of classes. Each team will also do a 10 to 15 minute presentation during the last week of lectures, where they will present and defend their project. Some examples for course projects are:

- Image mosaicking;

- Object detection and classification;
- Activity recognition; and
- Crowd analysis; etc.

Course Work Submission

Unless otherwise instructed, all course work should be submitted using Blackboard Learn.

Partial marks

Assignments will primarily be evaluated based on the correctness of solutions; however, partial credit may be assigned for documentation, discussion, etc.

Remarking

It is extremely important that all work is fairly graded. Please submit a remark request by email within 5 days of receiving the grade. The email must contain the reasons for which you think the work should be remarked. *Please note that a remark may result in a lower grade.*

Late submission policy

The penalty for a late submission is 10% per day. An assignment or project will get a **zero** if submitted more than 24 hours after the submission deadline.

Email traffic

The instructor and the TA will make every effort to respond to emails in a timely manner; however, it may take up to two working days to respond to an email. It simply means that emails sent right before a deadline may not be answered in time. Urgent emails may be sent to "faisal.qureshi@uoit.net" with the subject line "csci 4220u - winter 2019".

Discussions

Appropriate use of discussion groups include clarification of lecture material and assignments and other concerns and comments about the course that might of general interest to course participants. Please do not post assignment solutions to the discussion groups.

Collaboration

I encourage you to work together when discussing assignments/projects; however, it doesn't mean that you should share your written solutions or that you submit someone else's work as your own.

Course evaluation

It is important that every student participates in course evaluations. Course evaluations, which are completely anonymous, provide extremely useful feedback to the instructor and the TA, helping improve the course.

Academic integrity

Assignments and tests must be strictly individual work. UOIT takes academic dishonesty very seriously. Please read and understand UOIT's policy on academic integrity available here

Accessibility

Students with disabilities may request to be considered for formal academic accommodation in accordance with the Ontario Human Rights Code. Students seeking accommodation must make their requests through the Centre for Students with Disabilities in a timely manner, and provide relevant and recent documentation to verify the effect of their disability and to allow the University to determine appropriate accommodations. More information about Student Accessibility Services (SAS) is available here.

Freedom of Information and Protection of Privacy Act

UOIT is governed by the Freedom of Information and Protection of Privacy Act ("FIPPA"). In addition to providing a mechanism for requesting records held by the university, this legislation also requires that UOIT not disclose the personal information of its students without their consent. FIPPA's definition of "personal information" includes, among other things, documents that contain both your name and your Banner ID. To ensure that your rights to privacy are protected, the I encourage you to use only your Banner ID on assignments or test papers being submitted for grading (the exception to this rule are midterm and final exams, since these are returned individually). This policy is intended to prevent the inadvertent disclosure of your information where graded papers are returned to groups of students at the same time. If you still wish to write both your name and your Banner ID on your tests and assignments, please be advised that UOIT will interpret this as an implied consent to the disclosure of your personal information in the normal course of returning graded materials to students. Please contact the UOIT Chief Privacy Officer at *accessandprivacy@uoit.ca* for more information.

Sexual Violence Policy

UOIT is committed to the prevention of sexual violence in all is forms. For any UOIT student who has experienced Sexual Violence, **UOIT can help**. UOIT will make accommodations to cater to the diverse backgrounds, cultures, and identities of students when dealing with individual cases.

If you think you have been subjected to or witnessed sexual violence:

- Reach out to a Support Worker, who are specially trained individuals authorized to receive confidential disclosures about incidents of sexual violence. Support Workers can offer help and resolutions options which can include safety plans, accommodations, mental health support, and more. To make an appointment with a Support Worker, call 905.721.3392 or email supportworker@uoit.ca
- Learn more about your options at: www.uoit.ca/sexualviolence