CIT-690 Computer Vision

Lectures: Virtual Sundays 5:30-7:30 pm [Cairo Time GMT+2]
Labs: Virtual Tuesdays 6:00 - 7:00 pm [Cairo Time GMT+2]
Credit Hours: 3

Instructor: Dr. Mennatullah Siam <msiam@eecs.yorku.ca>,

Office Hours: Sundays 7:30-8:30 pm

TA: Eng. Marwa Shams <marwashams@gmail.com>,

Office Hours: Tuesdays 7:00-7:30 pm

Overview

Computer vision studies mathematical techniques that include both classical and machine learning based methods towards the goal of scene and video understanding, and recovering the 3D shape and appearance of objects in images. Different subtasks such as optical flow, motion detection, tracking, segmentation/grouping, and 3D reconstruction are studied towards such a goal. It serves a wide variety of applications including autonomous driving, understanding satellite imagery, medical image processing among others.

In this course we will study projective geometry, camera models, camera calibration and how to perform 3D reconstruction from stereo. We will also study motion estimation, tracking and classical segmentation techniques. The course will cover the background material around these topics in the lectures along with labs to help students understand the practical knowledge necessary for applying computer vision techniques. Students will participate in presentations about reading materials/papers related to these topics, along with conducting written/programming assignments and their main project. In order to assess their ability for understanding and applying different computer vision techniques.

Students must be familiar with programming languages, specifically python for both the programming assignments and the project.

Course work:

- Assignments: 30%

  (Assignment 1: 12%, Assignment 2: 12%, Assignment 3: 6%)

- Student Presentation: 20%
- Attendance and participation: 15% (Lab Tutorials)
- Project: 35% (10% proposal & review, 20% implementation, 5% final report)

References:

For the theoretical concepts we will use both text books:

1- Computer Vision: Applications and Algorithms. Richard Zseliski.

2- Multiple View Geometry in Computer Vision, Richard Hartley and Andrew Zisserman.

For the practical part in the labs we will be referring to:

1- Learning OpenCV, Gary Bradski and Adrian Kaehler.

TENTATIVE SCHEDULE:

Week 1 – Introduction to Computer Vision [27 February, 5:30-7:30 pm]

- History of Computer Vision
- Applications
- Image Formation Pipeline

Tutorial: Intro to OpenCV

Week 2 – Feature Extraction [6 March]

- Interest Point Detection (Harris Corners)
- Edge Detection

Tutorial:

Edge Detection

Harris Corners

Week 3 – Feature Extraction Cont, Optical Flow [13 March]

- Lines, Hough Lines
- Hough Circles
- Lucas Kanade Flow
- Geometric Primitives

Tutorial:

Lucas Kanade Optical Flow

Week 4 – 2D Projective Transformations [20 March]

- Basic 2D Transformations
- 2D Homography (DLT)
- 2D Homography (LLS, RANSAC)
- Image Warping

Tutorial:

2D Projective Transformations Playground

Week 5 – Visual Tracking [27 March]

- KLT Tracker
- Mean-shift Tracking

Tutorial:

OpenCV trackers

Week 6 – Image Segmentation [3 April]

- Active Contours (Snakes)
- GMMs

Tutorial:

Region Growing

Week 7 – Deep Learning [10 April]

- Convolutional Neural Networks
- Gradient Descent Optimization Techniques
- Image Classification

Tutorial:

Image classification with Pytorch

1-4 May - Eid AlFitr

19,24,26 April - Student Presentations + Project Discussion

Week 8 – Deep Learning II [8 May]

- Object Detection with CNNs
- Deep Semantic Segmentation

Tutorial:

Semantic segmentation with Pytorch

Week 9 – Camera Models and Calibration [15 May]

Tutorial:

Calibration Toolbox (OpenCV)

Week 10 – Epipolar Geometry [22 May]

- Fundamental Matrix
- Properties
- Fundamental Matrix Estimation

Tutorial:

Fundamental Matrix (OpenCV)

Week 11 – Stereovision [29 May]

- Stereo Matching
- Stereo Rectification
- Triangulation

Tutorial:

Stereo Matching/Rectification (OpenCV)

Week 12 - Project Discussions [28 - 30 June]

Student Presentations:

Student selected papers for discussion that are selected from top tier conferences including: CVPR - ICCV - ECCV - Neurips - ICML - ICLR.