Computer Vision (CMPS 3660)

This course provides a comprehensive introduction to computer vision. Major topics include image processing, detection and recognition, and video analysis. Students will learn basic concepts of computer vision as well as hands on experience to solve real-life vision problems.

Textbook

Readings will be assigned from the following textbook (available online for free):

- **Computer Vision: Algorithms and Applications**, by Richard Szeliski.
- https://szeliski.org/Book/

Additional readings will be assigned from relevant papers. Readings will be posted on the website.

The following textbooks can also be useful references for different parts of the class, but are not required:

- *Computer Vision: A Modern Approach,* by David Forsyth and Jean Ponce.
- *Digital Image Processing,* by Rafael Gonzalez and Richard Woods.

Course Module

Week 1 – Session 1	**Course Introduction**
Week 1 – Session 2	**Image Filtering**
Week 2 – Session 1	**Image Pyramids and Frequency Domain**
Week 2 – Session 2	**Hough Transform**
Week 3 – Session 1	**Detecting Corners**
Week 3 – Session 2	**Feature Detectors and Descriptors**

Week 4 – Session 1	**2D Transformations**
Week 4 – Session 2	**Image Homographies**
Week 5 – Session 1	**Geometric Camera Models**
Week 5 – Session 2	**Geometric Camera Models (cont.)**
Week 6 – Session 1	**Two-View Geometry**
Week 6 – Session 2	**Stereo**
Week 7 – Session 1	**Image Classification**
Week 7 – Session 2	**Image Classification (cont.)**
Week 8 – Session 1	**Neural Networks**
Week 8 – Session 2	**Neural Networks (cont.)**
Week 9 – Session 1	**Convolutional Neural Networks**
Week 9 – Session 2	**Optical Flow**
Week 10 – Session 1	**Alignment and Tracking**
Week 10 – Session 2	**Alignment and Tracking (cont.)**
Week 11 – Session 1	**Radiometry and Reflectance**
Week 11 – Session 2	**Radiometry and Reflectance (cont.)**
Week 12 – Session 1	**Photometric Stereo**
Week 12 – Session 2	**Digital Photography**
Week 13 – Session 1	**Digital Photography (cont.)**
Week 13 – Session 2	**Special Topics [Autonomous Driving]**

Assignments

Programming Assignment 1: Image Filtering and Hough Transform

Programming Assignment 2: Augmented Reality with Planar Homographies

Programming Assignment 3: 3D Reconstruction

Programming Assignment 4: Scene Recognition with Bag of Words

Programming Assignment 5: Neural Networks for Recognition

Programming Assignment 6: Video Tracking

Quizzes

Quiz 1: Convolutions and Fourier transforms

Quiz 2: Corners and Covariance Matrices

Quiz 3: Transformations, Heterogeneous, and Homogeneous Coordinates

Quiz 4: Camera Projection Matrices

Quiz 5: Essential and Fundamental Matrices

Quiz 6: Fundamental Matrices (cont.) and Nearest Neighbors

Quiz 7: Neural Networks

Quiz 8: Image Alignment

Quiz 9: Radiometry and Reflectance

Quiz 10: Photometric Stereo

Evaluation

Your final grade will be made up from:

- Six programming assignments (70%).
- Ten take-home quizzes (25%).
- Class participation (5%).

Programming assignments: Programming assignments (PAs) will require implementing a significant computer vision algorithm. Some of them will also have a small theory component relevant to the implementation. Programming will be done in Python.

Take-home quizzes: Take-home quizzes (TQs) will require solving two-three theory questions related to the corresponding week's two lectures.