Algorithms and Applications in Computer Vision - 046746
(3.0 Credit pts)

What
The course focuses on fundamental problems in computer vision describing practical solutions including stat-of-the-art deep learning approaches. The topics covered in the course range from semantic tasks like classification and segmentation to structure from motion (SfM), 3D reconstruction, and Stereo imaging. The course includes Python homework exercises aimed at enhancing the understanding of the various techniques as well as exposing students to actual implementation details.

When/Where

	When	Where
Lectures	Tues. 08:30-10:30	Meyer 165
Tutorials	Tues. 16:30-17:30	Meyer 165
	Wed. 14:30-15:30	Meyer 353

Who

	Name	Office	Office Hours
Lecturer	Prof. Anat Levin	Meyer 958 anat.levin@ee.technion.ac.il	**Send e-mail before (TBD)**
Teaching Assistant (Head TA)	Elias Nehme	Meyer 514 seliasne@campus.technion.ac.il	**Send e-mail before**
Teaching Assistant	Hila Manor	Fishbach 346 hila.manor@campus.technion.ac.il	**Send e-mail before**
HW	Alon Cohen	alon-cohen@alumni.technion.ac.il	**Send e-mail before**
	Inbal Kom Betzer	inbalkom@campus.technion.ac.il	**Send e-mail before**

Syllabus
- Image formation: The digital camera, Geometric transformations.
- Feature detection: Edge detection, Corner detection, Image Pyramids, Feature Descriptors.
- Deep learning: Supervised learning, Convolutional neural networks.
- Recognition: Image classification, Semantic Segmentation, Object Detection, Object Tracking.
- Feature matching: Image alignment and stitching, Motion estimation (Optical flow).
- 3D computer vision: Structure from Motion (SfM) and SLAM, Depth estimation and Epipolar geometry, Volumetric representations.
- Intro to computational photography.

Tentative schedule

Week	Lecture		Tutorial		Instructor
0	-		Pre-recorded	Python + Image Processing	Tal Daniel
1	26.10.2021	Intro + Camera	26.10.2021	Edge Detection	Elias Nehme
			27.10.2021		Hila Manor
2	02.11.2021	Features	02.11.2021	Probabilistic Discriminative Learning	Elias/Hila
			03.11.2021		
3	09.11.2021	Classification	09.11.2021	Deep Learning 1	Elias/Hila
			10.11.2021		

4	16.11.2021	CNNs	16.11.2021 17.11.2021	Deep Learning 2	Elias/Hila
5	23.11.2021	Segmentation	23.11.2021 24.11.2021	Deep Segmentation	Elias/Hila
6	30.11.2021	Hanuka	30.11.2021 01.12.2021	Hanuka	-
7	07.12.2021	Geometry	07.12.2021 08.12.2021	Homography	Elias/Hila
8	14.12.2021	Geometry	14.12.2021 15.12.2021	Object Detection	Elias/Hila
9	21.12.2021	Geometry	21.12.2021 22.12.2021	Geometry Review	Elias/Hila
10	28.12.2021	Geometry	28.12.2021 29.12.2021	Structure from Motion	Elias/Hila
11	04.01.2022	Stereo	04.01.2022 05.01.2022	3D Deep Learning	Elias/Hila
12	11.01.2022	Photometric Stereo	11.01.2022 12.01.2022	Reflectometry	Elias/Hila
13	18.01.2022	Optical Flow	18.01.2022 19.01.2022	Deep Tracking	Elias/Hila
14	25.01.2022	Computational Photography	25.01.2022 26.01.2022	Deep Imaging	Elias/Hila

Grading

The grade will be determined according to 45% Homework exercises + weekly Quizzes, and 55% Final Exam. The tentative HW schedule is:

HW	Subject	Out	Due	Weight
0	Image Processing Basics	26.10.2021	02.11.2021	Binary
1	Feature Descriptors	02.11.2021	23.11.2021	10%
2	Classifiers and Segmentation	23.11.2021	21.12.2021	10%
3	Homography and Panorama Stitching	21.12.2021	04.01.2022	10%
4	Structure from Motion	04.01.2022	26.01.2022	10%

The weekly Quizzes constitute 5% of the overall grade and are going to be dry and short (~ 1 question) to verify students are keeping up with the course material. The final exam dates are:

- Exam A – Tues., 03.02.2022.
- Exam B – Wed., 03.03.2022.

*Note that a passing grade in the exam (>55) is mandatory to successfully complete the course, regardless of the HW grades.

Prerequisites

- Image Processing and Analysis (046200)
- Linear algebra and vector calculus

- Basic probability theory and statistics
- Recommended: Data structures, Python programming, and Machine/Deep Learning.

For special cases (*e.g.* graduate students) – please contact the lecturer.

Literature

Classical textbooks

- Hartley, Richard, and Andrew Zisserman. *Multiple view geometry in computer vision*. Cambridge university press, 2003.
- Szeliski, Richard. *Computer vision: algorithms and applications*. Springer Science & Business Media, 2010.

Other

- Various research papers in the relevant fields from the last couple of years.