

CS6350: Computer Vision

July-Nov Semester 2021

‘C’ Slot;

Slots: Mon (10:00–10:50), Tue (09:00–09:50)

Wed: (08:00–08:50) and Fri (12:50–12.50)

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Note: The course webpage is www.cse.iitm.ac.in/~vplab/computer_vision.html. A google group will be formed for course related communications; please check the e-mail regularly.

1 Course Objectives

Computer Vision focuses on development of algorithms and techniques to analyze and interpret the visible world around us. This requires understanding of the fundamental concepts related to multi-dimensional signal processing, feature extraction, pattern analysis visual geometric modeling, stochastic optimization etc. Knowledge of these concepts is necessary in this field, to explore and contribute to research and further developments in the field of computer vision. Applications range from biometrics, medical diagnosis, document processing, mining of visual content, to surveillance, advanced rendering etc.

2 Learning Outcomes

- To apply mathematical modeling methods for low-, intermediate- and high- level image processing tasks
- To be able to design new algorithms to solve recent state of the art computer vision problems.
- To perform software experiments on computer vision problems and compare their performance with the state of the art.
- To develop a broad knowledge base so as to easily relate to the existing literature.
- To gather a basic understanding about the geometric relationships between 2D images and the 3D world.
- To build a complete system to solve a computer vision problem.

3 Course prerequisite(s)

COT

4 Classroom Mode

Traditional online lectures (4 * 50 mins slots per week) with slides. Tentatively, every alternate week tutorials are planned to be conducted within these slots, resulting in about 6-7 tutorials. Few extra hours of lecturing may be needed.

5 Textbooks

- Richard Szeliski, Computer Vision: Algorithms and Applications, Springer-Verlag London Limited 2011.
- Richard Hartley and Andrew Zisserman, Multiple View Geometry in Computer Vision, 2nd Edition, Cambridge University Press, March 2004

6 Reference Books

- R. Bishop; Pattern Recognition and Machine Learning, Springer, 2006
- K. Fukunaga; Introduction to Statistical Pattern Recognition, Second Edition, Academic Press, Morgan Kaufmann, 1990.
- R.C. Gonzalez and R.E. Woods, Digital Image Processing, Addison- Wesley, 1992.

7 Course Requirements

You are required to attend all the lectures. If you miss any of them it is your responsibility to find out what went on during the classes and to collect any materials that may be handed out.

Class participation is strongly encouraged to demonstrate an appropriate level of understanding of the material being discussed in the class. Regular feedback from the class regarding the lectures will be very much appreciated.

8 Planned Syllabus

- Digital Image Formation and low-level processing: Overview and State-of-the-art, *Fundamentals of Image Formation, Transformation: Orthogonal, Euclidean, Affine, Projective, etc; Fourier Transform, Convolution and Filtering, Image Enhancement, Restoration, Histogram Processing*
- Depth estimation and Multi-camera views: *Perspective, Binocular Stereopsis* : Camera and Epipolar Geometry; Homography, Rectification, DLT, RANSAC, 3-D reconstruction framework; Auto-calibration.
- Feature Extraction: Edges - Canny, LOG, DOG; Line detectors (Hough Transform), Corners - Harris and Hessian Affine, Orientation Histogram, SIFT, SURF, HOG, GLOH, Scale-Space Analysis- Image Pyramids and Gaussian derivative filters, Gabor Filters and DWT.
- Image Segmentation: *Region Growing, Edge Based approaches to segmentation, Graph-Cut, Mean-Shift, MRFs, Texture Segmentation;*
- Pattern Analysis: *Basics of Probability and Statistics, Clustering: K-Means, K-Medoids, Mixture of Gaussians, Classification: Discriminant Function, Supervised, Un-supervised, Semi-supervised; Classifiers: Bayes, KNN, ANN models; Dimensionality Reduction: PCA, LDA, ICA; Non-parametric methods.*
- Motion Analysis: Background Subtraction and Modeling, Optical Flow, KLT, Spatio-Temporal Analysis, Motion parameter estimation.
- Shape from X: Illumination models- Phong; Reflectance Map; Albedo estimation. Photometric Stereo; Surface Smoothness Constraint; Shape from Texture, color, motion & edges.

The topics shown in *italic* font will be left for self-study.

9 Tentative Grading Policy

The following allocation of marks is tentative. The flexibility will be used to the benefit of average grades for the entire class.

| | |
|------------------------------------|----------------|
| Quiz (50 mins) | 15 - 20 |
| End sem Exam (120-150 mins) | 35 - 40 |
| TPA | 30 - 35 |
| Tuts | 10 - 15 |
| Total | 100 |

10 Tentative Schedule (Dates)

Tentative dates of activities throughout the semester:

| | |
|-----------------------------------|------------------------------|
| Finalizing the groups by students | 20/08/2021 |
| Choice of TPA by students | 28/08/2021 |
| TPA Assignment to each group | 31/08/2021 |
| TA Interaction for TPA | 21/09/2021 |
| Interim TPA Review (optional) | 5/10/2021 |
| Final TPA Demo | TBD |
| Tutorial* Dates | TBD |
| Extra Classes | TBD |
| End Semester Exam | As per institute regulations |

* Tutorials will be conducted online in closed book mode.

11 Academic Honesty & Misc

Academic honesty is expected from each student participating in the course. NO sharing (willing, unwilling, knowing, unknowing) of assignment code between students, submission of downloaded code (from the Internet, or anywhere else) is allowed.

Academic violations will be handled by IITM Senate Discipline and Welfare (DISCO) Committee. Typically, the first violation instance will result in ZERO marks for the corresponding component of the Course Grade and a drop of one-penalty level in final course grade. The second instance of code copying will result in same as above for marks but drop of two levels of final course grades at end of semester. The DISCO Committee of IIT Madras will also be intimated of the matter.

Please protect your Moodle account password. Do not share it with ANYONE. Do not share your academic disk drive space on the Campus LAN.

Each proxy in the attendance will be penalized by 5% of (absolute) marks. It becomes 2% each for the donor & beneficiary, if both accept the fault.

Tutorials are not exams. Occasional exchange of technical ideas is permitted, but not copying. No complaints of copying will be entertained after the tutorial. If you find anybody copying, immediately inform the TAs present. If guilty, their submissions will not be evaluated and they will obtain zero marks for that tutorial.

Based on CSE-DCC approval, re-evaluation of online End Sem exam papers will only be done in front, after institute reopens. Only minor clarifications, totaling errors, any missed corrections will be considered till that time.