CS6350: Computer Vision

Jan-May Semester 2019
'B' Slot; CS 34
Slots: Mon (09–09.50), Tue (08:00–08.50), Wed (12:00–12.50) and Fri (11:00–11.50)
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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 lectures (4 × [50 mins. slots] per week) with slides. Seven tutorials are tentatively planned to be conducted within these slots.

5 Textbooks

- Richard Szeliski, Computer Vision: Algorithms and Applications, Springer-Verlag London Limited 2011.
- Computer Vision: A Modern Approach, D. A. Forsyth, J. Ponce, Pearson Education, 2003.

6 Reference Books

- Richard Hartley and Andrew Zisserman, Multiple View Geometry in Computer Vision, Second Edition, Cambridge University Press, March 2004.
- 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; Object detection.
- 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, Dynamic Stereo; Motion parameter estimation.
- Shape from X: Light at Surfaces; Phong Model; Reflectance Map; Albedo estimation. Photometric Stereo; Use of Surface Smoothness Constraint; Shape from Texture, color, motion and 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.

End Sem Exam	35-40
Mid Sem	15-20
Tutorials	10-15
TPA	30-35
Total	100

10 Tentative Dates

Tentative dates of activities throughout the semester:

Finalizing the groups by students	30/01/2019
Choice of TPA by students	06/02/2019
TPA Assignment to each group	13/02/2019
TA Interaction for TPA	20/03/2019
Interim TPA Review (optional)	04/04/2019 (17:00-18:00)
Final TPA Demo	25/04/2019, 13/05/2019
Tutorial Dates	30/01/2019, 13/02/2019, 27/02/2019, 13/03/2019, 27/03/2019, 10/04/2019, 24/04/2019
Extra Classes	23/02/2019 30/03/2019
Mid Semester Exam	06/03/2019 (12:00-13:00)
End Semester Exam	30/04/2019 (09:00-12:00)

11 Academic Honesty

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, Campus LAN, 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 in overall course grade. The second instance of code copying will result in a 'U' Course Grade and/or other penalties. The DISCO Committee can also impose additional penalties.

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, inform the TAs present immediately. If guilty, their copies will be taken away and they will be marked 0 for that tutorial