Syllabus

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1 Summary

Credits 4 (expected workload of 8 hours per week).

Location and time IC3.5 352, Tuesday and Thursday from 10:00 to 12:00.

Website classroom.google.com

Office hours Meetings are on demand. Send an email to schedule.

Learning objective The student will apply different computer vision techniques to address problems (extract information, create models, and make decisions) related to images and video.

Language The course will be offered in English.

2 Course Description

This course is an introduction to the theory and practice of computer vision, i.e., the analysis of patterns in images to understand the objects and processes in the world that generated them. Major topics include image processing, feature descriptors, geometry and motion, tracking, recognition, photometry, and segmentation. The emphasis of the course is on learning the core mathematical concepts and techniques, and their translation to programs to solve vision problems.

3 Pre-Requisites

- Data structures. The students will be writing code that builds a representation of images, features, and geometric constructions.
- A good working knowledge of C++ and/or Python. The programming assignments must be developed using OpenCV, which uses either language and should be tested in a constrained environment. Knowledge of Docker, version control (git), and makefiles is desired.
- This course has more math than many CS courses: Linear algebra, vector calculus, and linear algebra (that is not a typo).
- No prior knowledge of vision is assumed though any experience with Signal Processing or Image Processing will be helpful.

4 Topics

1. **Image processing.** Linear filtering, convolution and filters, edges and lines, Hough transform and shapes, and frequency domain.
2. **Feature descriptors.** Feature detection, feature descriptors, and model fitting.
3. **Geometry.** Camera models, stereo geometry, camera calibration, and multiple views.

Table 1. Grading weights per assignments.

Assignment	Grade %
HW 1	15
HW 2	15
HW 3	15
HW 4	15
Project	25
Miscellaneous	15
Total	**100**

Table 2. Grading scale conversion for postgraduates students.

Grade	Grade %
A	≥ 85
B	≥ 70
C	≥ 50
D	< 50

4. **Flow.** Motion and optical flow, motion models, and pyramids.
5. **Tracking.** Kalman and particle filters.
6. **Recognition.** Classification: generative and discriminative, part-based models, and deep learning.
7. **Activity recognition.** Introduction to activity recognition.
8. **Light and shading.** Photometry, lightness, and shape from shading.
9. **Grouping.** Clustering and segmentation.

5 Grading

The evaluation will be done based on four homework assignments (mini-projects), and one final project. Additionally, we will have miscellaneous assignments in which their grade will be distributed proportionally (weights will be defined during the course). The miscellaneous tasks comprise daily readings, occasional quizzes, and participation in class and online. The weights of each item are shown in Table 1.

In order to get a pass in the course, students must get at least an average of 50% on the homework assignments' and project's grades. Otherwise, the student will **fail the course**. This measure is to avoid skipping projects, as they are the core activity to evaluate student's knowledge in the course. For post-graduate students, the percentage will be converted to a grade based on Table 2.

The schedule for the readings and the due dates for the projects will be announced during the course. **This course has no exam.** The final project has a **poster presentation** that would happen in conjunction with other graduate courses on **November 27th**.

6 General Information

6.1 Attendance

Since we have daily readings (that will be evaluated, see § 5), the attendance is highly recommended as the student will miss these evaluations. Moreover, students are highly expected to discuss and participate during class. Thus, missing classes will prevent the development of the students' knowledge during the course. Hence, a student with less than 75% attendance will **fail the course**.

6.2 Late Work

Every project will have two deadlines (except the final project due to time constraints during the semester). After the first one, there is a 10% accumulative penalty per 24 hours late, up to five times. After that, there will be no submission for the assignment.

6.3 Honesty and Integrity Policy

Projects are to be done by the students, that can collaborate on a broad level. Students may help each other in a general sense, but **the code submitted by each student must be their own**. Anything taken from the internet or from other students is not your own and will be considered plagiarism.

Any instance of plagiarism, cheating, or anti-ethical behavior implies immediate failure (zero) in the course.

6.4 Materials

All the materials to be used in class will be available on our website, supported by Grupo Gestor de Tecnologias Educacionais (GGTE), at the URL: https://classroom.google.com/. Therefore, materials will not be distributed in class.

7 Bibliography

Mandatory

[1] D. Forsyth and J. Ponce, *Computer Vision: A Modern Approach*, 2nd ed., ser. Always learning. Pearson, 2012.

[2] R. Szeliski, *Computer Vision: Algorithms and Applications*, 1st ed. New York, NY, USA: Springer-Verlag New York, Inc., 2010, http://szeliski.org/Book/.

[3] I. Goodfellow, Y. Bengio, and A. Courville, *Deep Learning*. MIT Press, 2016, http://www.deeplearningbook.org.

Complementary

[4] *Research papers*, Several research papers to be announce during the semester.