Principles and Algorithms of Computer Vision

CAP 5415, Fall 2014
Department of Computer Science, Florida State University

Class time and location

Monday, Wednesday, and Friday, 02:30PM – 3:20 PM, LOV 301

Instructor

- Instructor: Xiuwen Liu (pronounced as Shu-wen Lea-l)
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- Office Hours: Monday and Wednesday, 1:15 PM – 2:15PM and by appointments

Teaching Assistant

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- Office: TBA
- Office hours: Monday, 11:30AM-12:30PM and 1:00PM-2:00PM

Class Home Page

http://www.cs.fsu.edu/~liux/courses/cap5415-2014/index.html.
This web site contains the up-to-date information related to this class such as news, announcements, assignments, lecture notes, and useful links to resources that are helpful to this class. Besides the web pages, Blackboard will be used to communicate changes and updates and post grades for this class; in particular, I will send emails using email addresses in the Blackboard system and please make sure that your email address on record is current.

Rationale

With the advances in software and hardware, intelligent components have become the most deciding factor in many applications and systems with intelligent components appear in daily news on a regular basis. Among different choices of sensors, visual sensors, i.e., cameras (and eyes in biological systems), are most efficient and effective in acquiring data of the environment and deriving information from the visual input should clearly be one of the important means and many applications such as automated target recognition have been long studied. Beyond visible spectra, advances in medical imaging and microscopic imaging have made computer vision and related techniques critical for many medical and biological applications. Additionally, with several decades of research, computer vision and related techniques are mature enough for solving problems in numerous applications.

Course Description

This course provides introductory but comprehensive coverage of principles, techniques, and algorithms to solve problems in computer vision, including linear and nonlinear filtering, edge/corner detection, stereopsis for 3D reconstruction, image segmentation and grouping, motion estimation, texture modeling, appearance-based recognition, tracking, and deformable template matching. It also offers opportunities to explore applications of computer vision techniques in solving real world problems, such as face detection and recognition.

Prerequisites

COP 4530 – Data Structures, Algorithms, and Generic Programming; basic knowledge and programming experience in any commonly used programming language (for example, C, C++, Java, or Matlab); basic knowledge and understanding of linear algebra algorithms and operations.

Course Objectives

Upon successful completion of this course of study, the student will:

- Have general knowledge of computational approaches and paradigms in image analysis and computer vision.
- Know imaging models and how images are generated.
- Understand how to model linear systems and know how to implement linear and nonlinear filtering.
- Know how to design and implement edge detection algorithms.
- Know the basic principles of stereopsis and how to implement basic 3D recovery algorithms from 2D images.
- Understand the basics of texture modeling and algorithms for texture classification.
- Know the basic principles of motion estimation and how to implement optical flow estimation algorithms.
- Understand the fundamental problems and importance of segmentation and grouping and know how to implement basic segmentation and grouping algorithms.
- Understand the issues in object recognition from images and know how to implement basic template matching and deformable template matching algorithms.
- Understand the basics of pattern theory and Bayesian framework for computer vision.
- Know the general approaches to solving real world problems such as face recognition, face detection, vision-based computer graphics, and tracking.
- Have some experience with research in computer vision.

Textbook and Course Materials

Required textbook: "Computer Vision: Algorithms and Applications," Springer, 2010, by Richard Szeliski. An online version available at http://www.szeliski.org/Book/drafts/SzeliskiBook_20100903_draft.pdf (September 3, 2010 version).

Optional reference book but not required: "*Computer Vision -- A Modern Approach*", Prentice Hall, 2003, by David Forsyth and Jean Ponce.

In addition to the textbook, papers and notes from the literature will be distributed along the lectures, including the following journals and conference proceedings:

- *IEEE Transactions on Pattern Analysis and Machine Intelligence.*
- *Internal Journal on Computer Vision*
- *Computer Vision and Image Understanding*
- *Proceedings of the International Conference on Computer Vision and Pattern Recognition.*
- *Proceedings of the International Conference on Computer Vision.*
- *Proceedings of the International Conference on Image Processing.*
- *Proceedings of the European Conference on Computer Vision*
- *Proceedings of the International Conference on Pattern Recognition.*

Student Responsibilities

Attendance is required for this class. Unless you obtain prior consent of the instructor, missing classes will be used as bases for attendance grading. In case that it is necessary to skip a class, students are responsible to make up missed materials. Participation of in-class discussions and activities is also required. All submitted assignments and projects must be done by the author(s). It is a violation of the Academic Honor Code to submit other's work and the instructor of this course takes the violations very seriously.

Assignments and Projects

About five homework assignments (including short programs in Matlab or other languages) will be given along the lectures and they need to be turned in. There will be two programming projects and a term project, which can be done in any programming language including Matlab, Java, and C/C++. Optionally, one can choose a grand project to substitute the two programming projects and the term project. There will be a midterm exam and no final exam.

Grading Policy

Grades will be determined as follows:

Assignment	Points	Assignment	Points
Class Attendance and Participation	10 %	Programming Project II	10 %
Homework Assignments	25 %	Term Project	15 %
Programming Project I	10 %	Midterm Exam	30 %

Grading will be based on the weighted average as specified above and the following scale will be used (suppose the weighted average is S in 100 scale)

Score	Grade	Score	Grade	Score	Grade
$93 \leq S$	A	$80 \leq S < 83$	B-	$67 \leq S < 70$	D+
$90 \leq S < 93$	A-	$77 \leq S < 80$	C+	$63 \leq S < 67$	D
$87 \leq S < 90$	B+	$73 \leq S < 77$	C	$60 \leq S < 63$	D-
$83 \leq S < 87$	B	$70 \leq S < 73$	C-	$S < 60$	F

Late Penalties

Assignments are due at the beginning of the class on the due date. Assignments turned in late, but before the beginning of the next scheduled class will be penalized by 10 %. Assignments that are more than one class period late will **NOT** be accepted.

Submission and Return Policy

All tests/assignments/projects/homework will be returned as soon as possible after grading but no later than two weeks from the due date.

Tentative Schedule

- Week 1: Introduction (Chapter 1)
  - General introduction to computer vision.
  - A brief introduction to the human visual information processing.
  - Fundamental problems and computational paradigms in computer vision.
  - Image formats, reading and writing images.
- Week 2: Point operations, algebraic operations, and geometric operations, morphological operators, linear and nonlinear filtering (Chapter 3).
- Weeks 3-4: Edge, corner, and other feature estimation and description (Chapter 4).
- Week 5: Camera/imaging models (Chapter 2)
- Weeks 6-7: Calibrated 3D reconstruction; stereopsis and algorithms to recover 3D information from 2D images (Chapters 7 and 11).
  - Introduction to shape analysis.
- Weeks 8-9: Segmentation (Chapter 5).
- Weeks 10-12: Recognition (Appendix B and Chapter 14).
- Week 13: Review and midterm exam.
- Week 13: Motion estimation (Chapters 6, 8, and 9).
- Week 14: Tracking (Chapter12).
- Week 15: Summary and Case studies (Chapters 10 and 13).
- Term Project, Due on Friday, 5:00PM, December 12, 2014

Academic Honor Code

The Florida State University Academic Honor Policy outlines the University's expectations for the integrity of students' academic work, the procedures for resolving alleged violations of those expectations, and the rights and responsibilities of students and faculty members throughout the process. Students are responsible for reading the Academic Honor Policy and for living up to their pledge to ". . . be honest and truthful and . . . [to] strive for personal and institutional integrity at Florida State University." (Florida State University Academic Honor Policy, found at http://dof.fsu.edu/honorpolicy.htm)

Assignments/projects/exams are to be done individually, unless specified otherwise. It is a violation of the Academic Honor Code to take credit for the work done by other people. It is also a violation to assist another person in violating the Code (See the FSU Student Handbook for penalties for violations of the Honor Code). The judgment for the violation of the Academic Honor Code will be done by the instructor and a third party member (another faculty member in the Computer Science

Department not involved in this course). Once the judgment is made, the case is closed and no arguments from the involved parties will be heard. Examples of cheating behaviors include:

❖ Discuss the solution for a homework question.
❖ Copy programs for programming assignments.
❖ Use and submit existing programs/reports on the world wide web as written assignments.
❖ Submit programs/reports/assignments done by a third party, including hired and contracted.
❖ Plagiarize sentences/paragraphs from others without giving the appropriate references. Plagiarism is a serious intellectual crime and the consequences can be very substantial.

Penalty for violating the Academic Honor Code: A 0 grade for the particular assignment/quiz/exam and a reduction of one letter grade in the final grade for all parties involved for each occurrence. A report will be sent to the department chairman for further administrative actions.

Accommodation for Disabilities

Students with disabilities needing academic accommodations should: 1) register with and provide documentation to the Student Disability Resource Center (SDRC), and 2) bring a letter to the instructor indicating the need for accommodation and what type. This should be done within the first week of class. *This syllabus and other class materials are available in alternative format upon request.*

For more information about services available to FSU students with disabilities, contact the Assistant Dean of Students:
Student Disability Resource Center
97 Woodward Avenue, South
108 Student Services Building
Florida State University
Tallahassee, FL 32306-4167
(850) 644-9566 (voice)
(850) 644-8504 (TDD)
sdrc@admin.fsu.edu
http://www.disabilitycenter.fsu.edu/