Course Syllabus

ECE 6930 - Special Topics in Electrical Engineering

"Machine Vision in Control and Automation"

Summer 2002, Independent Study Course.

Instructor: YangQuan Chen, Center for Self-Organizing and Intelligent Systems
Department of Electrical and Computer Engineering, Utah State University
Room EL-256. T: (435) 797-0148, E: yqchen@ece.usu.edu
Consulting Professor: Kevin L. Moore.
Office Hours: Friday 3:00 PM to 5:30 PM or by appointment.

Text: D. A. Forsyth and J. Ponce, ***Computer Vision: A Modern Approach***. Prentice Hall, 2003. (Early version of the e-copy is available, 973 pages.)

References:
Books:
[1]. L. G. Shapiro and G. C. Stockman, *Computer Vision*, Prentice Hall, 2001.
[2]. A. Watt, *The Computer Image*, Addison-Wesley, 1998.
[3]. M. Sonka, V. Hlavac and R. Boyle. *Image Processing, Analysis, and Machine Vision*, Brooks/Cole Publishing, 1999.
[4]. E. Trucco and A. Verri. *Introductory Techniques for 3-D Computer Vision*, Prentice-Hall, 1998.
[5]. R. Jain, R. Kasturi, and B. G. Schunck. *Machine Vision*, MacGraw-Hill, 1995.
[6]. V. S. Nalwa. *A Guided Tour of Computer Vision*, Addison-Wesley, 1993.
[7]. O. Faugeras. *Three-Dimensional Computer Vision*, MIT Press, 1993.

Survival URLs:
- http://www-2.cs.cmu.edu/afs/cs/project/cil/ftp/html/vision.html
- http://www.dai.ed.ac.uk/CVonline/
- http://iris.usc.edu/Vision-Notes/bibliography/contents.html

Journals
1. Computer vision and image understanding : CVIU
   (*USU* SCITECH Call #: TA 1632 .C835)
2. Graphical models and image processing : GMIP
   (*USU* SCITECH Call #: T 385 .C89)
3. CVGIP. Graphical models and image processing
   (*USU* SCITECH Call #: T 385 .C83)
4. International journal of computer vision
   (*USU* SCITECH Call #: TA 1632 .I57)
5. IEEE transactions on pattern analysis and machine intelligence (PAMI)
   (*USU* SCITECH Call #: Q 334 .I43)

Prerequisites: Undergraduate control systems (ECE4310, ECE5320) and graduate linear multivariable systems (ECE6320). A good working knowledge of C and C++ programming and Matlab/Simulink, Linear algebra, Vector calculus etc. No prior knowledge of vision is assumed. Knowledge with "Nonlinear and adaptive control" (ECE6330) will be an added advantage but not compulsory.

Credits: 3

Course Load: 10 hours per week. 12 weeks.

Course Requirements:

4 Projects	80 points
2 Literature Survey Reports:	20 points

(The details will be sent via email.)

There is no Mid-term Exam and Final Exam.

Notes:

1. This course is designed for 12 weeks summer independent study.
2. To get 3 credits, you have to spend at least 10 hours a week and 120 hours in total in this course, although you have the *flexibility* to arrange your efforts.
3. A weekly group discussion is encouraged (but not compulsory) in the Instructor's office in the course office hour. Friday 3:00pm-5:30pm.
4. Computer simulations will be necessary for some projects. Matlab/Simulink is the preferred computing environment for these simulations. In some projects, C/C++ programming is required.
5. *A CD containing the essential course materials is available from the Instructor.*

Course Description:

The goal of machine vision is to compute properties of the three-dimensional world from digital images. Problems in this field include identifying the 3D shape of an environment, determining how things are moving, and recognizing familiar people and objects, all through analysis of images and video. However, in control and automation applications, we are more interested in using vision to achieve better control performance for certain tasks not possible by other means.

In addition to common topics in machine vision such as feature detection, image segmentation, motion estimation and object recognition, we will emphasize on

1) *Visual servo problems such as visual servoing, visual docking, visual platooning, visual formation etc.*
2) *Template matching for applications such as visual inspection tasks in factory automation, picture retrieval in graphical database etc.*
3) *Camera calibration techniques for visual metrology applications.*

Appendix: Basic Syllabus and the Table of Contents

Extracted from the Text: D. A. Forsyth and J. Ponce, ***Computer Vision: A Modern Approach***. Prentice Hall, 2003. (Early version of the e-copy is available, 973 pages.)

One-Semester Introductory Class

This one-semester introduction to computer vision is designed for seniors or first-year graduate students in computer science, electrical engineering, or other engineering or science disciplines. The students receive a broad presentation of the field, including application areas such as digital libraries and HCI. Although the hardest theoretical material in differential geometry and probability theory is omitted, there is a thorough treatment of the basic geometry and physics of image formation. Note that this syllabus assumes that only parts of certain chapters be covered (e.g., only the introduction and Section1of Chapter 1, etc.).

1. Chapter 2 Radiometry
2. Chapter 3 Sources, Shadows and Shading
3. Chapter 4 Color
4. Chapter 1 Cameras
5. Chapter 8 and Chapter 9 Linear Filters and Edge Detection
6. Chapter 11 Texture
7. Chapter 22 Digital Libraries
8. Chapter 12 The Geometry of Multiple Views
9. Chapter 13 Stereopsis
10. Chapter 16 and Chapter 17 Segmentation and Fitting
11. Chapter 19 Tracking Using Linear Dynamic Models
12. Chapter 24 Correspondence and Pose
13. Chapter 25 Template Matching
14. Chapter 26 Recognition by Relations between Templates
15. Chapter 29 Toward Category-Level Recognition

and the enterprising may wish to read some of the other chapters on their own time.

Note that: the above should be considered as the "*bottom-line reading load*" for ECE6930 summer 2002 independent study, in addition to the focused reading and literature review tasks.

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