ComS 401 - Projects in Computing

Fall 2006
Lectures: Monday and Wednesday 3:10 - 4:00 p.m. (Howe Hall, Room 1304)
Labs: Tuesday or Wednesday 12:10 - 2:00 p.m. (Pearson Hall, Room 0141)
Iowa State University
Ames, Iowa 50011

Instructor: Alexander Stoytchev

Office:	Howe Hall, Room 1620F
Phone:	515-294-5904 (email preferred)
Email:	alex@cs.iastate.edu
Web Page:	http://www.cs.iastate.edu/~alex
Office Hours:	TBD, or by appointment

Teaching Assistant: TBD

Office:	TBD
Email:	TBD
Web Page:	http://www.vrac.iastate.edu/~tbd
Office Hours:	TBD, or by appointment

Catalog Description: Applications of software development methods (requirements collection and analysis, software design, project management, documentation and testing), programming techniques, database designs and administration, and network application programming to solve real-world computing needs. A study of practical applications of emerging technologies in computing. Emphasis on semester-long team programming projects. Lab assignments. Oral and written reports. Non-major graduate credit.

Topics to be Covered: This semester the class will focus on applications of computing technology in human inhabited environments (e.g., an intelligent room or an intelligent home). The class will cover computational perception techniques for detecting and recognizing the activities of humans using different sensing modalities.

The class will cover the following topics: Tutorials on Matlab, open computer vision library (OpenCV), and speech recognition packages. Basic image processing. Color and movement detection. Human activity recognition based on motion history images. Tracking techniques including Kalman filters and particle filters. Face detection and face recognition: eigenfaces and cascades. Methods for interfacing with sensors. Immersive visualization and virtual reality environments: C4 cave. Affective computing, i.e., computing that relates to, arises from, or deliberately influences human emotions.

Textbook & Readings: There is no required textbook for this class. The lectures will be based on a number of sources most of which are available for download from the Internet (links will be provided on the class web page). Reading material that is not available on-line will be placed on reserve in the library. A tentative list of readings to be covered in this class is provided at the end of this document.

Students with Disabilities: Iowa State University complies with the American with Disabilities Act and Section 504 of the Rehabilitation Act. Any student who may require an accommodation under such provisions should contact the instructor as soon as possible and no later than the end of the first week of class or as soon as you become aware.

Prerequisites: Engl 105, Sp Cm 212, Com S 309, and either 362 or 363.

HCI students and non-majors with programming skills are welcome. This class counts for non-major graduate credit. Just check with your major professor and POS committee that you can include this class in your degree plan.

This is a **PROGRAMMING INTENSIVE** and **READING INTENSIVE** class. Knowledge of C/C++ is highly recommended. If you are not sure whether this class is for you, please talk to the instructor.

Labs: Unless otherwise stated, there will be a lab session every week of the semester. The labs will cover practical aspects of the material covered during the lectures. Ten labs will have lab assignments that will be graded. Each of them is worth 4% of the final grade.

Final Project: The final project must be a research or design project that is related to the topics covered in class. You may choose to work individually or in small groups (2-3 members each). Working in groups, however, is highly recommended.

You are encouraged to select a topic for your final project as soon as possible. A written project proposal (3-5 pages) will be due on October 4. The final project report (10-15 pages) will be due on November 29. Each team will be required to present the results of their final project during the last week of the semester.

Policy on Collaboration: You are encouraged to form study groups and discuss the reading materials assigned for this class. You are allowed to discuss the lab assignments with your colleagues. However, each student will be expected to write his own solutions/code. Sharing of code is not allowed.

Attendance: You are expected to attend every class and participate in the class discussions. If you miss a class, it is your responsibility to find out what we talked about, including any announcements that were made in class. In addition to that you are expected to attend all labs and perform the lab assignments.

Grading: Your grade will be determined as follows:

Class Participation:	10%
Lab Assignments:	40% (10 $\times$ 4% each)
Final Project:	50%

Tentative Schedule and Reading List

INTRO (1 week)

Overview of the class

- Deb Roy, Rupal Patel, Philip DeCamp, Rony Kubat, Michael Fleischman, Brandon Roy, Nikolaos Mavridis, Stefanie Tellex, Alexia Salata, Jethran Guinness, Michael Levit, Peter Gorniak. (2006). "The Human Speechome Project". In the Proceedings of the 28th Annual Cognitive Science Conference.
- Kidd, Cory D., Robert J. Orr, Gregory D. Abowd, Christopher G. Atkeson, Irfan A. Essa, Blair MacIntyre, Elizabeth Mynatt, Thad E. Starner and Wendy Newstetter (1999). "The Aware Home: A Living Laboratory for Ubiquitous Computing Research," In the Proceedings of the Second International Workshop on Cooperative Buildings.

BASIC IMAGE PROCESSING (2 weeks)

Mathematical Morphology

- Jain, Kasturi, and Schunck (1995). Machine Vision, "Chapter 2: Binary Image Processing," McGraw-Hill, pp. 25-72.
- Haralick and Shapiro (1993). Computer and Robot Vision, "Chapter 5: Mathematical Morphology," Addison-Wesley.

Image Filtering

- Jain, Kasturi, and Schunck (1995). Machine Vision, "Chapter 4: Image Filtering," McGraw-Hill, pp. 112-139.
- Burt and Adelson (1983). "The Laplacian Pyramid as a Compact Image Code," IEEE Transactions on Communications, vol. 31(4), pp. 532-540.

COLOR AND MOVEMENT (1 week)

Color and Skin detection

- Yang, Lu, and Waibel (1997). "Skin-color modeling and adaptation", CMU-CS-97-146, May 1997.

Motion Energy and Motion History

- A. F. Bobick and J.W. Davis. "An apearance-based representation of action". In Proceedings of IEEE International Conference on Pattern Recognition 1996, August 1996, pp. 307-312.
- Davis, J. and A. Bobick (1997). "The Representation and Recognition of Action Using Temporal Templates", In Proceedings of IEEE Conference on Computer Vision and Pattern Recognition, June 1997, pp. 928-934.

OVERVIEW OF DIFFERENT SENSORS (1 week)

- TBD

IMMERSIVE VR ENVIRONMENTS (1 week)

- TBD

FACE DETECTION AND FACE RECOGNITION (1 week)

Cascades

- Paul Viola and Michael Jones (2001). "Robust Real-time Object Detection", Second International Workshop on Statistical and Computational Theories of Vision Modeling, Learning, Computing, and Sampling, Vancouver, Canada, July 13, 2001.

Eigenfaces

- M. Turk and A. Pentland (1991). "Eigenfaces for recognition". Journal of Cognitive Neuroscience, 3(1).
- Dana H. Ballard (1999). "An Introduction to Natural Computation (Complex Adaptive Systems)", Chapter 4, pp 70-94, MIT Press.

PRELIMINARY PROJECT PRESENTATIONS (1 week)

SPEECH RECOGNITION (1 week)

- Rabiner, Lawrence, and Juang (1993). "Theory and Implementation of Hidden Markov Models", Chapter 6 in Fundamentals of Speech Recognition, Prentice-Hall, pp. 321-389.

TOPIC TO BE DETERMINED (1 week)

TRACKING TECHNIQUES (1 week)

Kalman Filter

- Maybeck, Peter S. (1979). Chapter 1 in "Stochastic models, estimation, and control",Mathematics in Science and Engineering Series, Academic Press.
- Greg Welch and Gary Bishop (2001). SIGGRAPH 2001 Course: "An Introduction to the Kalman Filter".

Particle Filters

- Michael Isard and Andrew Blake (1998). "CONDENSATION – conditional density propagation for visual tracking", International Journal of Computer Vision, 29, 1, 5–28.
- Ioannis Rekleitis (2004). A Particle Filter Tutorial for Mobile Robot Localization. Technical Report TR-CIM-04-02, Centre for Intelligent Machines, McGill University, Montreal, Quebec, Canada.

ACTIVITY RECOGNITION (1 week)

Gesture Recognition

- Stefan Waldherr, Roseli Romero, Sebastian Thrun (2000). "A Gesture Based Interface for Human-Robot Interaction", Autonomous Robots, Volume 9, Issue 2, September 2000, pp. 151 - 173.
- Thad Starner and Alex Pentland (1996) "Real-Time American Sign Language Recognition from Video Using Hidden Markov Models" PAMI July 1997.
- Tanawongsuwan, R., Stoytchev, A., and Essa, I. (1999). "Robust Tracking of People by a Mobile Robotic Agent", Technical Report GIT-GVU-99-19.

Handwriting recognition

- Larry Yaeger, Brandyn Webb, and Richard Lyon (1998). "Combining Neural Networks and Context-Driven Search for On-Line, Printed Handwriting Recognition in the Newton", Spring 1998 issue of AAAI's AI Magazine.
- Larry Yaeger, Richard Lyon, and Brandyn Webb (1996). "Effective Training of a Neural Network Character Classifier for Word Recognition", NIPS 1996.
- MacKenzie and Zhang (1997). "The Immediate Usability of Graffiti", Graphics Interface 1997, pp. 29-137.

TOPIC TO BE DETERMINED (1 week)

THANKSGIVING BREAK (1 week)

AFFECTIVE COMPUTING (1 week)

Affective Computing

- Rosalind W. Picard (1997). "Affective Computing", MIT Press.
- Rosalind W. Picard (1995). "Affective Computing", MIT Media Lab TR-321, November 1995 (abbreviated version of the book).
- A. R. Demasio (1994). "Descartes' Error: Emotion, Reason and the Human Brain",New York: Gosset/Putnam Press (excerpt).

FINAL PROJECT PRESENTATIONS (1 week)

TOTAL: 16 weeks

Week	Day/Date		Topic	Lab Topic
1	Monday	8/21	Introduction and Overview	No Lab
	Wednesday	8/23	Basic Image Processing	
2	Monday	8/28	Guest Lecture: Sensor Networks	Matlab (part 1)
	Wednesday	8/30	Basic Image Processing	
3	Monday	9/4	NO CLASS: Labor Day	Matlab (part2)
	Wednesday	9/6	Image Filtering	
4	Monday	9/11	Color and Movement Detection	OpenCV
	Wednesday	9/13	Color and Movement Detection	
5	Monday	9/18	Overview of Different Sensors	Interfacing with Sensors
	Wednesday	9/20	Overview of Different Sensors	
6	Monday	9/25	Immersive VR environments	C4 (4-sided VR cave)
	Wednesday	9/27	Self-sensing Environments	
7	Monday	10/2	Face Detection	Face Detection
	Wednesday	10/4	Face Recognition	
8	Monday	10/9	Preliminary Project Presentations	No Lab
	Wednesday	10/11	Preliminary Project Presentations	
9	Monday	10/16	Speech Recognition	Speech Recognition
	Wednesday	10/18	Speech Recognition	
10	Monday	10/23	TBD	TBD
	Wednesday	10/25	TBD	
11	Monday	10/30	Tracking Techniques	Object Tracking
	Wednesday	11/1	Tracking Techniques	
12	Monday	11/6	Activity Recognition	Work on Projects
	Wednesday	11/8	Activity Recognition	
13	Monday	11/13	TBD	Work on Projects
	Wednesday	11/15	TBD	
14	Monday	11/20	NO CLASS: Thanksgiving Break	Work on Projects
	Wednesday	11/22	NO CLASS: Thanksgiving Break	
15	Monday	11/27	Affective Computing	Work on Projects
	Wednesday	11/29	Affective Computing	
16	Monday	12/4	Project Presentations	No Lab
	Wednesday	12/6	Project Presentations	