

CAP 6938
Special Topics in Pen-Based User Interfaces
Fall 2008

<http://www.eecs.ucf.edu/courses/cap6938/fall2008/penui>

Instructor: Joseph J. LaViola Jr.

Office: Engineering III Room 321

Hours: Tues. 5:00pm-7:00pm

Wed. 5:45pm- 6:45pm

Tablet PC Lab: Engineering III 208

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If you want to email me, MAKE SURE to enter in the subject line “**cap6938**” followed by **your name**.

Course Objective and Topics

Topic in Pen-Based User Interfaces is a course designed to give students a thorough understanding of the latest techniques, algorithms, and evaluation methodologies used in designing and developing pen-, sketch-, and gesturally-based user interfaces. In addition reading and presenting research papers, students will write several programs to reinforce concepts discussed in class and will produce a final project of their choice.

General Topics include:

1. Introduction and History of Pen-computing
2. C#, Visual Studio, and Windows Presentation Foundation
3. Ink Preprocessing
4. Gestural User Interfaces
5. Ink Segmentation
6. Classification Algorithms for Recognizing Ink
7. 2D Parsing
8. Sketch-based Interfaces
9. Evaluation Methodologies

Syllabus

Week 1

August 25, 2008 Lecture - Introduction to Pen-based UIs
 -- go over course mechanics
 -- discuss the history pen computing
 -- present some challenges with pen computing
 -- present various applications

Readings

Sutherland, I. SketchPad: A Man-Machine Graphical Communication System, Proceedings of AFIPS Spring Joint Computer Conference, 329-346, 1963.

Blackwell, F. and R. Anderson. An on-line symbolic mathematics system using hand-printed two-dimensional notation. Proceedings of the 1969 24th National Conference, 551-557, 1969.

Herot, C. Graphical Input Through Machine Recognition of Sketches, Proceedings of SIGGRAPH'76, 97-102, 1976.

August 27, 2008 Talk about final projects
 Papers discussion

Week 2

September 1, 2008 Holiday – No Class

September 3, 2008 Lecture - Visual Studio, C#

Readings

Nathan, A. Windows Presentation Foundation Unleashed, 2007.

Week 3

September 8, 2008 Lecture - Tablet PC SDK, Windows Presentation Foundation
Assignment 1 Out

September 10, 2008 Lecture - Ink Preprocessing & Simple Features
 -- data representation
 -- filtering
 -- transformation invariance
 -- dehooking, cusps, and self intersections

Readings

Guerfali, Wacef and R´ejean Plamondon. Normalizing and Restoring On-Line Handwriting. *Pattern Recognition*, 26(3):419-431, March 1993.

Tevfik Metin Sezgin, Thomas Stahovich, and Randall Davis. Sketch Based Interfaces: Early Processing for Sketch Understanding. *Workshop on Perceptive User Interfaces*, Orlando FL . 2001.

Matsakis, Nicholas, Recognition of Mathematical Expressions, Master's thesis, MIT, page 21-28. 1999.

Week 4

September 15, 2008 Papers discussion

September 17, 2008 Lecture - Gestural User Interfaces

- in computer graphics/modeling
- gesture structure - 1 or multi-stroke
- gesture invocation - buttons & button placement
- gesture learning - existing notations, tutorial, embedding in GUIs
 - visual (pre & post) feedback
- FSAs
- punctuated gestures

Assignment 1 due

Assignment 2 out

Readings

Zelevnik, R., K. Herndon, and J. Hughes. SKETCH: An Interface for Sketching 3D Scenes. *Proceedings of SIGGRAPH'96*, ACM Press, 163-170, 1996.

Igarashi, T., S. Matsuoka, and H. Tanaka. Teddy: A Sketching Interface for 3D Freeform Design. *Proceedings of SIGGRAPH'99*, ACM Press, 409-416, 1999.

Robert Zelevnik and Timothy Miller. Fluid Inking: Augmenting the Medium of Free-Form Inking with Gestures. In *Graphics Interface*. Canadian Human-Computer Communications Society, p 155-162, June 2006.

Week 5

September 22, 2008 Papers discussion

September 24, 2008 Lecture - Ink Segmentation
-- spatial segmentation
-- temporal segmentation

Readings

Gennari, L., L. Kara, and T. Stahovich. Combining geometry and domain knowledge to interpret hand drawn diagrams, *Computers and Graphics*, 29(4):547-562, 2005.

Smithies, Steve, Kevin Novins, and James Arvo. A Handwriting-Based Equation Editor. In *Proceedings of Graphics Interface'99*, 84-91, 1999.

Tevfik Metin Sezgin and Randall Davis. Sketch Interpretation Using Multiscale Models of Temporal Patterns. In *IEEE Journal of Computer Graphics and Applications*, Volume: 27, Issue: 1, pp: 28-37, 2007.

Week 6

September 29, 2008 Papers discussion
Assignment 2 due
Assignment 3 out

October 1, 2008 Lecture - Classification Algorithms for Recognizing Digital Ink (Part 1)
-- Feature Extraction

Week 7

October 6, 2008 Lecture - Classification Algorithms for Recognizing Digital Ink (Part 2)
-- Classifiers
- procedural
- template matching
- linear classifiers
- SVMs
- K-nearest neighbor
- AdaBoost

Readings

LaViola, J., and Zeleznik, R. "A Practical Approach to Writer-Dependent Symbol Recognition Using a Writer-Independent Recognizer", *IEEE Transactions on Pattern Analysis and Machine Intelligence*, 29(11):1917-1926, November 2007.

Connell, Scott D. and Anil K. Jain. Template-Based On-Line Character Recognition. Pattern Recognition, 34(1):1-14, January 2000.

Patel, R., B. Plimmer, J. Grundy, and R. Ihaka. Ink Features for Diagram Recognition, Proceedings of the 2007 Eurographics Workshop on Sketch-based Interfaces and Modeling, August, 2007.

October 8, 2008 Papers discussion

Week 8

October 13, 2008 Lecture - Parsing Ink
 -- parsing mathematics
 -- multi-stage
 -- parsing drawings
 -- parsing diagrams
 - 2D grammars
 - graph rewriting
 - procedurally coded syntax rules
 - stochastic grammars

Assignment 3 due

Assignment 4 out

Readings

D. Blostein and A. Grbavec, "Recognition of Mathematical Notation," in Handbook of Character Recognition and Document Image Analysis, Eds. H. Bunke and P. Wang, World Scientific, 1997, pp. 557-582.

Chan, Kam-Fai and Dit-Yan Yeung. An Efficient Syntactic Approach to Structural Analysis of On-Line Handwritten Mathematical Expressions. Pattern Recognition, 33(3):375-384, March 2000.

Ye, Ming, and Paul Viola. Learning to Parse Hierarchical Lists and Outlines Using Conditional Random Fields. International Workshop on Frontiers in Handwriting Recognition, 2004.

Michael Shilman, Hanna M. Pasula, Stuart Russell, and Richard Newton, Statistical Visual Language Models for Ink Parsing. In Proc. AAI Spring Symposium on Sketch Understanding, Stanford, March 2002.

October 15, 2008 Papers discussion

Week 9

October 20, 2008 Lecture - Sketch-based Interfaces and Understanding
-- multi-domain sketch understanding frameworks

Readings

LaViola, J. and Zeleznik, R. "MathPad2: A System for the Creation and Exploration of Mathematical Sketches", ACM Transactions on Graphics (Proceedings of SIGGRAPH 2004), 23(3):432-440, August 2004.

Christine Alvarado and Randall Davis. SketchREAD: A Multi-Domain Sketch Recognition Engine. In Proceedings of UIST 2004, pp.23-32. New York, New York, October 24-27 2004.

Lockwood, K., Lovett, A., Forbus, K., Dehghani, M., and Usher, J. Automatic Interpretation of Depiction Conventions in Sketched Diagrams. *Proceedings of the Eurographics Workshop on Sketch-Based Interfaces and Modeling*, 167-174, 2008.

Hammond, T., and R. Davis. Ladder: A Sketching Language for User Interface Developers, *Computers and Graphics* 29, 518-532, 2005.

October 22, 2008 Papers discussion
Assignment 4 due

Week 10

October 27, 2008 Lecture - Evaluation Methodologies
-- user studies
-- qualitative vs. quantitative
-- comparative vs. formative.
Project proposals due

Readings

LaViola, J. "An Initial Evaluation of a Pen-Based Tool for Creating Dynamic Mathematical Illustrations", In the proceedings of the Eurographics Workshop on Sketch-Based Interfaces and Modeling 2006, 157-164, September 2006.

Li, Y., Hinckley, K., Guan, Z., Landay, J. A. Experimental Analysis of Mode Switching Techniques in Pen-based User Interfaces. CHI 2005, 461-470.

LaViola, J., Leal, A., Miller, T., and Zeleznik, R. "Evaluation of Techniques for Visualizing Mathematical Expression Recognition Results", *Proceedings of Graphics Interface 2008*, 131-138, May 2008.

October 29, 2008 Papers discussion
Project proposal decisions made

Week 11

November 3, 2008 Student paper presentations

November 5, 2008 Student paper presentations

Week 12

November 10, 2008 Student paper presentations

November 12, 2008 Project status updates

Week 13

November 17, 2008 Student paper presentations

November 19, 2008 Project status updates

Week 14

November 24, 2008 Student paper presentations

November 26, 2008 No class

Week 15

December 1, 2008 Student paper presentations

December 3, 2008 Project Status updates

Week 16

December 8, 2008 **DEMO DAY and Final Reports Due!!!!**

Collaboration Policy

Students must do their own work but are encouraged to collaborate with others in the form of discussion of concepts and implementation details pertaining to Visual Studio, C#, and Windows Presentation Foundation. For final projects, teams of up to two students are encouraged.

Assignments

Paper Presentations – Students will have to present 1-2 papers of their choice, outside of the assigned readings and give a 20 minute presentation on it.

Guided Discussion – During the paper discussion sections, students will lead the discussion on a particular paper that was assigned in class.

Programming Assignments

1. Intro

Students will create a simple 2D/3D drawing application to get them acclimated to Visual Studio, C#, and Windows Presentation Foundation. This application will also be a test bed for the other assignments in the course.

2. Corner Finder (Research Contest)

Students will implement Wolin and Hammond’s state of the art corner finding algorithm and will try to improve its performance.

3. Math Symbol Recognizer (Research Contest)

Students will implement Wobbock et al.’s \$1 symbol recognizer and try to improve its performance.

4. Pen Calculator

Using their results from assignment 3, students will develop a simple pen-based calculator by developing a 2D mathematical expression parsing engine using a simple 2D grammar.

5. Final Project

Students will do a final project of their choice that explores a particular concept in pen-based user interfaces. They must first write a short proposal and get it approved by the professor. Students will also have to prepare a final report on their projects.

Tentative Grading Scheme:

Assignment 1	10%
Assignment 2	10%
Assignment 3	10%
Assignment 4	10%
Paper discussions	5%
Paper presentations	5%
Final Project	50%

The instructor reserves the right to use plus/minus grading in this course.