

CAP 5937
Special Topics in Pen-Based User Interfaces
Fall 2007

<http://www.eecs.ucf.edu/courses/cap5937/fall2007>

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 “**cap5937**” 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 20, 2007 Lecture - Introduction to Pen-based UIs
 -- go over course mechanics
 -- discuss the history pen computing
 -- present some challenges with pen computing
 -- present various applications

August 22, 2007 Talk about final projects
 Papers discussion
 Paper summaries due

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.

Week 2

August 27, 2007 Lecture - Visual Studio, C#

August 29, 2007 Lecture - Tablet PC SDK, Windows Presentation Foundation
 Assignment 1 Out

Readings

Nathan, A. Windows Presentation Foundation Unleashed, 2007.

Week 3

September 5, 2007 Lecture - Ink Preprocessing & Simple Features
 -- data representation
 -- filtering
 -- transformation invariance
 -- dehooking, cusps, and self intersections

Assignment 1 Due

Assignment 2 Out

Week 4

September 10, 2007 Papers discussion
Paper summaries due

Readings

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

Tevfik Metin Sezgin. Feature Point Detection and Curve Approximation for Early Processing of Free-Hand Sketches. Master's Thesis. May 2001. Department of EECS, MIT.

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

September 12, 2007 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

Week 5

September 17, 2007 Papers discussion
Paper summaries due

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.

September 19, 2007 Lecture - Ink Segmentation
-- spatial segmentation
-- temporal segmentation

Week 6

September 24, 2007 Papers discussion
Paper summaries due
Assignment 2 due

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.

Lehmberg, Stefan, Hans-Jurgen Winkler, and Manfred Lang. A Soft-Design Approach for Symbol Segmentation Within Handwritten Mathematical Expressions. In *1996 International Conference on Acoustics, Speech, and Signal Processing*, 3434-3437, 1996.

Pearce, Stephen, and Ahmed Maher. An Evolutionary Algorithm for General Symbol Segmentation, *Seventh International Conference on Document Analysis and Recognition (ICDAR'03)*, 726-731, 2003.

September 26, 2007 Lecture - Classification Algorithms for Recognizing Digital Ink (Part 1)
-- Feature Extraction
Assignment 3 out

Week 7

October 1, 2007 Lecture - Classification Algorithms for Recognizing Digital Ink (Part 2)
-- Classifiers
- procedural
- template matching
- Linear classifiers
- SVMs
- K-nearest neighbor
- AdaBoost

October 3, 2007 Papers discussion
Paper summaries due

Readings

LaViola, J., and Zeleznik, R. "A Practical Approach to Writer-Dependent Symbol Recognition Using a Writer-Independent Recognizer", submitted to IEEE Transactions on Pattern Analysis and Machine Intelligence, 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.

Week 8

October 8, 2007 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

October 10, 2007 Papers discussion
 Paper summaries due

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.

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.

Wais, P., A. Wolin, and C. Alvarado. Designing a Sketch Recognition Front-End: User Perception of Interface Elements, Eurographics Workshop on Sketch-based Interfaces and Modeling, 2007.

Week 11

October 29, 2007 Student paper presentations (3)
Project proposal decisions made

October 31, 2007 Student paper presentations (3)

Week 12

November 5, 2007 Student paper presentations (3)

November 7, 2007 Project status updates

Week 13

November 12, 2007 Student paper presentations (3)

November 14, 2007 Project status updates

Week 14

November 19, 2007 Student paper presentations (3)

November 21, 2007 No class

Week 14

November 26, 2007 Student paper presentations (3)

November 28, 2007 Project Status updates

Week 15

December 3, 2007 Student paper presentations (3)

December 5, 2007 Project status updates

Week 16

December 10, 2007 **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 Summaries -- Students will have to prepare 1-2 page summaries of the papers they read for class. The summaries will include an overview of the paper, the strengths and weaknesses of the paper, and how the paper could be improved.

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

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. Gestural UI

Students will extend their drawing application by adding a gestural user interface for creating 2D drawing primitives (circles, squares, etc...) as well as supporting editing operations such as erasing, selection and manipulation. The gestural UI will utilize a simple rule-based approach for gesture recognition. This assignment will also expose students to ink-preprocessing routines.

3. Math Expression Recognizer

Students will create the first part of a simple mathematical expression recognizer. They will create a symbol recognizer using a feature-based classifier based on Rubine's recognition algorithm.

4. Math Parser

Students create the second part of a simple mathematical expression recognizer. They will develop a 2D mathematical expression parsing engine using a simple 2D grammar. Students will also provide expression evaluation functionality for numerical expressions. This will result in a simple pen-based calculator.

5. Final Project

Students will do a final project of their choice that explores a particular concept in pen-based user interfaces. Those students taking the course for 6000 level credit must have a research component in their project. 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 reviewing	5%
Paper presentations	5%
Final Project	50%

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