CAP 6105
Pen-Based User Interfaces

Fall 2012

http://www.eecs.ucf.edu/courses/cap6105/fall2012/

Instructor: Joseph J. LaViola Jr.

Office: Engineering I Room 383
           Hours: Tues. 4:00pm-5:30pm
                   Wed. 6:00pm-7:00pm
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If you want to email me, MAKE SURE to enter in the subject line "**cap6105**" 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-, touch-, and gesturally-based user interfaces. In addition to 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- and Sketch-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 and Multi-touch based Interfaces

9. Evaluation Methodologies

Syllabus

<u>Week 1</u>

August 20, 2012   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 22, 2012   Talk about final projects
                Papers discussion

<u>Week 2</u>

August 27, 2012   Lecture - Visual Studio, C#, Tablet PC SDK

August 29, 2012   Lecture - Windows Presentation Foundation

Readings

Nathan, A. *WPF 4 Unleashed*, Sams, 2010.

<u>Week 3</u>

September 3, 2012   Holiday – No Class
                Assignment 1 Out

September 5, 2012   Lecture - Ink Preprocessing & Simple Features
                -- data representation
                -- filtering
                -- transformation invariance
                -- dehooking, cusps, and self intersections

Readings

Wolin, A., Eoff, B., and Hammond, T. ShortStraw: A Simple and Effective Corner Finder for Polylines. *Eurographics 5th Annual Workshop on Sketch-Based Interfaces and Modeling*, Annecy, France, June, 2008, pp. 33-40.

Xiong, Y. and LaViola, J. "Revisiting ShortStraw – Improving Corner Finding in Sketch-Based Interfaces", *Proceedings of the Sixth Eurographics/ACM Symposium on Sketch-Based Interfaces and Modeling 2009*, 101-108, August 2009.

Herold, J. and Stahovich, T. SpeedSeg: A Technique for Segmenting Pen Strokes Using Pen Speed *Computers and Graphics, Volume 35, Issue 2*, 2011, pp. 250-264

Week 4

September 10, 2012   Papers discussion

September 12, 2012   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

Zeleznik, 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.

Hinckley, K., Yatani, K., Pahud, M., Coddington, N., Rodenhouse, J., Wilson, A., Benko, H., and Buxton, B. Pen + Touch = New Tools. In *Proc. UIST 2010 Symposium on User interface Software and Technology*, 27-36, October 2010.

Zeleznik, R., Bragdon, A., Adeputra, F., and Ko. H. Hands-On Math: A Page-based Multi-touch and Pen Desktop for Technical Work and Problem Solving. In *Proceedings of the 23rd Annual Symposium on User Interface Software and Technology* (UIST 2010), 17-26, October 2010.

Week 5

September 17, 2012   Papers discussion

September 19, 2012   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.

Peterson, E., Stahovich, T., Doi, E., and Alvarado, C. Grouping Strokes into Shapes in Hand-Drawn Diagrams *Proc. of the 24th AAAI Conference on Artificial Intelligence (AAAI-10)*, 2010, pp. 974-979

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 24, 2012   Papers discussion

September 26, 2012   Lecture - Classification Algorithms for Recognizing Digital Ink (Part 1)
                                     -- Feature Extraction
                     Assignment 2 due
                     Assignment 3 out

Week 7

October 1, 2012   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.

Herold, J., and Staohvich, T. ClassySeg: A Machine Learning Approach to Automatic Stroke Segmentation. In *Proceedings of the Eighth Eurographics/ACM Symposium on Sketch-Based Interfaces and Modeling 2011*, 109-116, August 2011.

Rachel Blagojevic, R., Chang, S., and Plimmer, B. The Power of Automatic Feature Selection: Rubine on Steroids, In *Proceedings of the Seventh Eurographics/ACM Symposium on Sketch-Based Interfaces and Modeling 2010*, 79-86, June 2010.

Wobbrock, J. O., Wilson, A. D., and Li, Y. 2007. Gestures without libraries, toolkits or training: a $1 recognizer for user interface prototypes. In *Proceedings of the 20th Annual ACM Symposium on User interface Software and Technology* UIST '07. ACM, New York, NY, 159-168.

October 3, 2012   Papers discussion

Week 8

October 8, 2012   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. AAAI Spring Symposium on Sketch Understanding, Stanford, March 2002.

October 10, 2012   Papers discussion

Week 9

October 15, 2012   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 17, 2012   Papers discussion

Week 10

October 22, 2012   Lecture - Evaluation Methodologies
                                    -- user studies
                                    -- qualitative vs. quantitative
                                    -- summative vs. formative
                        Assignment 4 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.

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.

Bragdon, A., Zeleznik, R., Williamson, B., Miller, T., and LaViola, J. "GestureBar: Improving the Approachability of Gesture-based Interfaces", Proceedings of ACM CHI 2009, 2269-2278, April 2009.

October 24, 2011   Papers discussion
Project proposals due

Week 11

October 29, 2012   Student paper presentations
Project proposal decisions made

October 31, 2012   Student paper presentations

Week 12

November 5, 2012   Student paper presentations

November 7, 2012   Project status updates

Week 13

November 12, 2012   Student paper presentations

November 14, 2012   Project status updates

Week 14

November 19, 2012   Student paper presentations

November 21, 2012   No class

Week 15

November 26, 2012   Student paper presentations

November 28, 2012   Project Status updates

Week 16

December 10, 2012   **DEMO DAY!!!**

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 25 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 replicate Windows Journal to get them acclimated to Visual Studio, C#, Windows Presentation Foundation, and pen and multi-touch input. This application will also be a test bed for the other assignments in the course.

2. 2D SKETCH

Students will develop a 2D shape recognition program to create and manipulate circles, rectangles, squares, and triangles. Students will explore how to best combine pen and multi-touch input for the various operations needed. The focus of the assignment will be on heuristic gesture recognition.

3. Math Symbol Recognizer (Research Contest)

Students will implement Anthony and Wobbock's $N symbol recognizer and try to improve its accuracy.

4. Pen Calculator

Using the math symbol recognizer created in assignment 3, students develop a pen-based calculator that will recognize and evaluate mathematical expressions.   Students will use both pen and multi-touch input for different parts of this assignment.

5. Final Project

Students will do a final project of their choice that explores a particular concept in pen-, sketch-, or multi-touch-based user interfaces. They must first write a short proposal and get it approved by the professor.

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.