CAP 6105 Pen-Based User Interfaces

Fall 2013

http://www.cs.ucf.edu/courses/cap6105/fall2013/

<u>Instructor</u>: **Joseph J. LaViola Jr.**

<u>Office</u>: **Engineering III Room 321**
          Hours: Tues. 4:00pm-5:30pm
          Wed. 6:00pm-7:00pm

Pen Computing Lab: Engineering III 208

<u>Email:</u> jjl@eecs.ucf.edu

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

Week 1

August 19, 2013 – 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 21, 2013 – Talk about final projects Papers discussion

Week 2

August 26, 2013 – Lecture - Visual Studio, C#, Tablet PC SDK

August 28, 2013 – Lecture - Windows Presentation Foundation

Readings

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

Week 3

September 2, 2013 – Holiday – No Class
<div align="center">**Assignment 1 Out**</div>

September 4, 2013 – 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 9, 2013 – Papers discussion

September 11, 2013 – 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 16, 2013 – Papers discussion

September 18, 2013 – 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.

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.

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 23, 2013 – Papers discussion

September 25, 2013 – Lecture - Classification Algorithms for Recognizing Digital Ink (Part 1)
                               -- Feature Extraction
                          Assignment 2 due Assignment 3 out

Week 7

September 30, 2013 – 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.

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.

Li, Yang 2010. Protractor: a fast and accurate gesture recognizer. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '10)*. ACM, New York, NY, USA, 2169-2172, April 2010

October 2, 2013 – Papers discussion

Week 8

October 7, 2013 – 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 9, 2013 – Papers discussion

Week 9

October 14, 2013 – 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 16, 2013 – Papers discussion

Week 10

October 21, 2013 – 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 23, 2013 – Papers discussion
Project proposals due

Week 11

October 28, 2013 – Student paper presentations
Project proposal decisions made

October 30, 2013 – Student paper presentations

Week 12

November 4, 2013 – Project status updates

November 6, 2013 – Student paper presentations

Week 13

November 11, 2013 – Veteran's Day, No class

November 13, 2013 – Project status updates

Week 14

November 18, 2013 – Student paper presentations

November 20, 2013 – Project status updates

Week 15

November 25, 2013 – Student paper presentations

November 27, 2013 – No Class

Week 16

December 2, 2013 – Project status updates

December 9, 2013 – **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 compare Anthony and Wobbock's $N symbol recognizer against Li's Protractor algorithm and try to improve overall recognition accuracy for both pen and touch data.

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.