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 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-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

Blackwell, F. and R. Anderson. An on-line symbolic mathematics system using hand-printed two-

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


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*


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*


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

Smithies, Steve, Kevin Novins, and James Arvo. A Handwriting-Based Equation Editor. In

Segmentation Within Handwritten Mathematical Expressions. In 1996 International Conference on

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


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


**Week 9**

**October 15, 2007**  Lecture - Sketch-based Interfaces and Understanding  
-- mult-domain sketch understanding frameworks

**October 17, 2007**  Papers discussion  
**Paper summaries due**  
**Assignment 4 due**

**Readings**


**Week 10**

**October 22, 2007**  Lecture - Evaluation Methodologies  
-- user studies  
-- qualitative vs. quantitative  
-- comparative vs. formative.

**October 24, 2007**  Papers discussion  
**Paper summaries due**  
**Project proposals due**

**Readings**

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


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. The 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:**

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<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>Assignment 1</td>
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<td>Assignment 2</td>
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<td>Assignment 3</td>
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<td>Assignment 4</td>
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<tr>
<td>Paper reviewing</td>
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<tr>
<td>Paper presentations</td>
<td>5%</td>
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<tr>
<td>Final Project</td>
<td>50%</td>
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The instructor reserves the right to use plus/minus grading in this course.