Today
- Pen Modes
- Pen Input
  - Pointing
  - Discrete Selection
  - Control
  - Text Input
  - Content selection
  - Recognized input
  - Glyphs
  - Gestures
  - Diagrams
  - Handwriting

Announcements
- 1/24, 1/26: HCI for Pen Computing
- 1/31: Real Time Stylus (Arin Goldberg)
- 2/2: Topic TBA (Valentin)
- 2/7: No class (probably)
- 2/9: Prototype presentations (teams)

Pen mode solutions
- Problem: How do you allow different operations with a pen
  - Ink vs. erasing
    - Explicit modes
  - Ink vs. gesture
    - Recognition of gesture overrides ink
  - Ink vs. recognition vs. control
    - Area based modes

Pen mode study
Yang Li et al., CHI 2005
- Barrel Button
- Hold
- Non-preferential hand button
- Pressure
- Eraser

Quick poll
A. Barrel Button
B. Hold
C. Non-preferential hand button
D. Pressure
E. Eraser

Student Quick Poll
Classify input activities with a pen

What type of input activities are easy with a pen?

What type of input activities are difficult with a pen?

Table 1. The participants' preferences for each technique.

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Write</th>
<th>Read</th>
<th>Select</th>
<th>Press</th>
<th>Erase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Learning</td>
<td>4.4</td>
<td>3.6</td>
<td>4.0</td>
<td>3.5</td>
<td>4.2</td>
</tr>
<tr>
<td>Like</td>
<td>3.7</td>
<td>2.5</td>
<td>4.1</td>
<td>3.4</td>
<td>2.4</td>
</tr>
<tr>
<td>Activity</td>
<td>3.7</td>
<td>2.8</td>
<td>4.0</td>
<td>3.3</td>
<td>3.8</td>
</tr>
<tr>
<td>Speed</td>
<td>4.5</td>
<td>1.7</td>
<td>4.5</td>
<td>4.0</td>
<td>1.3</td>
</tr>
<tr>
<td>Fun</td>
<td>4.1</td>
<td>3.3</td>
<td>3.6</td>
<td>3.9</td>
<td>4.2</td>
</tr>
<tr>
<td>Hard</td>
<td>3.8</td>
<td>3.3</td>
<td>4.5</td>
<td>3.3</td>
<td>3.1</td>
</tr>
</tbody>
</table>

Activity classification

Easy

Moderate

Difficult

Discrete selection

- Choose from a finite set
  - Command from a menu
  - Character from an alphabet
- Repeated selection from finite sets
  - Hierarchical menus
  - Commands with arguments
  - Sequences of characters
    - Words
    - Multi-digit numbers

How many distinct mechanisms can you construct to select between four choices with a pen?

Assume a pen without a button

Selection mechanisms

- Crossing
- Pointing
- Writing
- Tapping
- Pressure
Basic pen operation

- Crossing
  - Operation triggered by a stroke crossing a line segment

CrossY: Crossing based UI

- Specify operations by drawing through

Hierarchical crossing

- Principle – multiple commands without lifting the pen

Flow Menu

- Use movement through octants for control information

Abstract writing

- Enter text with specialized, stroke based recognition
  - Optimized for automatic recognition
  - Not human readable
  - Character based or word based

Cirrus (Georgia Tech)

interaction
education
Selection problem
- Identify one or more graphical elements from a domain
- Mechanisms
  - Bounding Region
  - Geometric defined by stroke
  - Distance from cursor

If the red circle is a selection tool, what is selected?

Bubble cursor
- Selection radius depends on object proximity

Recognition UIs
- UIs based on attaching meaning to ink
- Gestures
- Diagram recognition
- Handwriting recognition
  - Free form
  - Constrained recognition
Gestures
- Commands issued with a single stroke
- May be drawn or invisible
- Support from SDK
  - Register gestures to be recognized
- UI Issues
  - Similar to keyboard short cuts
    - Speed up for experts
    - Hard to learn / remember

Gestures
- Ambiguity
  - Distinction between gestures
  - Distinction between gesture and other ink
- Robustness
  - Handling misrecognized gestures
    - False positive
    - False negative
  - Gesture initiated actions should be undoable

Diagram recognition
- Challenges to recognition
  - Even simple shapes are hard!
  - Variation in drawing
  - Ink artifacts

Text recognition
- We will have a great lecture later in the course!
- Basic approach
  - Collect a huge amount of data
  - Use data to train neural net

Handwriting Recognition: Identify the following words

<table>
<thead>
<tr>
<th>programmer</th>
<th>apartment</th>
</tr>
</thead>
<tbody>
<tr>
<td>sketch</td>
<td>objective</td>
</tr>
<tr>
<td>sketch</td>
<td>sự kiện</td>
</tr>
<tr>
<td>shooters</td>
<td></td>
</tr>
</tbody>
</table>

Recognition results

All programmers are optimistic. Perhaps this is because they believe in happy endings and fairy tales.
Recognition scenarios

- What level of error is tolerable
- How is feedback provided to the user on recognition
- How does the user specify corrections?