HCI For Pen Based Computing

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What is a good pen based application?

- The windows desktop and browser are NOT good pen based apps!

What is a good UI?
How do you measure it?

Mechanical Properties

Keystroke level model

KLM

- Analyze task by summing individual operation times

Moving hand to mouse	360 ms
Pointing to a new line with mouse	1500 ms
Clicking the mouse	230 ms
Moving hand to keyboard	360 ms
Total	2450 ms

Targeting

- Fundamental operation
  - Moving a cursor to a specific location
  - Pointing and selection

Experiment: measure time to move cursor to target

T(A, W) Targeting time for amplitude A and width W

Cursor

A

W

Target

Index of difficulty

W

A

- How does T behave as a function of A (W fixed)?

T

A

- How does T behave as a function of W (A fixed)?

T

W

Fitts' Law

- A task's movement difficulty is given by $ID = \log_2(A / W)$
  - ID – index of difficulty
  - A – amplitude of the move
  - W – width of the target region
- T = a + b ID

Interpretation of Fitt's Law

- Scale invariance
  - Dependence on A/W
- Exponential targeting
  - Log factor – as in binary search

Menu design

- What can you say about the cost of accessing items in the following menu
  - Cursor is at the top of the menu

Low level mechanisms

- State machine model
  - Registers
    - X, Y, Pressure
  - Pen state
    - Down, Hover, Out-of-range
  - Pen button
    - Up, Down
- Polling model

X

Y

Pres

Control primitives

- Hover
- Tap
- Double Tap
- Press-and-hold
- Hold-through
- Drag
- Hold-drag

Mode Problem

- Cognitive difficulties in remembering / keeping track of modes
  - Which mode?
  - Remapping operations
  - Retaining mode across context switch
- But modes are very useful
  - Efficient use of limited input controls
- Not all modes are the same
  - Shift key vs. Caps Lock
  - Mouse move vs. mouse drag
  - Pen color

Do cars have modes?

- A system has modes if it has states where the controls have different functions.
- Do cars have modes? If so, give an example
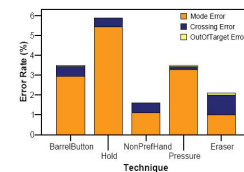
Pen mode solutions

- 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

Table 1. The participants' preferences for each technique.

Dimension	Barrel-Button	Hold	NonPref-Hand	Pressure	Eraser
Learning	4.4	3.5	4.7	3.5	4.2
Use	3.7	2.2	4.1	3.4	2.4
Accuracy	3.7	2.9	4.6	3.3	3.6
Speed	4	1.7	4.5	4	1.9
Eye fatigue	4.1	3.3	4.4	3.9	4.2
Hand fatigue	3.5	3.3	4.1	3.3	2.1

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

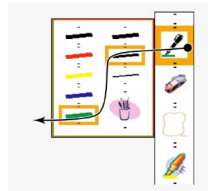# Selection mechanisms

- Crossing
- Pointing
- Writing
- Tapping
- Pressure

Basic pen operation

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

CrossY: Crossing based UI
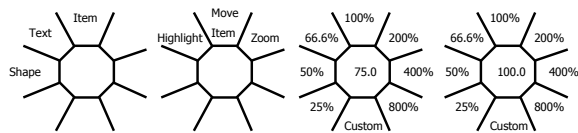
- Specify operations by drawing through

Hierarchical crossing

- Principle – multiple commands without lifting the pen
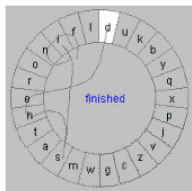
Flow Menu

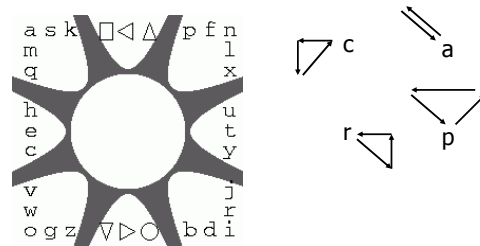- Use movement through octants for control information

Abstract writing

- Enter text with specialized, stroke based recognition
  - Optimized for automatic recognition
  - Not human readable
  - Character based or word based
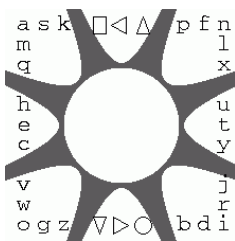
Cirrus (Georgia Tech)
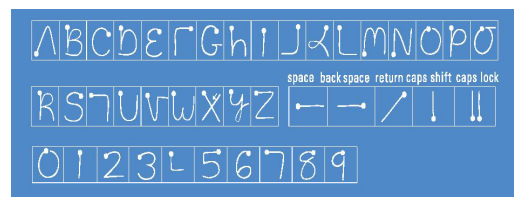

interaction

education

Quikwrite [Perlin, NYU]

Write
helloworld

Graffiti (Palm)

More

Graffiti

- Mostly single stroke
- Close to standard alphabet (learnability)
- Write only
- Location written for additional meaning

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

Recognition results

Recognition scenarios

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

Other details

- Hands, obstructions, orientation

Obstructions and handedness

- Hand blocks the screen
- Accommodate left and right handedness
  - Menu direction
  - Context menus
- Difficulties at the edge of the screen

Screen orientation

- Landscape vs. Portrait mode
- Surprisingly big difference in feel of applications
- Tablet PC requires rapid orientations switch
- Many standard desktop apps not designed for portrait mode