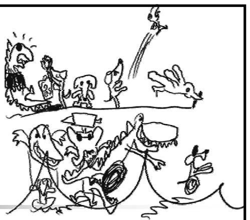


Pen Computing

CSEP 510
Lecture 6, February 12, 2004
Richard Anderson

Announcements

Outline

- Pen computing
- Stylus based input
- Tablet PC
- Inking
- Recognition

Pen Computing

- Wide range of devices fall under pen computing
- Classification by size
  - Hand held
  - Tablet
  - Large display

Key features

- Stylus for continuous input
- Direct manipulation with the display

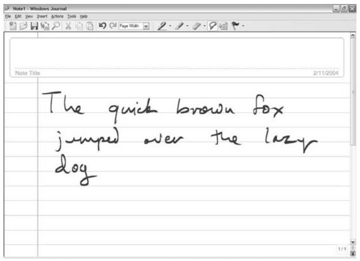
History of Pen Computing

- Sketchpad (1963)
- GRiD GRiDPad (1989)
- GO Pen Point (1991)
- Microsoft Windows for Pen Computing (1992)
- Apple Newton (1993)

Handwriting test

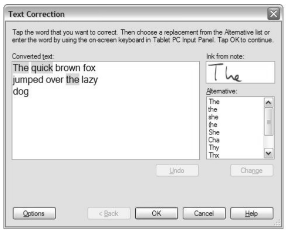
- Write the following phrase in journal:
  The quick brown fox jumped over the lazy dog
- Convert to text
  - Edit -> Select All
  - Actions -> Convert Handwriting to Text…
- For each word, record status
  - correct, correct?, incorrect?, incorrect

Text Entry



The quick brown fox
jumped over the lazy
dog

Reco



Tap the word that you want to correct. Then choose a replacement from the Alternative list or enter the word by using the on-screen keyboard in Tablet PC Input Panel. Tap OK to continue.

Converted text:

The quick brown fox
jumped over the lazy
dog

Ink from note:

The

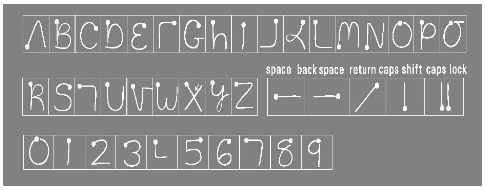
Alternative:

The
the
she
(he
She
Cha
Thy
Thx

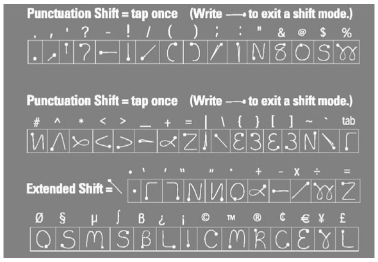
Stylus Input

- Specialized alphabets
- Issues
  - Ease of recognition (accuracy)
  - Ease of learning
  - Speed
- Human readability and archiving are not issues
  - Write-only

Graffiti (Palm)

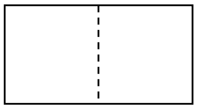


More

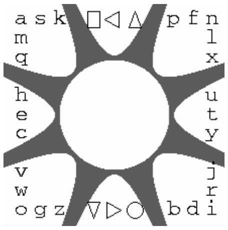

Punctuation Shift = tap once (Write —• to exit a shift mode.)
. , ' ? - ! / ( ) ; : " & @ $ %
Punctuation Shift = tap once (Write —• to exit a shift mode.)
# ^ * < > _ + = | \ { } [ ] ~ ` tab
Extended Shift =
• ' ' " " • + - X ÷ =
Ø § µ ∫ ß ¿ ¡ © ™ ® ¢ € ¥ £

Graffiti

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



Quikwrite [Perlin, NYU]

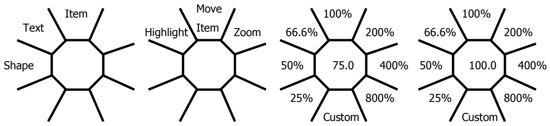


Homework assignment

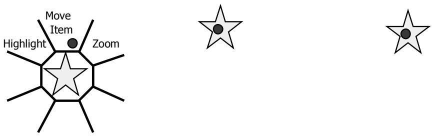
- Implement quikwriting

Flow Menu

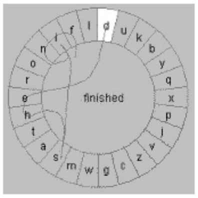
- Use movement through octants for control information



Interaction with direct manipulation



Cirrus [Mankoff, GaTech]



What are the limits to input speed

- Key stroke rates
- Pointing rates (from Fitts' law)
- Information rate

Information theory

- Binary code for {a, b, c, d}
  - 00, 01, 10, 11
  - bad = 010011
- Binary code for {a, b, c, d}
  - 0, 10, 110, 111
  - bad = 100111
- Letter probabilities
  - 0.5, 0.25, 0.125, 0.125

Information content

- Information content
  - Average length of optimally compressed text
- Content of English
  - 1 bit per character
  - Keyboards inefficient by a factor of 6
- Faster typing
  - Input in optimal code
- Fitts' law measurements
  - Information rate of pointing – 14 bits per second
  - Input rate – 170 words per minute
    - With just one finger!

Dasher

- Pen based selection (as cirrus)
- Dynamically change layout
  - Prediction of next character

Mode Problem

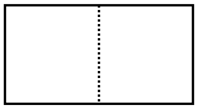
- Cognitive difficulties in remembering / keeping track of modes
  - Which mode?
  - Remapping operations
  - Retaining mode across context switch
- But modes are very useful
  - Efficient use of limited input controls
- Not all modes are the same
  - Shift key vs. Caps Lock
  - Mouse move vs. mouse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

Pen mode issues

- Advantages of pen
  - Single, well understood device
  - Low cognitive requirements for use
  - High precision
  - Ideal for two dimensional curve input
- Disadvantages
  - Limited number of distinct operations
  - Continuous operations make discrete actions more difficult
  - Conflict between input and control

Pen mode options

- Pen buttons
- Separate pens
  - Eraser
  - Multiple colored pens for smart board
- Short term modes
- Distinct writing areas



Implicit modes

- Ink recognition for modes
- Requires overloading some writing
- Scratch out gesture
- Inferred mode (Saund – Lank)
  - Infer meaning of operations
  - Soft prompt on ambiguous strokes

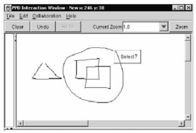

PPD Interaction Window - New x: 245 y: 38
File Edit Collaboration Help
Clear
Undo
Redo
Current Zoom 1.0
Zoom
Select?

Figure 1. Handling ambiguity in user gestures.

Tablet PC

- Basic slate hardware
  - Full fledged PC
  - Hi DPI Screen
- Portable
  - Light weight, 2 to 5 pounds
  - Wireless

Tablet vs. Laptop

- Convertible form factor
- Dual purpose device
- Many activities are best done with a keyboard
- Compromises to support both slate and laptop use

Digitizers

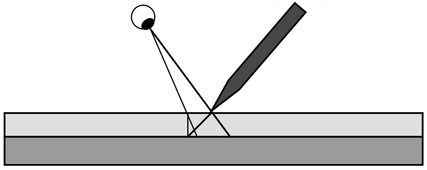
- Resistive digitizers
  - Respond to pressure
- Electromagnetic digitizer
  - Detect pen at distance
  - Hardware below LCD screen
  - Can detect rotation and tilt
- Digitizer distortion

Display Hardware

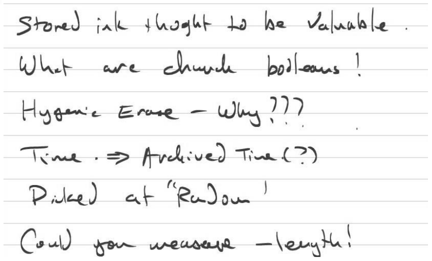
- Protective cover for LCD
  - Avoid psychedelic color blooming
  - Damage to LCD
- Glass covering
  - Hard surface
  - Slippery
  - Thickness

Parallax

- Difference between real and apparent location do to viewing angles



Alignment problems



Stored ink thought to be valuable.

What are chunk bolleans!

Hygenic Erase – Why???

Time. ⇒ Archived Time (?)

Picked at "Radom'

Could you measure –length!

Pens

- Highly personal item
- Close to ballpoint in size and weight (?)

Pen as a Mouse Positioning

- Pen positioning can be arduous work if UI requires targeting all over the display
  - Mouse can move the cursor far without much arm/hand movement, but the pen requires a lot of arm/hand movement
  - Menus and toolbars are typically at the top of a window; editing often occurs mid-way or toward the bottom
    - Lots of physical arm/hand movement results – a real pain for users
    - More local UI is desirable (e.g. context menus)

Pen as a Mouse Clicking

- Clicking with a pen is tough
  - Legacy applications typically assume during a click the mouse doesn't move
  - Pen taps are more like little strokes or stabs because of pen skidding and high-precision digitizers
  - Detecting the difference between tap and a drag is an interesting problem!
- Double-clicking is even tougher
  - Quick motion means sloppier result
- Right-clicking is even tougher

Pen as a Mouse Targeting guidelines

- Cursor feedback
- Bigger, easily-targeted controls
- Generous tap, double-click, and hover tolerances
- Keep related objects in proximity

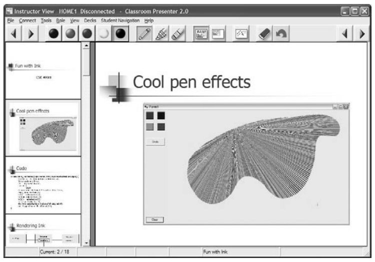
Hover

- Hovering still with a pen is tough
  - While in-air, control of a pen is considerably worse than when the pen is touching a surface
  - Mouse is intrinsically static, pen is not
  - Many applications typically assume cursor must be perfectly still for e.g. tooltips to appear
  - Software help needed to “smooth” hover location of cursor

Target and selection

- Buttons, Targets, Splitters, Scroll bars need to be bigger
- Digitizer inaccuracy
- Parallax
- Pen movement
- Mobility
- Pen slippage
- Obstructions

Pen UI Examples

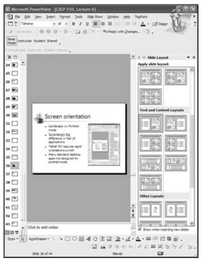

Instructor View HOME1 Disconnected - Classroom Presenter 2.0
File Connect Tools Role View Decks Student Navigation Help
Fun with Ink
Cool pen effects
Code
Rendering Ink
Undo
Clear
Current: 2 / 18
Fun with Ink

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


Microsoft PowerPoint - [CSEP 510, Lecture 6]
File Edit View Insert Format Tools Slide Show Window Help TexPoint
Tahoma
Design
Reply with Changes...
Base Mode Instructor Student Shared
Slide Layout
Apply slide layout:
Text and Content Layouts
Other Layouts
Show when inserting new slides
Screen orientation
Click to add notes
Draw AutoShapes
Slide 36 of 44
Blends

Digital Ink

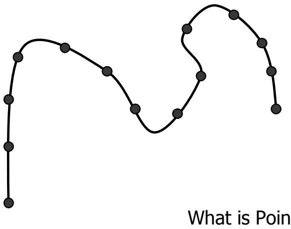
- Writing needs to be real time
  - Inking must not lag
- Ink should look smooth
  - No “jaggies” -> antialiased
  - No straight lines -> curve-fitted
- Use pen pressure information
  - Vary stroke width (more pressure means wider stroke)
- Support pen tips
  - Round/ballpoint vs. rectangular/ highlighter

Under the hood

Ink Representation

- Stroke representation
  - Array of ink packets
    - Ink packets in HIMETRIC Coordinates
    - Sampled ~150 times per second
    - Ink may have pressure and other properties
  - Stroke information – color, pen nib, transparency
- Ink Represntation
  - Array of strokes

Interpolation

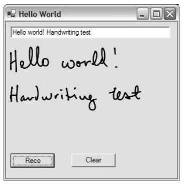


What is Points[6.4]?

Sample code

```
void BroadcastStroke (Stroke stroke){
            Ink.Ink ink = new Ink.Ink();
            Ink.Strokes strokes = stroke.Ink.CreateStrokes(new int[] { stroke.ID});
            ink.AddStrokesAtRectangle(strokes, strokes.GetBoundingBox());
            SendObject(new IncomingStroke(ink);
}


 private void ReceiveStroke(IncomingStroke incomingStroke){
             InkScribble s = GetOverlay().InkScribble;
             Strokes strokes = incoming.Stroke.Ink.Strokes;
             lock(this){
                         s.Ink.AddStrokesAtRectangle(strokes, strokes.GetBoundingBox());
             }
 }
```

Hello World



Hello world! Handwriting test

Hello world!
Handwriting test

Form Code

```
private InkCollector inkCollector;
private Recognizers recognizers;

public Form1()
{
            InitializeComponent();
            this.inkCollector = new InkCollector(this.Handle);
            this.inkCollector.Enabled = true;
            this.recognizers = new Recognizers();
}
```

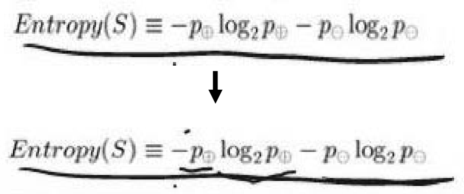
Event Code

```
private void ClearInk()
{
          this.inkCollector.Enabled = false;
          this.inkCollector.Ink = new Ink();
          this.Invalidate();
          this.inkCollector.Enabled = true;
}

private void OnReco(object sender, System.EventArgs e)
{
          this.textBox1.Text = this.inkCollector.Ink.Strokes.ToString();

}
```

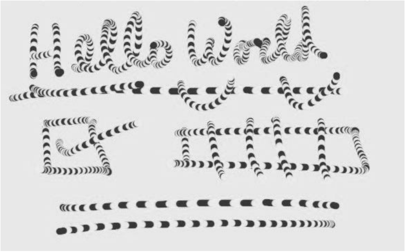
Limitations of digital ink

- Not real enough!
- Uniform, solid color
- Fails to show layering, speed, timing . .

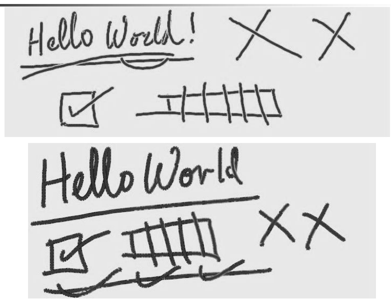
Inking examples


$Entropy(S) \equiv -p_{\oplus} \log_2 p_{\oplus} - p_{\ominus} \log_2 p_{\ominus}$
$Entropy(S) \equiv -p_{\oplus} \log_2 p_{\oplus} - p_{\ominus} \log_2 p_{\ominus}$

Enhanced Ink



Boundary added to ink



Fading ink

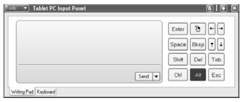
Hello World
Hello World
Hello World

Gestures

- Gestures need precise tuning
  - Trade-off between accidental activation vs. not getting when wanted
  - False activations are annoying and distracting to the task!
- Guideline
  - Use gestures guardedly
  - Error on the side of having “zero” incidence of false activation
  - Non-destructive consequences are better

Inking regions

- Users have an initial expectation that they can write digital ink anywhere
- Guideline
  - Communicate clearly where users can ink
  - Ink enabled controls should be self-evident



Recognition

- Handwriting recognition is highly variable by person
  - Errors are expected
  - Perceived good or bad handwriting effects expectation of accuracy
- Guideline
  - Be realistic about recognition accuracy rate, don’t rely heavily on it for authoring

Handwriting results

	The	quick	brown	fox	jumped
Correct					
Correct?					
Incorrect?					
Incorrect					

Handwriting results

	over	the	lazy	dog
Correct				
Correct?				
Incorrect?				
Incorrect?				

Tablet PC Usability Observations

- Buttons
  - Already covered
- Toshiba symbol commander
- Compaq / HP Q-Menu
- Auto rotate
- Toshiba button misfires by putting pen in holder
- Compaq pen failure – leaky pen