Pen-Based Computing
Agenda

- Natural data types
  - Pen, Audio, Video
- Pen-based topics
  - Technology
  - Ink as data
  - Recognition
Natural Data Types

• As we move off the desktop, means of communication mimic “natural” human forms of communication
  • Writing..............Ink
  • Speaking............Audio
  • Seeing..............Video

• Each of these data types leads to new application types, new interaction styles, etc.
Pen Computing

- Use of pens has been around a long time
  - Light pen was used by Sutherland before Engelbart introduced the mouse
- Resurgence in 90’s
  - GoPad
  - Much maligned Newton
- Types of “pens”
  - Passive (same as using a finger)
  - Active (pen provides some signal)
Example Pen Technology

- Passive
  - Touchscreen (e.g., PDA, some tablets)
  - Contact closure
  - Vision techniques
- Active
  - Pen emits signal(s)
  - e.g. IR + ultrasonic
- Where is sensing? Surface or pen
Questions about Pens

- What operations detectable
  - Contact – up/down
  - Drawing/Writing
  - Hover?
  - Modifiers? (like mouse buttons)
  - Which pen used?
  - Eraser?

- Difference between pen and mouse.
Example: Expansys Chatpen

- Reads dot pattern on paper
- Transmits via Bluetooth

Example: mimio

- Active pens
  - IR + ultrasonic
- Portable sensor
  - Converts any surface to input surface
- We have chained these to create big surface

- http://www.mimio.com
Pen input

Free-form ink (uninterpreted)

Soft keyboards

Recognition systems
  - generalize to gesture-based systems
Free-form ink

ink as data

- humans can interpret
- time-stamping
- implicit object detection
- special-purpose “domain” objects
Free-form ink examples

Ink-Audio integration
- Tivoli (Xerox PARC)
- eClass (GT)
- FlatLand (Xerox PARC)
- Dynomite (FX-PAL)
- The Audio Notebook (MIT)
Soft Keyboards

common on small mobile devices

many varieties

• tapping interfaces
• Key layout (QWERTY, alphabetical, … )
• learnability vs. efficiency
T9 (Tegic Communications)

- Alternative tapping interface
- Phone layout plus dictionary

- Soft keyboard or mobile phone
Quickwrite (Perlin)

“Unistroke” recognizer
Cirrin (Mankoff)

Word-level unistroke recognizer

finished
Recognizing pen input

Graffiti
• unistroke alphabet

Other pen gesture recognizers
• for commands
  • Stanford flow menus; PARC Tivoli implicit objects
• measure features of strokes
  • Rubine, Long
• usually no good for “complex” strokes
Handwriting recognition

Lots of resources
• see Web
• good commercial systems

Two major techniques:
• on-line
• off-line
Mixing modes of pen use

Users want free-form and commands
• or commands vs. text

How to switch between them?
• (1 mode) recognize which applies
• (2 modes) visible mode switch
• (1.5 modes) special pen action switches
Error correction

Really slows effective input
• word-prediction can prevent errors

Various strategies
• repetition (erase and write again)
• n-best list
• other multiple alternative displays
Other interesting applications

Signature verification
Note-taking
• group (NotePals by Landay @ Berkeley)
• student (StuPad by Truong @ GT)
• meetings (Tivoli and other commercial)
Sketching systems
• early storyboard support (SILK, Cocktail Napkin)
• sketch recognition (Eric Saund, PARC; others)
Toolkits for Pen-Based Interfaces

- SATIN (Landay and Hong) – Java toolkit
- MS Windows for Pen Computing
- MS Pocket PC, CE.net
- Apple Newton OS
- GO PenPoint
- Palm Developer environments
- GDT (Long, Berkeley) Java-based trainable unistroke gesture recognizer
- OOPS (Mankoff, GT) error correction
SATIN (UIST 2000)

- Pen input for informal input
  - Sketching (others have investigated this)
- Common toolkit story
  - Gee, “X” sure is a neat class of apps!
  - Golly, making “X” apps is tough!
  - Here’s a toolkit to build “X” things easily!
The SATIN Toolkit

- The application space
  - Informal ink apps
  - Beyond just recognition
  - Pen “look-and-feel”

- Abstractions
  - Recognizers
  - Interpreters
  - multi-interpreters