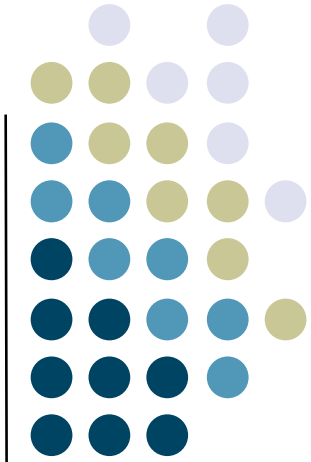
Pen-Based Computing



Georgia Tech

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

- http://www.expansys.com/product.asp?code=ERIC_CHATPEN

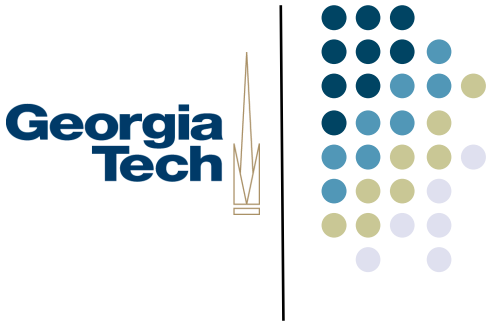
Example: mimio

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

mimio

Windows

- 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

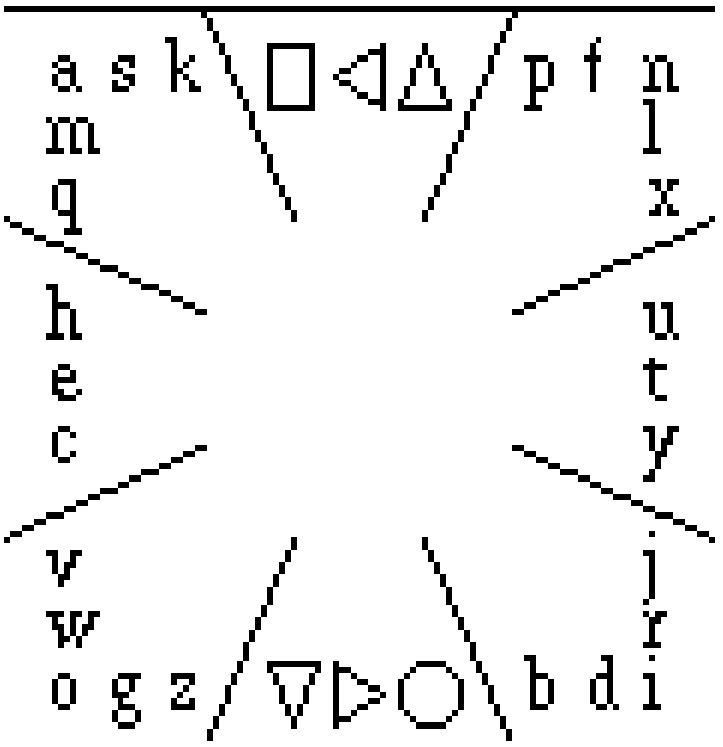
T9 (Tegic Communications)

- Alternative tapping interface
- Phone layout plus dictionary

- Soft keyboard or mobile phone

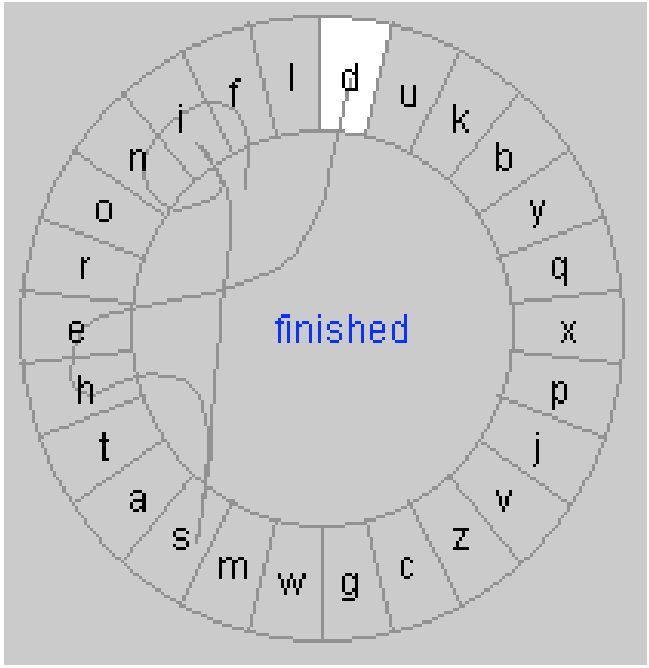
Quickwrite (Perlin)

"Unistroke" recognizer

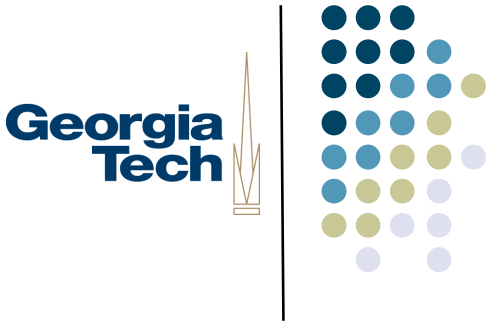


Cirrin (Mankoff)

Word-level unistroke recognizer



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

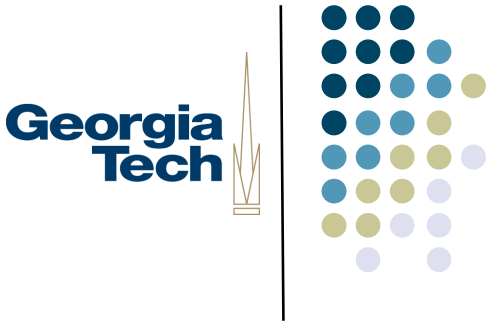
Signature verification

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)

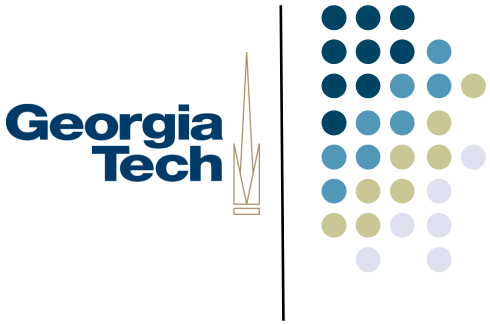


Toolkits for Pen-Based Interfaces

- SATIN (Landay and Hong) – Java toolkit

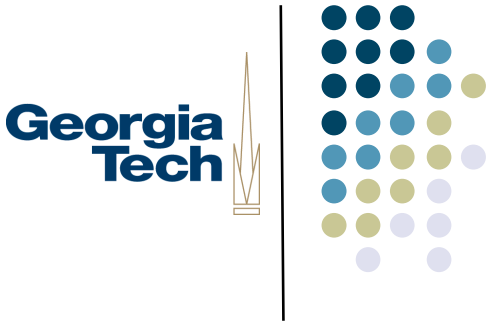
- MS Windows for Pen Computing
- MS Pocket PC, CE.net
- Apple Newton OS
- GO PenPoint
- Palm Developer environments
- GDT (Long, Berkeley) Java-based trainable unistroke gesture recognizer
- OOPS (Mankoff, GT) error correction

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