Pen- and Touch-Based Computing

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Agenda

- Natural data types
  - Pen, Audio, Video
- Pen-based topics
  - Technology
  - Ink as data
  - Recognition
- Related: Gestures (on surfaces)
  - iPhone, MS Surface
  - Technology sometimes similar to pens
  - Related issues with 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 (like MS Surface)
  - Capacative sensing (like iPhone)
- 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?
- Differences between Pen and Finger Gestures?
  - Can't detect fine-grained points (difficult to do writing, for instance)
  - No buttons on fingers! (But can use different gestures for "modes")
- 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
- Can chain these to create big surface

- http://www.mimio.com

Pen input

1. Free-form ink (*mostly* uninterpreted)

    - Tablet PC applications, digital notebooks, etc.

2. Soft keyboards

    - Provide high-accuracy (although slow) mechanism for inputting machine-interpretable text

3. Recognition systems

    - Recognition of **content**
        - Text: handwriting recognition, simplified textual alphabets
        - Graphics, doodles, figures: sketch-based interfaces
    - Recognition of **commands**
        - Specialized vocabulary of command symbols
        - Modal input of commands
        - Contextual commands: commands distinguished from content only in how they are used

1. Free-form ink

ink as data: when uninterpreted, the easiest option to implement

- humans can interpret
- time-stamping perhaps (to support rollback, undo)
- implicit object detection (figure out groupings, crossings, etc.)
- special-purpose "domain" objects (add a little bit of interpretation to some on-screen objects)
  - E.g., Newton: draw a horizontal line across the screen to start a new page
  - See also Tivoli work (Moran, et al., Xerox PARC)

Free-form ink examples

Ink-Audio integration

- Tivoli (Xerox PARC)
- eClass (GT)
- Flatland (Xerox PARC)
- Dynomite (FX-PAL)
- The Audio Notebook (MIT)

2. Soft Keyboards

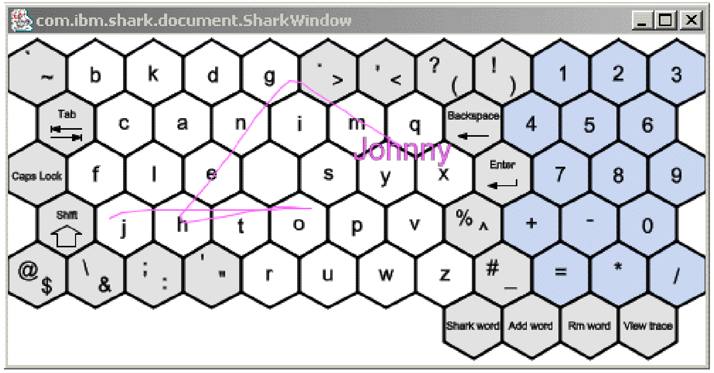
Make “recognition” problem easier by forcing users to hit specialized on-screen targets

(Sometimes a blurry line between what’s “recognition” and what’s a “soft keyboard”)

common on small mobile devices

many varieties

- tapping interfaces
- Key layout (QWERTY, alphabetical, …)
- learnability vs. efficiency



T9 (Tegic Communications)

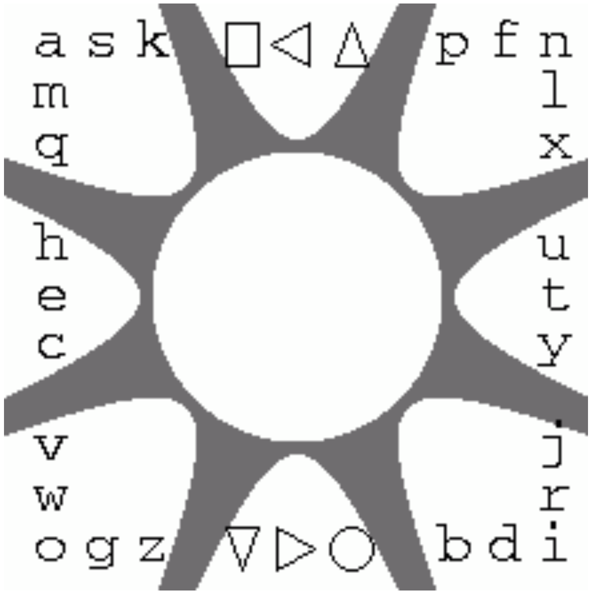
- Alternative tapping interface
- Phone layout plus dictionary

- Soft keyboard or mobile phone

  - Not usually "pen based" but ideas for rapid text entry often carry over from fingertips to pens

Quickwrite (Perlin)

“Unistroke” recognizer

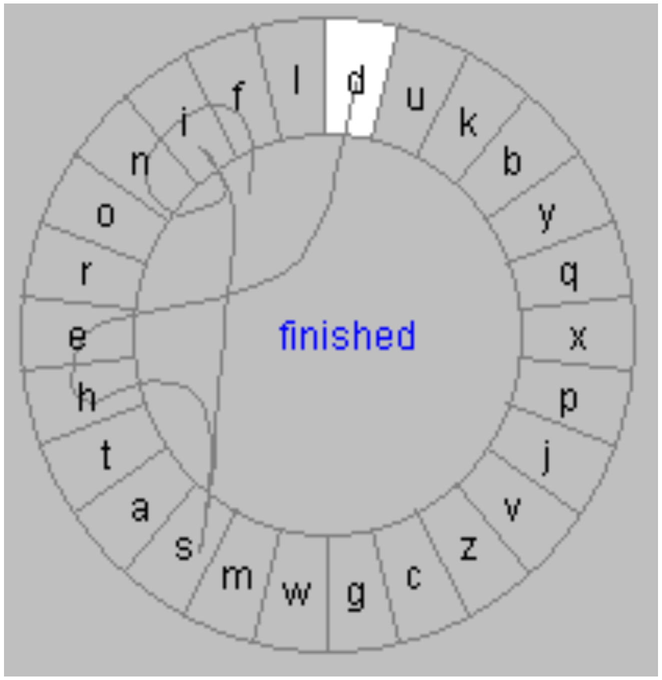


- Start in “rest” zone (center)
- Each character has a *major zone*: large white areas
- ... and a *minor zone:* its position within that area
- To enter characters in the center of a major zone, move from the rest zone to the character’s major zone, then back
    - Example: for *A*, move from rest to upper left zone then back to rest
- To enter characters at other points in a zone, move into the character’s major zone, then into *another* major zone that corresponds to the character’s minor zone
    - Example: *F* is in the top-right zone (its major zone). Move from rest to that major zone. Since *F* is in the top-center of its major zone, move next into the top-center major zone , then back to rest
- Allows quick, continual writing without ever clicking a mouse button or lifting the stylus

Cirrin (Mankoff & Abowd)

Word-level unistroke recognizer

Ordering of characters minimizes median distance the pen travels (based on common letter pairings)



3. Recognizing pen input

- Unlike soft keyboards, recognize more "natural" pen strokes
- Can be used for both content and commands

- Some are less natural than others: 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 (content) recognition

Lots of resources

- see Web
- good commercial systems

Two major techniques:

- on-line (as you write)

- off-line (batch mode)

Which is harder?

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- on-line (as you write)

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Offline. You don't have the realtime stroke information (direction, ordering, etc.) to take advantage of in your recognizer... only the final ink strokes.

Mixing modes of pen use

Users want free-form content and commands

- or commands vs. text

How to switch between them?

- (1 mode) recognize which applies: contextual commands, a la Tivoli, Teddy, etc.
- (2 modes) visible mode switch: Graffiti (make special command gesture)
- (1.5 modes) special pen action switches: temporary or transient mode, e.g., Wacom tablet pens

Error correction

Necessary when relying on recognizers (which may often produce incorrect results)

UI implications: even small error rates (1%) can mean lots of corrections, must provide UI techniques for dealing with errors

Really slows effective input

- word-prediction can prevent errors

Various strategies

- repetition (erase and write again)
- n-best list (depends on getting this from the recognizer as confidence scores)
- 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