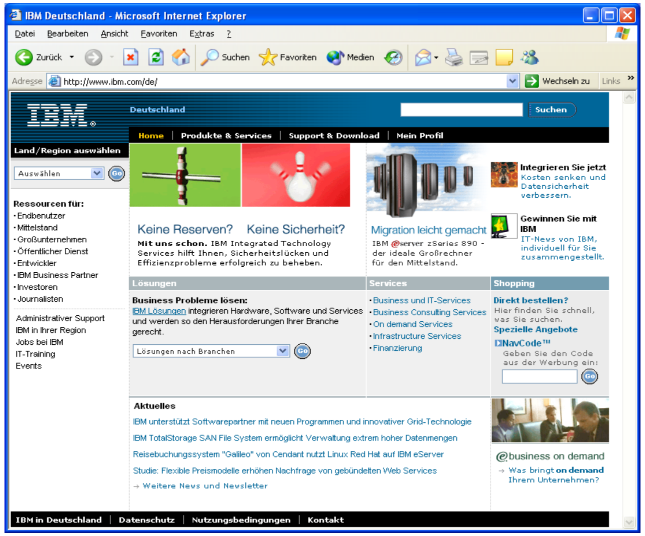
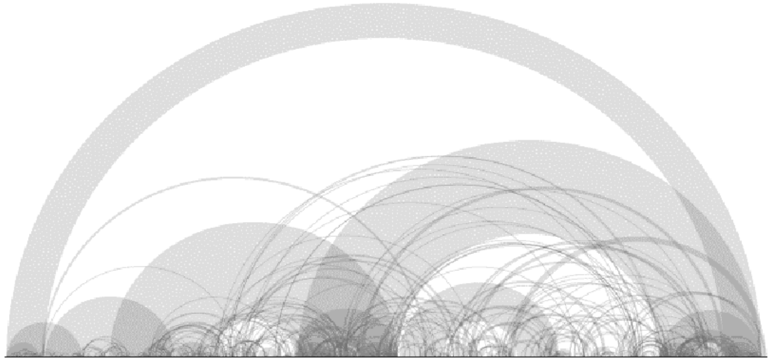
Structure

- Chapter 1:
  HCI and the WWW



- Chapter 2:
  Mobile and Ubiquitous User Interfaces

- Chapter 3:
  Information Visualization



1 Mobile and Ubiquitous User Interfaces

2.1 Mobile Computing

2.2 Input and Output on Mobile Devices

2.3 Design Guidelines for Mobile Devices

2.4 System Architectures for Mobile Devices

2.5 Example Applications

2.6 HCI and Ubiquitous Computing

Literature:

- Scott Weiss: Handheld Usability, Wiley 2002
- Steve Love: Understanding Mobile Human-Computer Interaction, Elsevier 2005
- Ch. Lindholm/ T. Keinonen/ H. Kiljander: Mobile Usability, McGraw-Hill 2003

Definition: Mobile Computing

- ***Mobile Computing*** is a generic term describing the application of small, portable, and wireless computing and communication devices. This includes devices like laptops with wireless LAN technology, mobile phones, wearable computers and Personal Digital Assistants (PDAs) with Bluetooth or IRDA interfaces, and USB flash drives.
  (Wikipedia, 19 May 07)
- ***Mobile***, or "untethered," ***computing*** means that the computing device is not continuously connected to the base or central network. Mobile devices include PDAs, laptop computers, and many of today’s cell phones (aptly called "smart phones"). These products may communicate with a base location with or without a wireless connection. An example of a wireless mobile application is using a modem-equipped PDA to receive text messages via satellite technology. A non-wireless mobile example could involve sending data from a laptop to a central database or network server over a temporary dial-up connection. In the latter example, the laptop can still be used as a mobile device regardless of whether or not it ever connects to another computing device.
  (Texas Department of Information Resources)

Mobile Computing as a Future Trend

Industry News

Mobile computing market to reach $88.9 billion by 2011

Posted : April 19, 2007

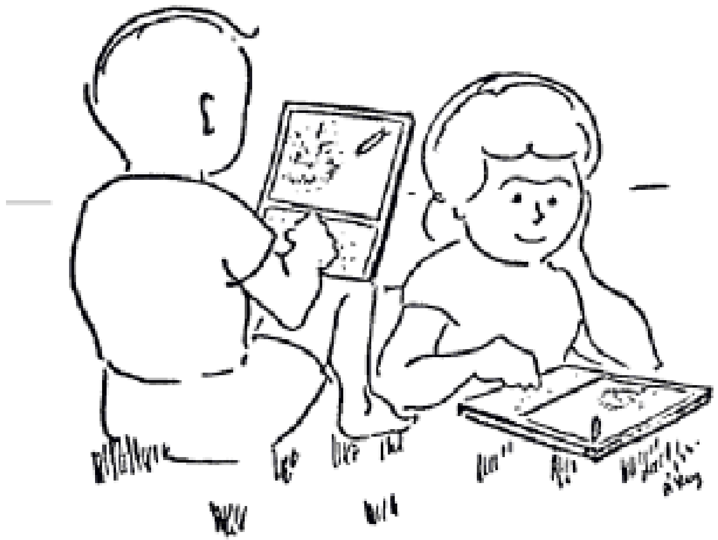
(United States) BCC Research, in its latest technical market report, 'The Future of Mobile Computing' estimates that the global market for mobile computing will reach more than $88.9 billion by 2011. One of the key growth drivers is laptop computers, which are expected to account for almost 96 percent of the total market share or $69.2 billion. Smart phones have the highest growth potential of 15.7 percent, based on a compounded annual growth rate (CAGR) amounting to almost $17.8 billion.This uptrend in mobile computing market is greatly influenced by the increasing demand on office-related, communications-based, and global positioning applications installed in handheld devices and mobile phones.The constant demand for more portable and multifunction devices to keep up with the fast-paced lifestyles of many, ensures the steady growth of the mobile computing industry.

(www.computerproducts.globalsources.com)

- The global market for mobile computing was almost $55.6 bln in 2005 and $63.5 bln in 2006. (http://blogs.zdnet.com/ITFacts/index.php?p=12576)

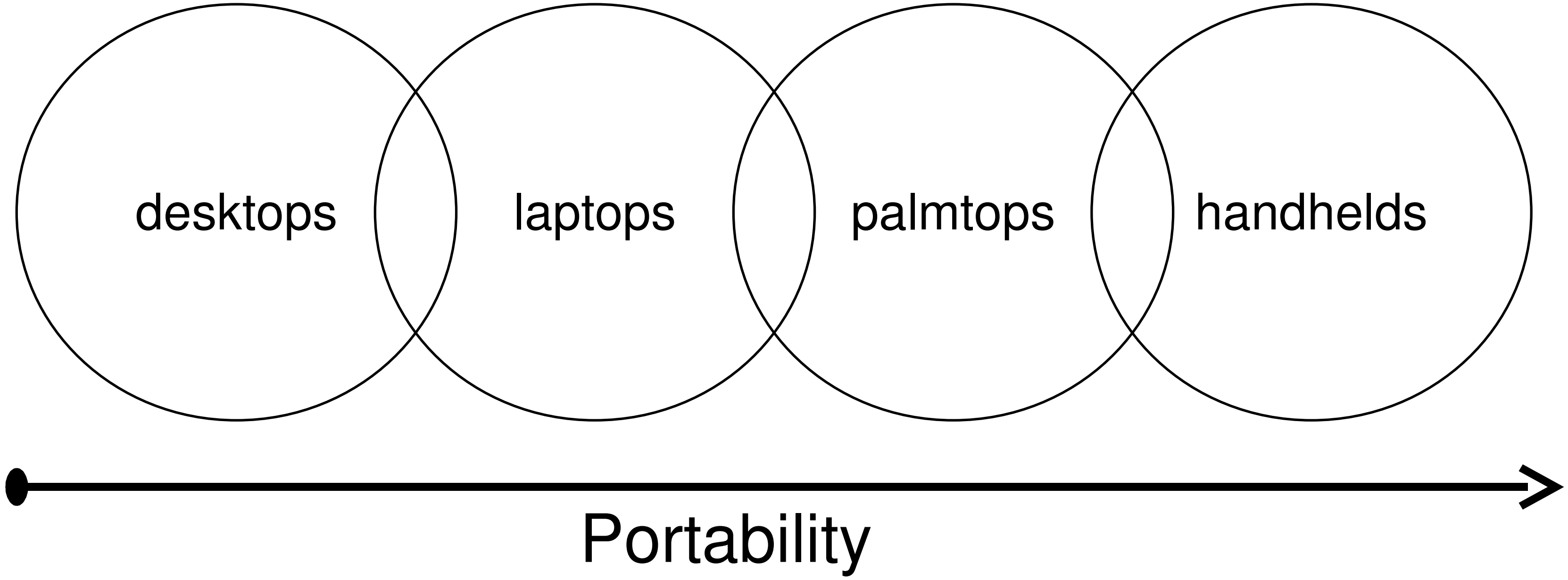
Dynabook Vision

Alan Kay, late 1960s



- Handheld
- Wireless connectivity
- Multimedia capabilities
- Support for programming

The Personal Computing Continuum

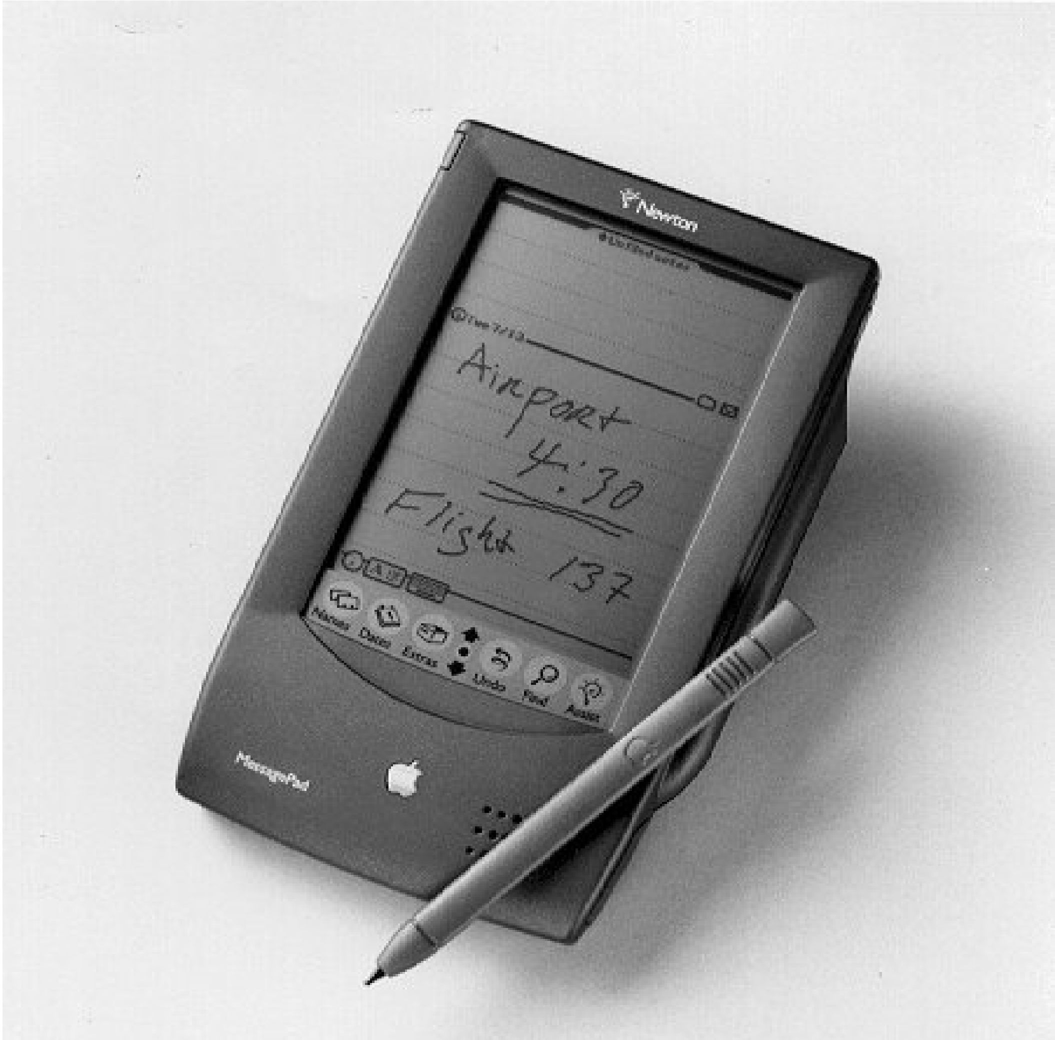


Parallel to handhelds, other forms of high portability/local adaptation evolve:
- Wearable computing systems (e.g. intelligent jackets)
- Embedded computing systems, e.g. in cars, homes

Scott Weiss p. 3

Apple Newton
Commercial Handheld Computer

- Recognition Architecture
  - Recognizes handwriting--printed, cursive, or a mixture of the two--with the assistance of a 93,000-word, built-in word list
  - Lets you add up to 1,000 words
  - Includes four pop-up keyboards: typewriter, numeric, phone, and time/date
  - Recognizes graphics and symmetrical objects
- 320 by 240 pixels Display
- Sold from 1993



http://applemuseum.bott.org/sections/computers/omp.html

Itsy
Pocket Computer

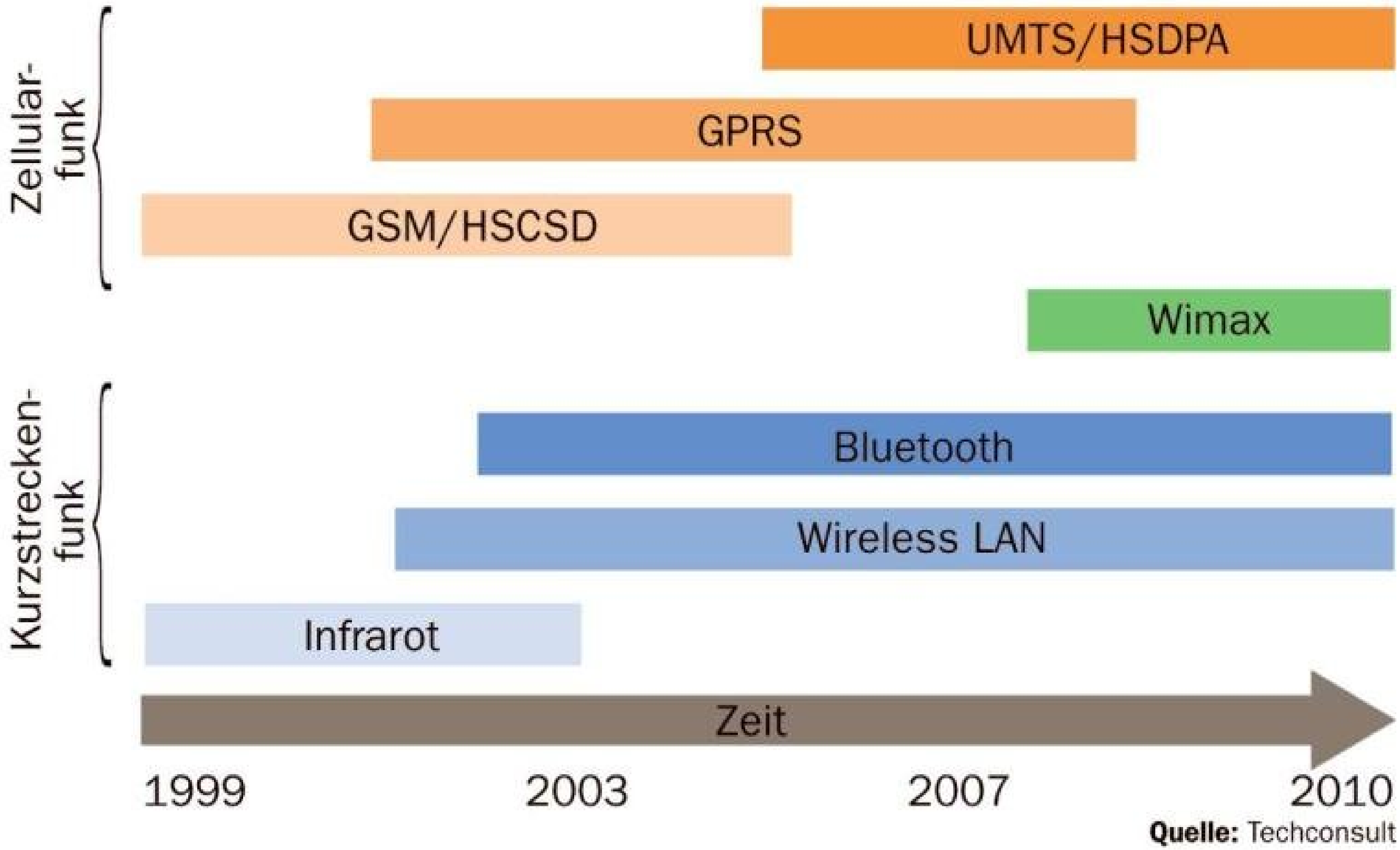
- Research platform (1998)
- Gesture and speech interaction
- *tilt-to-scroll* and *Rock 'n' Scroll* to include the use of gestures to issue commands.

http://www.hpl.hp.com/downloads/crl/itsy/index.html

http://www.hpl.hp.com/techreports/Compaq-DEC/WRL-2000-3.pdf (2000)

http://www.informationweek.com/830/innovation.htm (2001)

Relevante Kommunikationstechnologien



Frank Heuer, in Computerwoche, Sep 06

Key Differences Fixed – Mobile Systems

	Fixed	Mobile
Purpose	Lengthy information processing tasks, Web browsing, email	On-the-go lookup an entry of information, quick communication
Form	Requires table, best used when seated	Less than DIN A4, often fits into shirt pocket or even invisible
Power	Requires power connection	Relies on battery life - has to deal economically with power
Connectivity	Fast and reliable connectivity	Slow and unreliable connectivity, but improving...
Input	Input by keyboard and mouse	Challenged input, but also new options (gestures, speech)
Display	Large display	Small display
Memory	Large working memory (Gigabytes)	Small working memory (Megabytes, in good cases)
Storage	Extensive storage options including large hard disks	Sometimes none, often limited to removable media (e.g. 1 GB)

Example: Internet Use Differences

- Surf vs. hunt
  - Wireless users hunt for their information, do not easily get side-tracked
- Unlimited use vs. cost per unit
- Open landscape vs. walled garden
  - Location of “Open URL” in Web and handset browser
- Bookmarking
  - Who uses bookmarks on mobile devices?
- Privacy & security
  - Mobile devices are considered very private property
    - » E.g. local password storage is likely too be used
  - Mobile devices are easily lost, are attractive theft targets

Evolution of Mobile Devices

- Example: Nokia mobile phones (Lindholm et al.)

Model	1011	2110	6110	6210	6610	8800
Year	1992	1994	1997	2000	2002	2007
Display	2 x 8 chars	3 x 10 + 2 x 6 chars	84 x 48 px	96 x 60 px	128 x 128 px	208 x 208 px (Ths. colours)
# Keys	22	23	21	21	23	21 (?)
# Display texts	406	378	1719	2777	3085	?
Volume (ccm)	340	170	130	95	71	67
Weight (g)	475	240	140	114	84	134

1 Mobile and Ubiquitous User Interfaces

Input Technologies for Mobile Devices

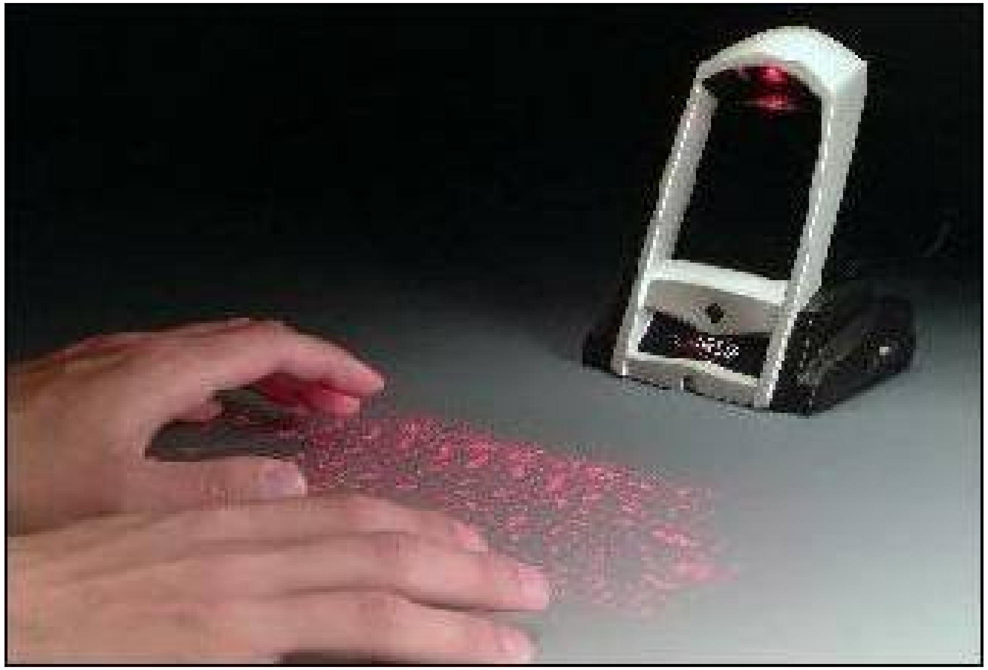
- Soft Keyboards
- Screen Keyboards

Input Technologies for Mobile Devices

Keyboards

Input Technologies for Mobile Devices

- Virtual Keyboards
- Projection Keyboards



http://www.alpern.org/weblog/stories/2003/01/09/projectionKeyboards.html

Input Technologies for Mobile Devices

- Chord Keyboard
- One-handed Keyboards
- Example Twiddler
  - Combines keyboard and Mouse
  - Keypad designed for "chord" keying:

    This means you press one or more keys at a time. Each key combination generates a unique character or command.
  - 12 finger keys and 6 thumb keys, the twiddler can emulate the 101 keys on the standard keyboard

Yoyo Input Device designed for artic environments

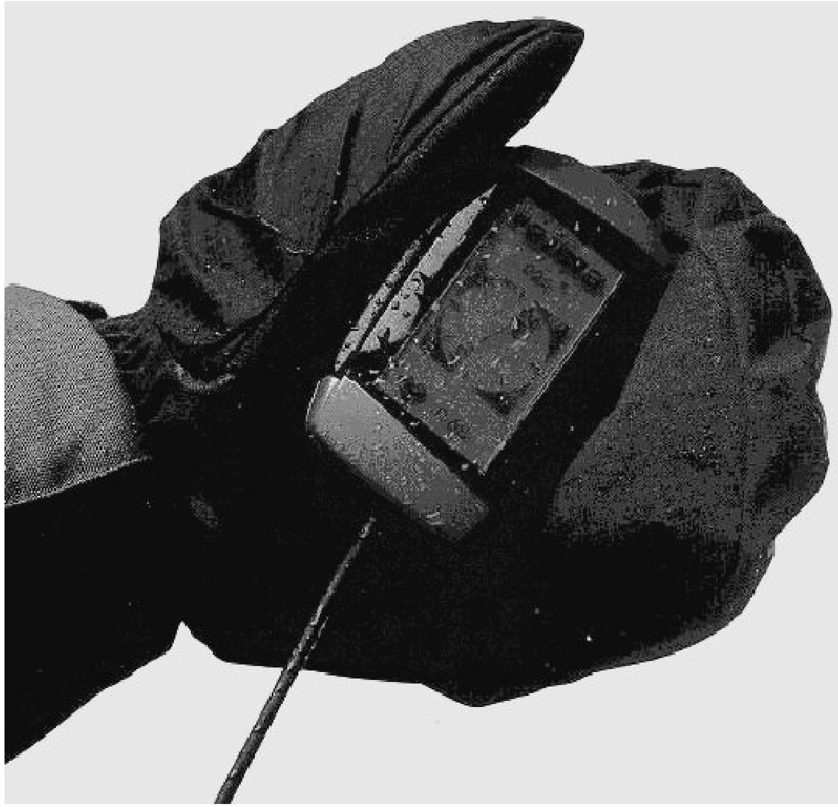
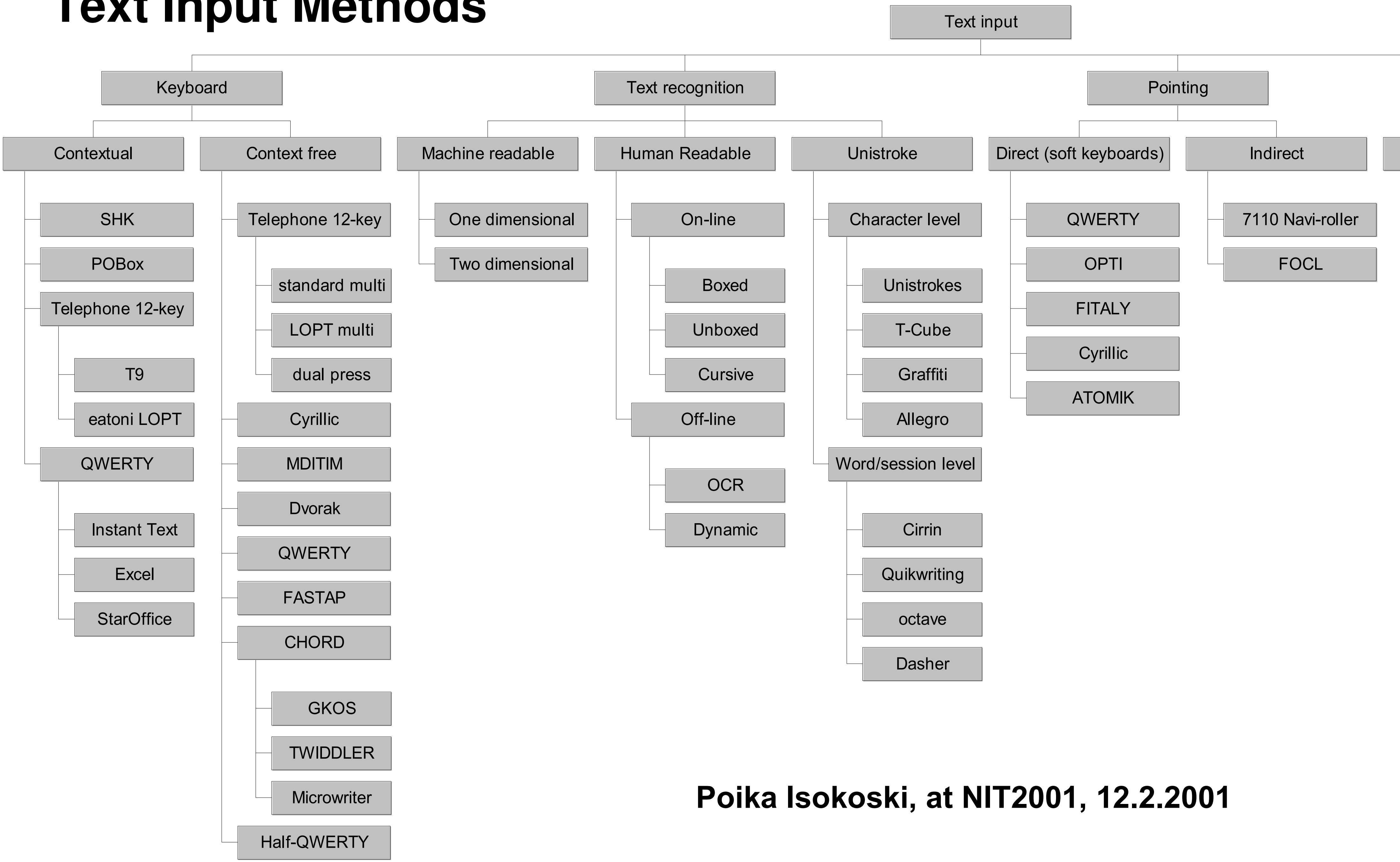


Figure 5. The Yo-Yo user interface.

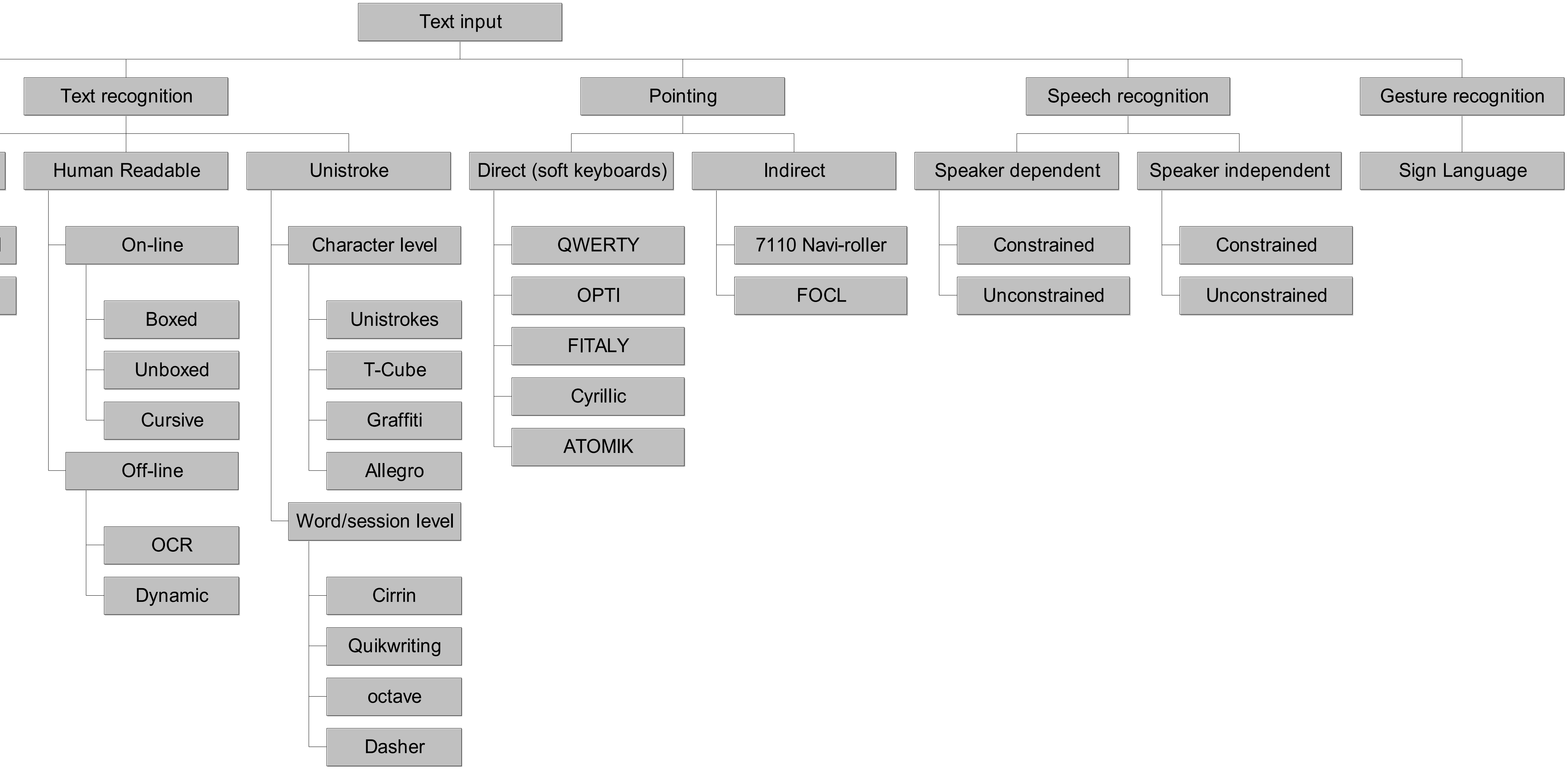
- Smart Clothing for the Arctic Environment by J. Rantanen et al. in proceedings of the int. Symposium on Wearable Computing 2000 (ISWC2000)

Text Input Methods



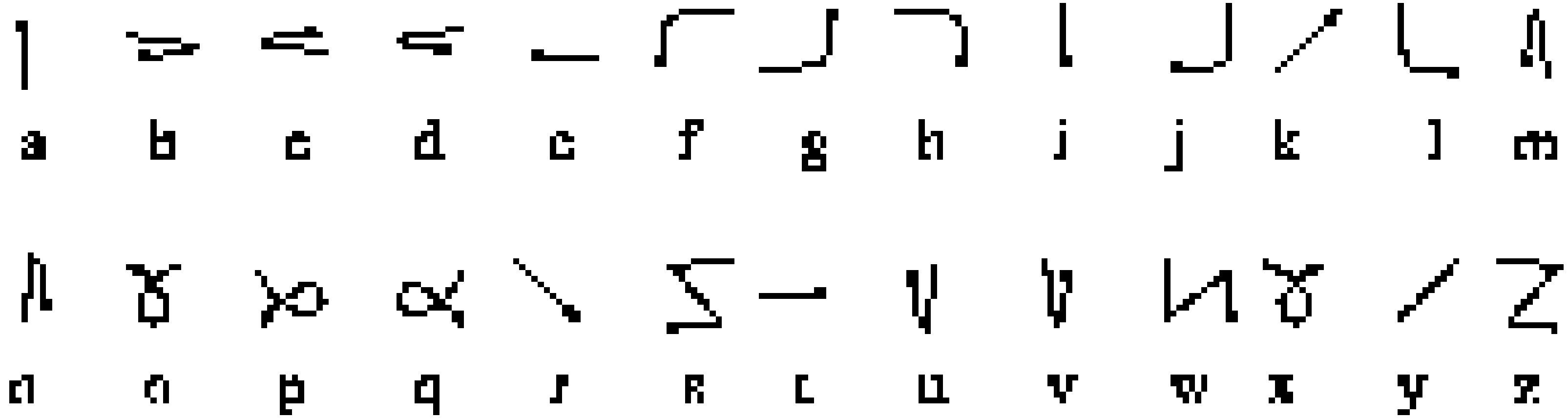
Poika Isokoski, at NIT2001, 12.2.2001

Text Input Methods



Poika Isokoski, at NIT2001, 12.2.2001

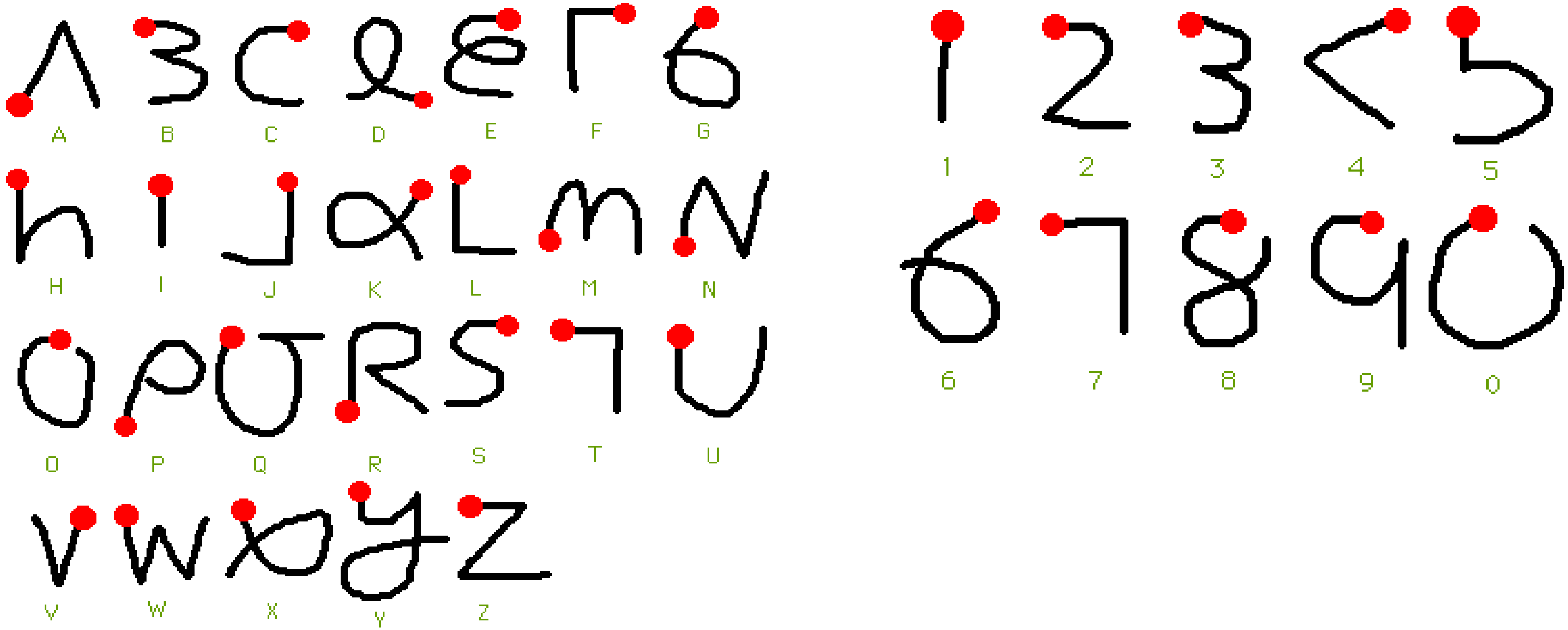
Unistroke



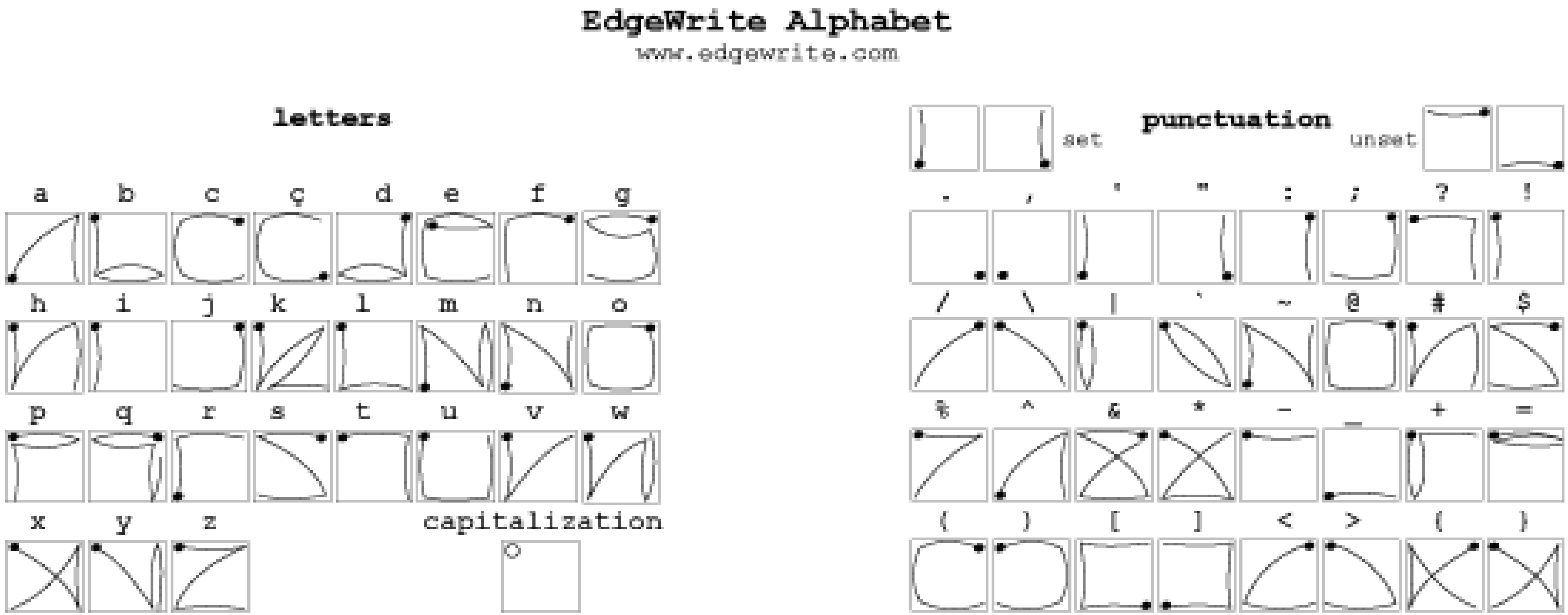
- Explored in the PARCTab Experiment
- Each letter is written in a single stroke
- Lifting the pen indicates a new letter
- Solves the separation problem

http://sandbox.parc.com/parctab/csl9501/paper.html

Graffiti
Unistroke used in PalmOS



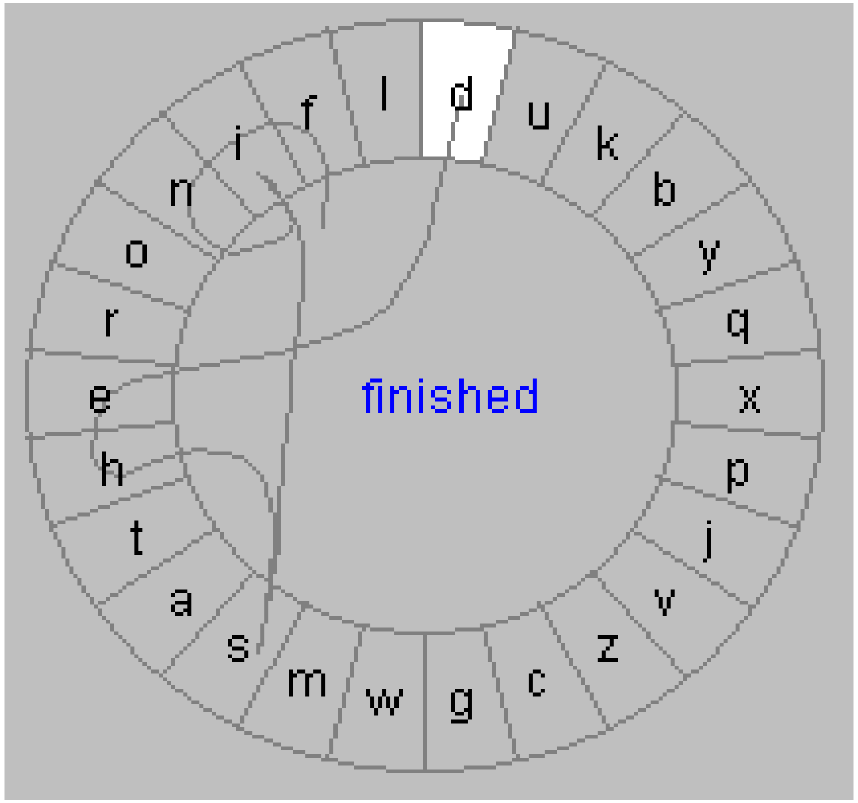
EdgeWrite



- VIDEO
- http://depts.washington.edu/ewrite/

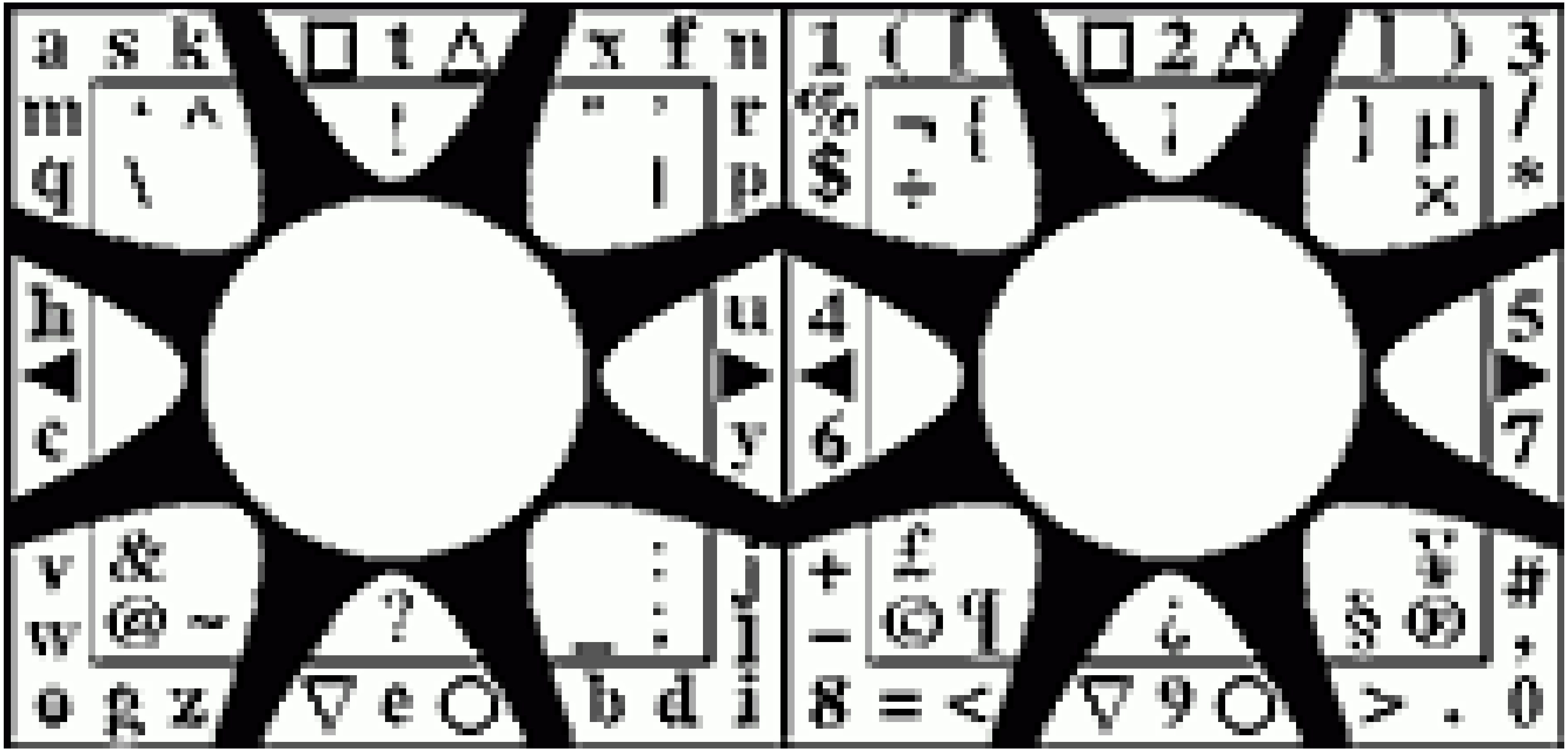
Cirrin - (the CIRculaR INput device)

- A word-level unistroke keyboard is a soft keyboard allowing a user to go from any key to any other key without lifting the pen or entering unwanted keys
- Jennifer Mankoff and Gregory D. Abowd. Cirrin: A word-level unistroke keyboard for pen input.
  In *Proceedings of UIST '98*. Technical note. pp.213-214

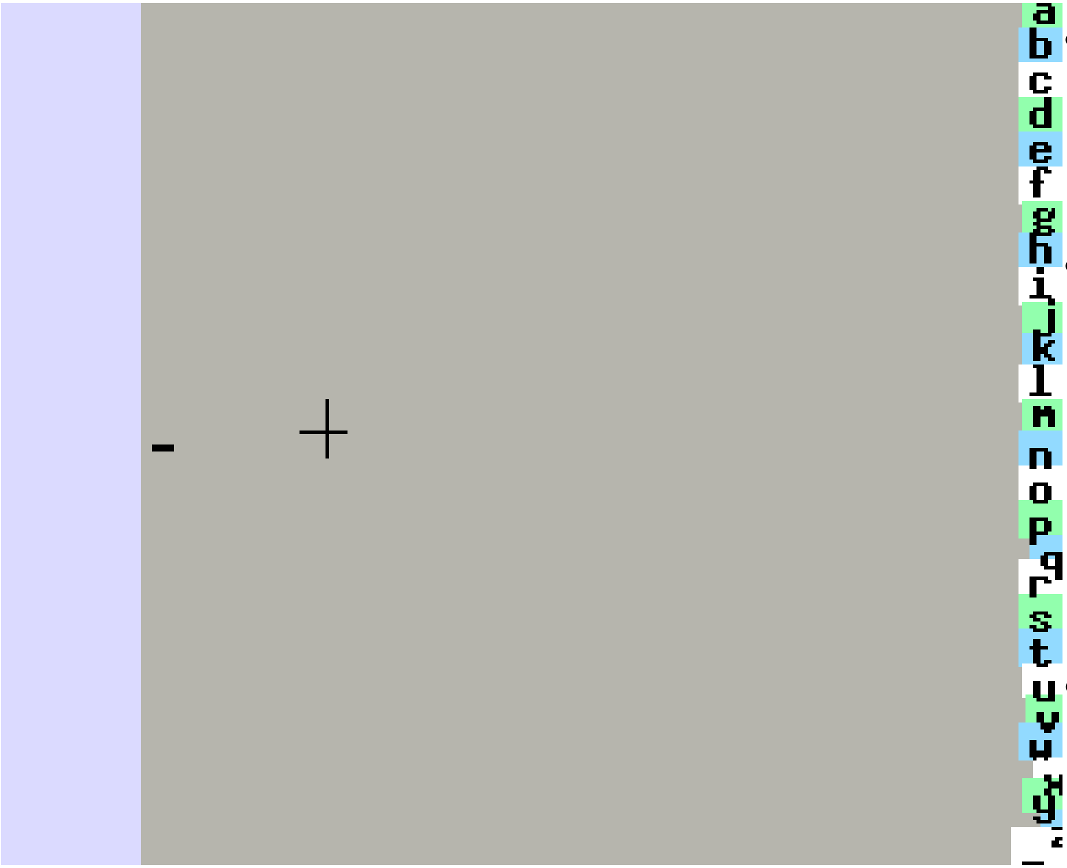


Quikwriting

- http://mrl.nyu.edu/projects/quikwriting/
- Authors claim “Quikwriting is significantly faster and less stressful to use than Graffiti”



Dasher



- Dasher is a data entry interface incorporating language modelling and driven by continuous two-dimensional gestures.
- “Tests have shown that, after an hour of practice, novice users reach a writing speed of about 20 words per minute while taking dictation. Experienced users achieve writing speeds of about 34 words per minute, compared with typical ten-finger keyboard typing of 40-60 words per minute.”
- http://www.dasher.org.uk/

Mobile Phone Text Input

- Fewer keys than letters!
- Approaches
  - Multitap
  - Dictionary based disambiguation
  - Prefix-based disambiguation
  - Multiple simultaneous key presses
- Metrics
  - Complexity
  - Visibility
  - Keystrokes per character (KSPC)

Multi-Tap

- A key has more than one letter assigned
- Pressing the key once gives the first, twice the second, and so on
- After a period of time or when changing to another button the letter is selected
- Advantage
  - You can see what you write
  - Easy to understand
- Problem
  - High number of average key presses per letter
- About 2 KSPC

Predictive Text Input
Dictionary based disambiguation

- Example T9
- Input is compared to a dictionary
- Input is matched to existing words
- If non-ambiguous a single word is offered
- If multiple words are possible the one with the highest probability is offered and a mechanism to select the others
- Advantage
  - Very fast input mechanism for words in the dictionary
- Problems
  - Slow for words that are not in the dictionary
  - The word that is actually typed is not always visible
- For words in the dictionary KSPC is close to 1

Basis for predictive input

- Word frequency
- Letter frequency
- Frequency of letter groups
- Frequency of word groups

- http://deafandblind.com/word_frequency.htm
- http://www.fortunecity.com/skyscraper/coding/379/lesson1.htm

Prefix-based disambiguation

- EATONI
  - LetterWise
  - WordWise
  - http://www.eatoni.com/

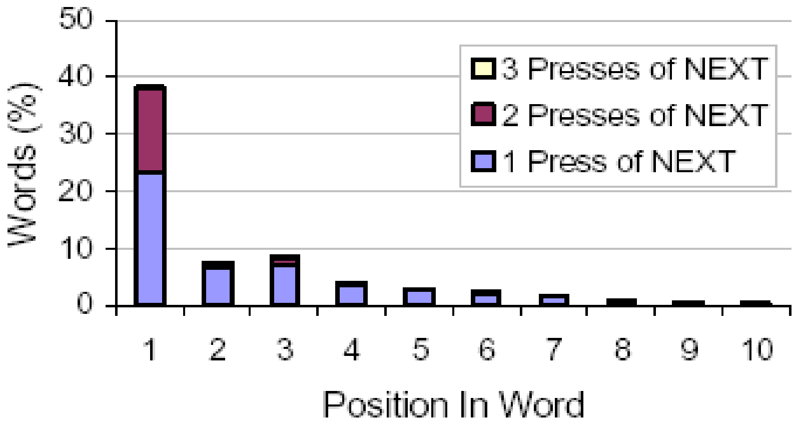


Figure 2. Press of NEXT vs. letter position in word

- Language is analysed and probabilities for letter sequences is calculated
  - P(“a“)=… P(“b“)=… P(“y“)=… P(“z“)=…
  - P(“aa“)=… P(“ab“)=… P(“zy“)=… P(“zz“)=…
  - P(“aaa“)=… P(“aab“)=… P(“zzy“)=… P(“zzz“)=…
- Probabilities are used to chose next character that is displayed

  I. Scott MacKenzie, Hedy Kober, Derek Smith, Terry Jones and Eugene Skepner LetterWise: Prefix-based Disambiguation for Mobile Text Input in the proceedings of the 14th Annual ACM Symposium on User Interface Software and Technology (UIST), November 2001, Orlando, Florida.

- See also: http://www.speedscript.biz/

Multiple Simultaneous Key Presses

- Frogpad
  - Mini-keyboard
  - Static arrangement of letters based on frequency in the language text corpus
  - Pressing two keys provides the second option
  - http://www.frogpad.com/
- Cord keyboard
  - Twiddler

Fasttap

Fastap's keypad may look small, but the buttons work and feel a lot like the keys on your computer keyboard.

Letters are raised and number keys are lowered so that your finger will probably touch letter keys when you strike a number - but that's okay.

That's how Fastap technology works, you don't need to be careful!

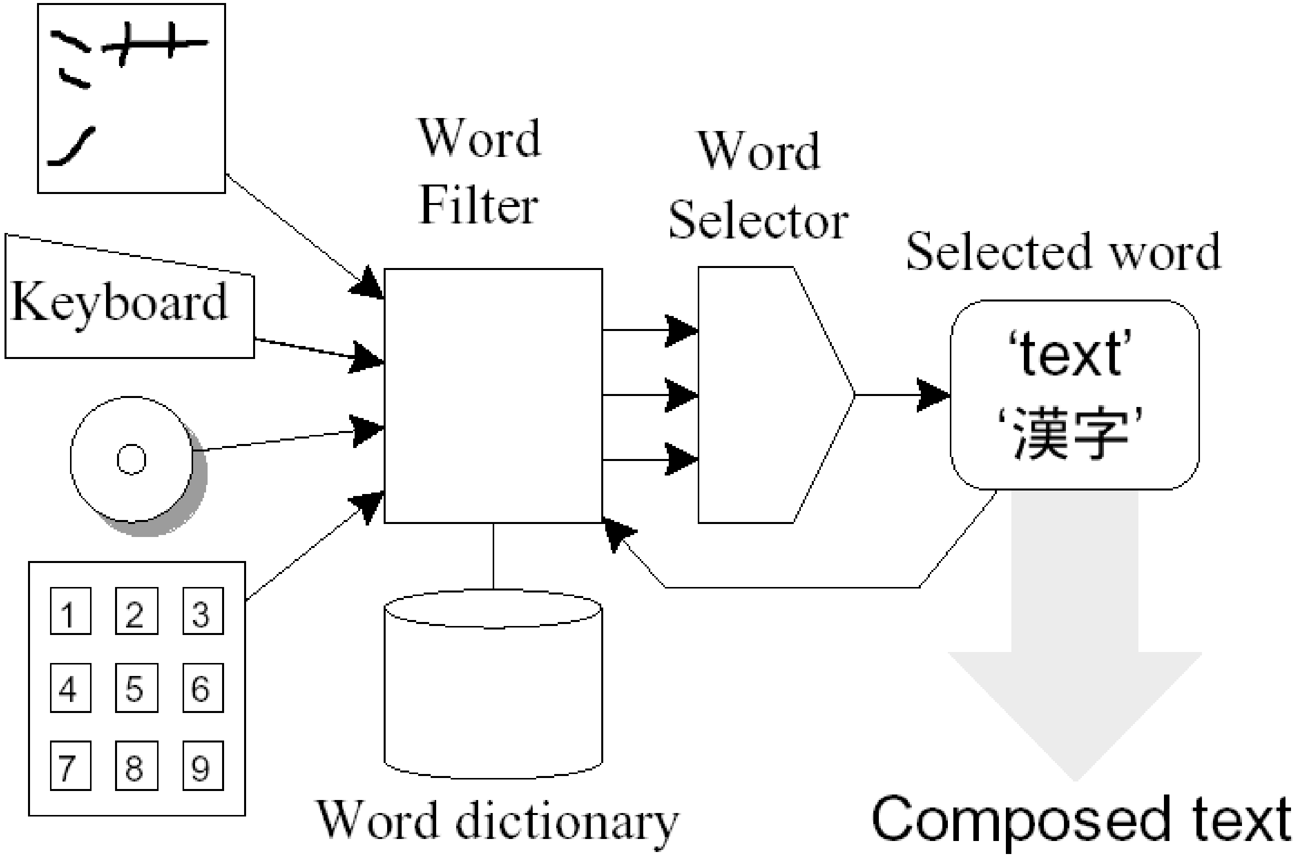
- Different keys for numbers and letters
- Different height

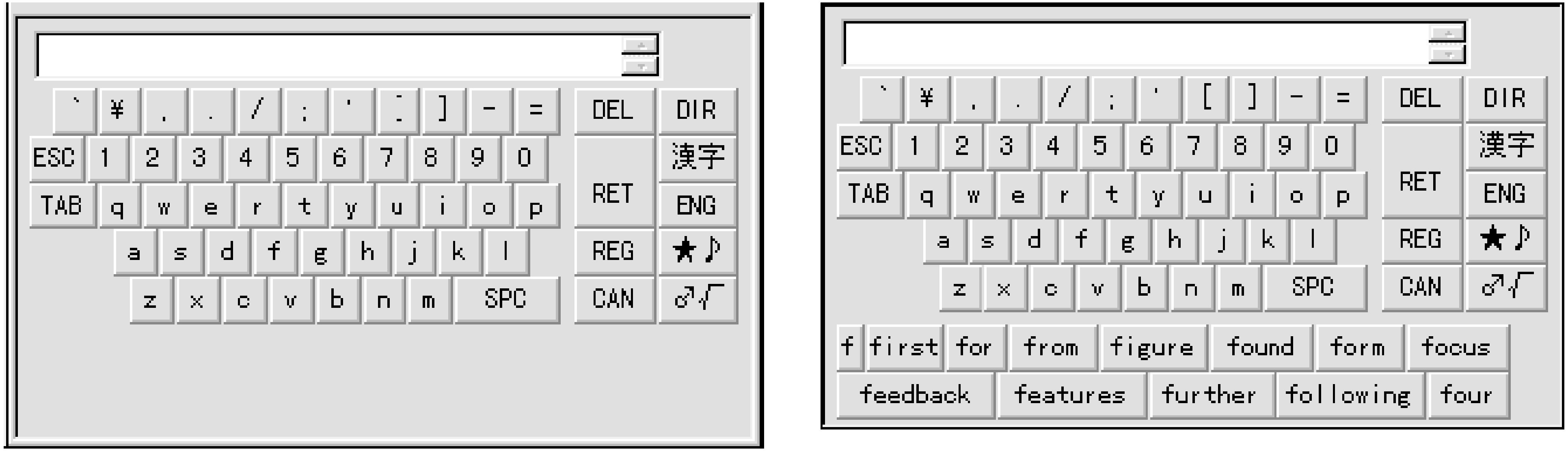
  http://www.ideal-group.org/demonstrations/fasttap.htm

  http://www.phonescoop.com/articles/video_fastap/

Predictive Input

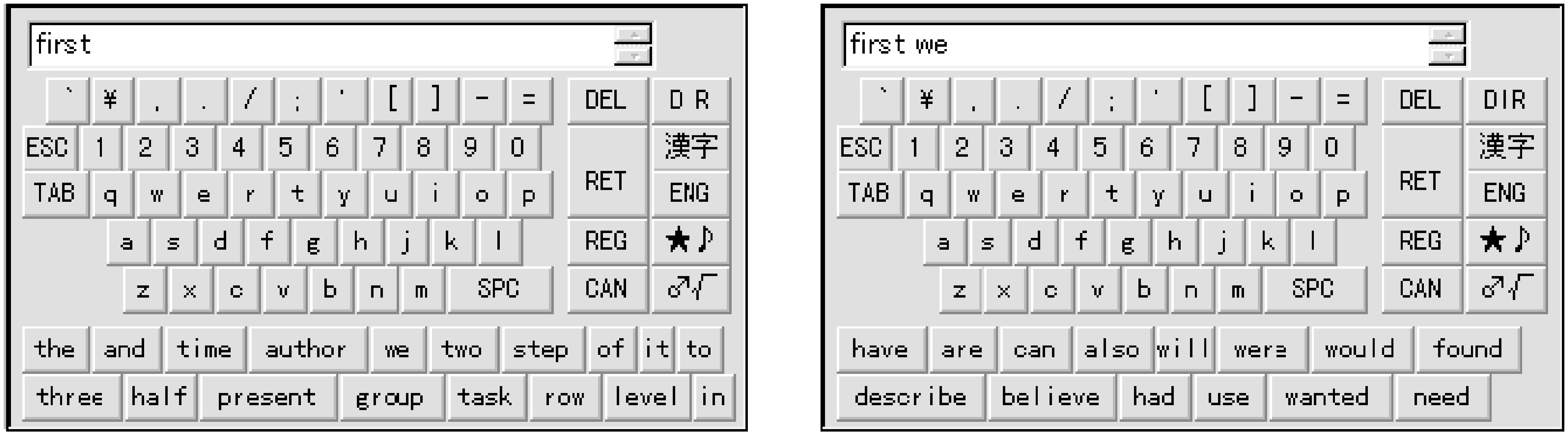
- Example: POBox - An Efficient Text Input Method for Handheld and Ubiquitous Computers. Toshiyuki Masui. HUC99 http://www.csl.sony.co.jp/person/masui/papers/HUC99/HUC99.pdf
- Predictive cOmposition Based On eXample





(a) Initial Display (b) After tapping the "F" key

Fig. 4. Pen-based POBox.



(a) After selecting '`first`' (b) After selecting '`we`'

Fig. 5. After selecting "`first`" and "`we`".

Output
What to present?

- Text
- Non-speech Audio
- Music
- Speech
- Images
- Video

- Tactile feedback (e.g. vibration alarm)

Head-up Displays

- Images in front of the eye
- Appears like free floating
- See through

http://www.microopticalcorp.com

Haptic feedback
Application in Pedestrian guidance

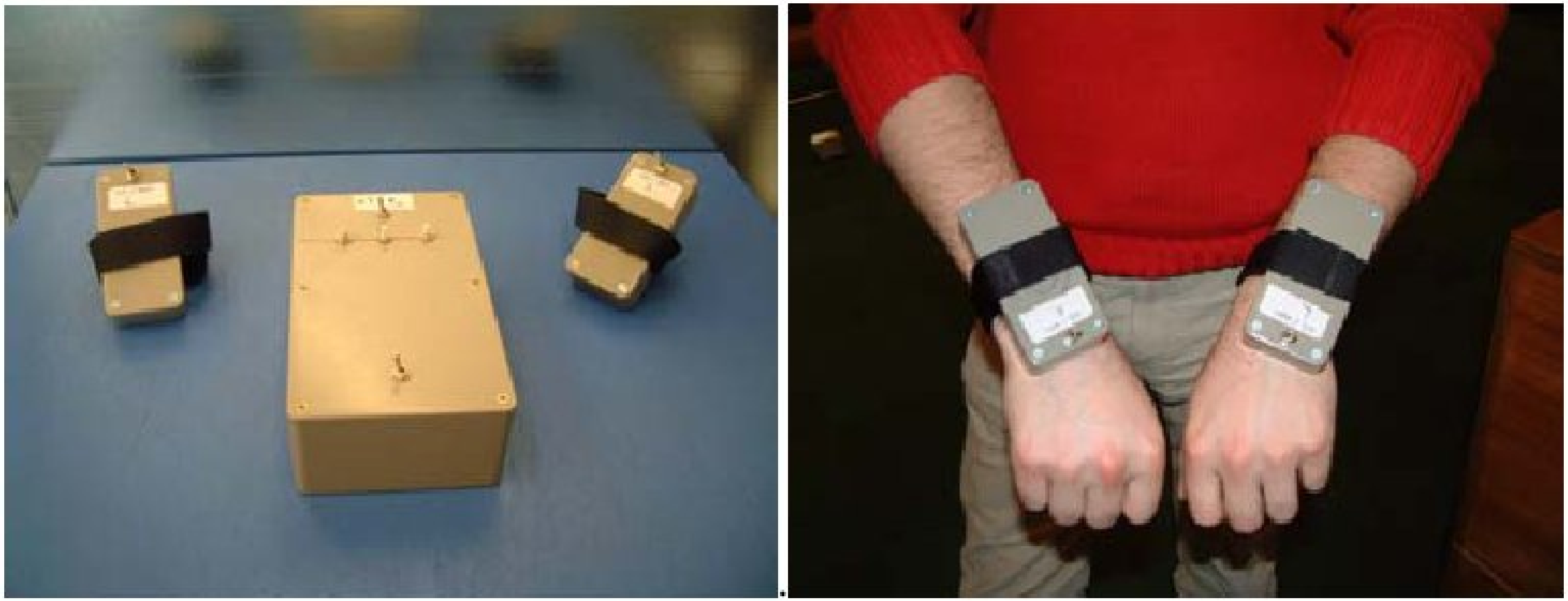


Fig. 1. (a) GentleGuide control unit and wrist devices (b) GentleGuide worn by a participant

- **GentleGuide: An exploration of haptic output for indoors pedestrian guidance** S.Bosman, B.Groenendaal, J.W.Findlater, T.Visser, M.de Graaf & P.Markopoulos. Mobile HCI 2003. Udine