MMI 2: Mobile Human-Computer Interaction

History

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Girl Texting Falls Into a Fountain

http://www.youtube.com/watch?v=uXKVtMri75g

Review

- What is the “Dynabook”?
- What characterizes mobile interaction?
- What is “ubiquitous computing”?
- What interaction techniques do handheld devices offer?

Preview

- History of mobile interaction
- Technological enablers
- Platforms

Lectures

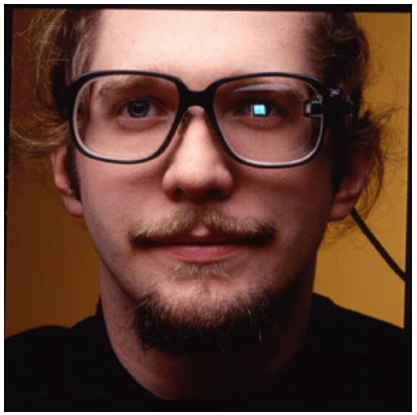
#	Date	Topic
1	19.10.2011	Introduction to Mobile Interaction, Mobile Device Platforms
2	26.10.2011	History of Mobile Interaction, Mobile Device Platforms
3	2.11.2011	Mobile Input and Output Technologies
4	9.11.2011	Mobile Interaction Design Process
5	16.11.2011	Mobile Communication
6	23.11.2011	Location and Context
7	30.11.2011	Prototyping Mobile Applications
8	7.12.2011	Evaluation of Mobile Applications
9	14.12.2011	Visualization and Interaction Techniques for Small Displays
10	21.12.2011	Mobile Devices and Interactive Surfaces
11	11.1.2012	Camera-Based Mobile Interaction 1
12	18.1.2012	Camera-Based Mobile Interaction 2
13	25.1.2012	Sensor-Based Mobile Interaction 1
14	1.2.2012	Sensor-Based Mobile Interaction 2
15	8.2.2012	Exam

Exercises

#	Date	Topic
1	24.10.2011	Mobile usage scenarios
2	31.10.2011	Touch screen input
3	7.11.2011	Animations
4	14.11.2011	Exchanging data
5	21.11.2011	Location-based audio
6	28.11.2011	Paper-prototyping a mobile application
7	5.12.2011	Evaluating the paper prototype
8	12.12.2011	Visualizing off-screen data
9	19.12.2011	Interacting with small targets
10	9.1.2012	Tactile feedback
11	16.1.2012	Feature recognition
12	23.1.2012	Feature recognition
13	30.1.2012	Gesture recognition
14	6.2.2012	Exam preparation

INTRODUCTION

Mobile and Wearable Devices



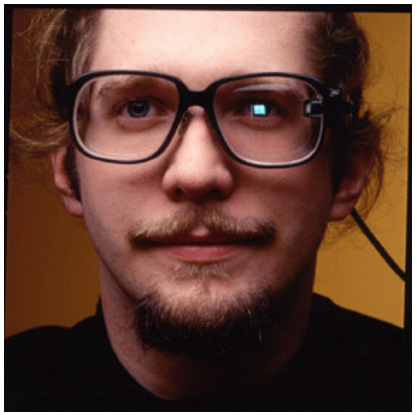
Smart glasses

Smart jacket

Linux wristwatch videoconferencing

Mobile and Wearable Devices

- Technically
  - Diverse form factors
  - Diverse set of functions
- As a part of everyday life
  - “Business tool”
  - “Relationship appliance”
  - “Remote control” for the real world
  - Tool to overcome commuter boredom



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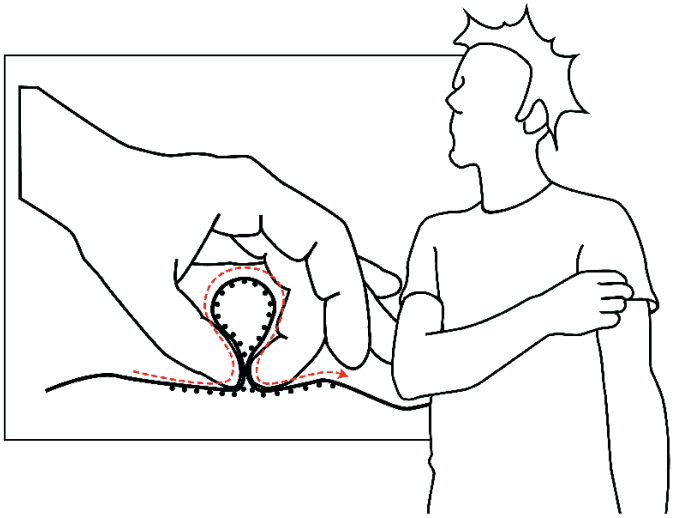
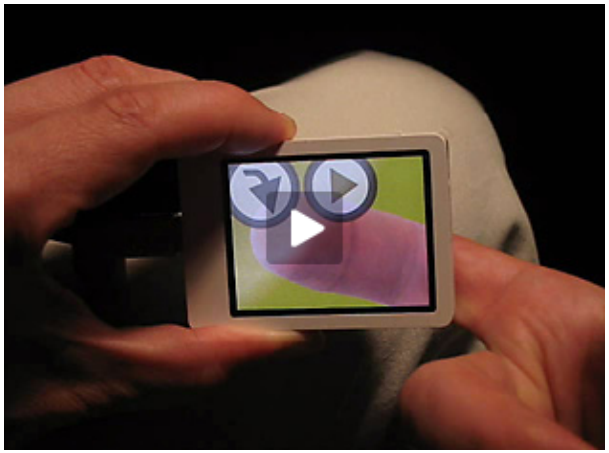
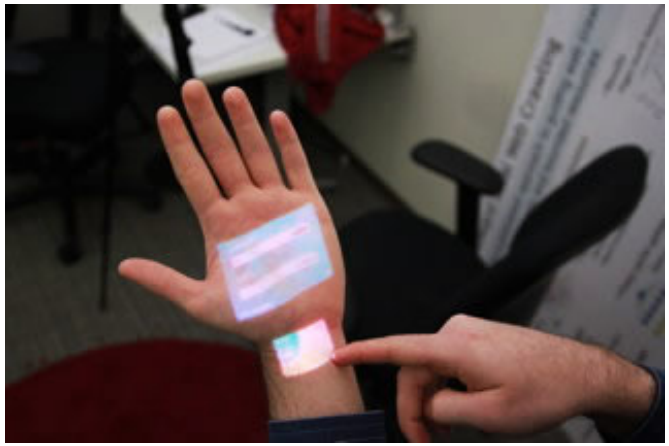
Research Prototypes



Karrer et al.: Pinstripe

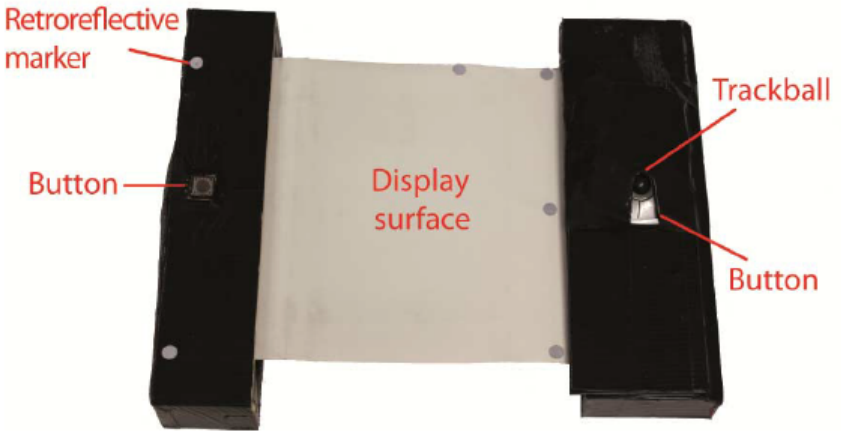


Baudisch, Chu: nanoTouch

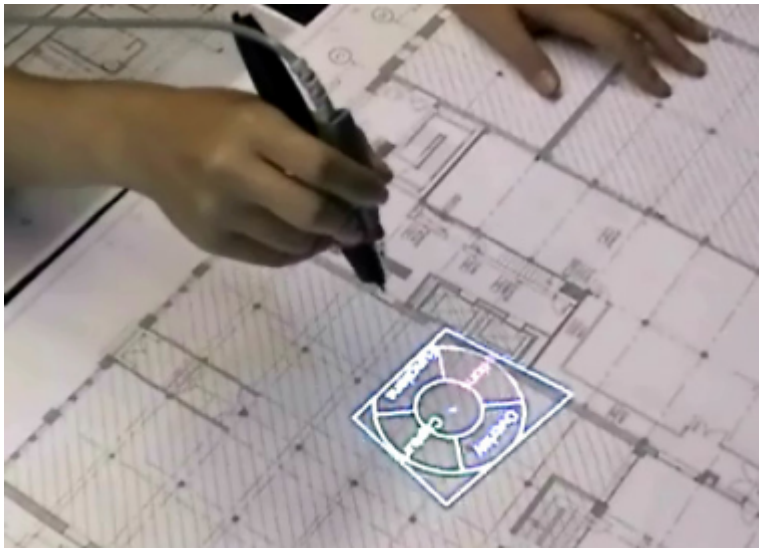


Harrison et al.: OmniTouch

Research Prototypes

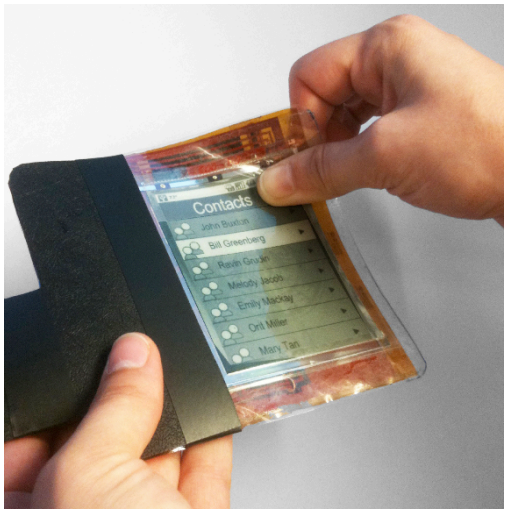


Khalilbeigi et al.: Xpaaand



Song et al.: PenLight

Pasquero et al.: Haptic Wristwatch



Lahey et al.: PaperPhone

Active Artifacts

- Example: MediaCup
  - http://mediacup.teco.edu
- Add “self perception” to everyday things
  - Temperature, fill level, movement
- Communicate their own state
  - e.g., Bluetooth, ZigBee
- Determine activity where it occurs
  - “Meeting” if collocated cups with hot liquid
- The artifact digitally supports its own applications

Ambient Umbrella

- “Never forget your umbrella again. The Ambient Umbrella lets you know when rain or snow is in the forecast by illuminating its handle. Light patterns intuitively indicate rain, drizzle, snow, or thunderstorms. Automatically receives local weather data from AccuWeather.com — no setup, no sensors, no wet commute. This intelligent umbrella has you covered.”
- http://www.ambientdevices.com/products/umbrella.html

Communication or Information Devices?

- Information optimists
  - *"Mobile phones […] have suddenly become platforms for entertainment and commerce and tools for information management and media consumption"*

    Christian Lindholm et al., Mobile Usability, 2003
- Communication advocates
  - *"…mobile devices will be first and foremost about offering users the ability to keep in touch with friends, family and colleagues, and that this will take precedence over technologies and applications that will offer information access and use."*

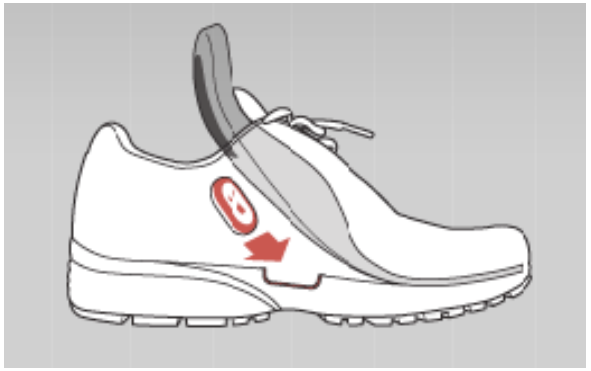
    Richard Harper, People versus Information, Mobile HCI 2003
- Convergence
  - Communications power and information access

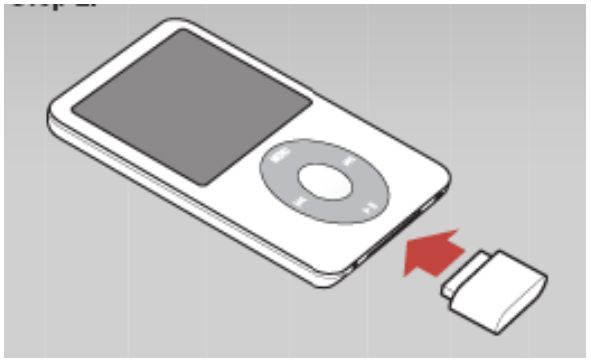
Information Appliances

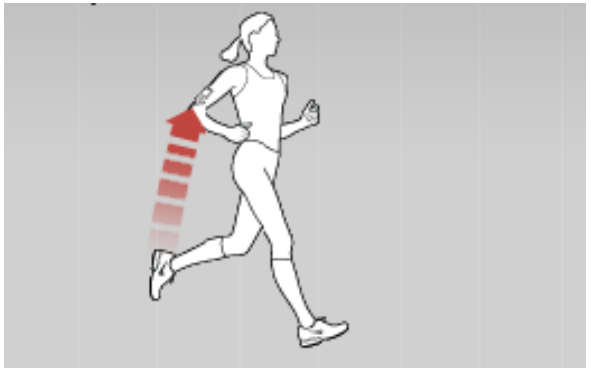
- Support a specific activity
- Designed for one application
- Connected to other information appliances

+

Accelerometer

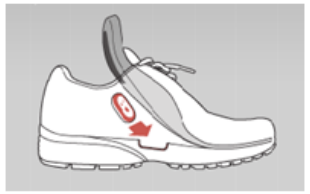






Information Appliances

- Information appliance
  - Small, focused function set
  - Support a specific activity
  - Connected to other information appliances
- iPod: “1000 songs in your pocket”
  - Clickwheel with 5 buttons
  - Uncluttered, minimalist interface
- Interconnected devices: iPod & Nike
  - Transmitter under inner sole of shoe
  - Receiver connected to iPod
  - Data: elapsed time, distance, pace, or calories burned
  - Celebrity feedback upon personal best



Information Appliance or Swiss Army Knife?

Many devices with one function?

Or one device with many functions?

Swiss Army Knife

- All-purpose devices
- Personal Digital Assistant (PDA)

- *“Sure, it is fun to look at, sure it is handy if you are off in the wilderness and it is the only tool you have, but of all the umpteen things it does, none of them are done particularly well.”*

  Donald A. Norman,
  The Invisible Computer

Keitai Culture

- keitai denwa = mobile phones
- Read a book on a cell phone?

Lesen 2.0

Japans meistverkaufte Bücher kommen direkt aufs Handy

Handyromane, sie werden in kleinen Lieferungen verschickt, an die 100 Kapitel, über drei, vier Monate hinweg, drei Minuten ist ein Kapitel ungefähr lang, die Zeit eben zwischen zwei U-Bahn-Stationen. »Keitai« heißt diese Art von Mobilromanen, die bis zu 20 Millionen Mal heruntergeladen werden – und nun auch ganz oben stehen auf den Bestsellerlisten der Literatur 1.0: Vier

nen selbst Erfolg haben. Umgerechnet 60 Millionen Euro setzte die Branche 2006 um, bei 100 Millionen Handys in Japan ist da aber noch Wachstum möglich. »Ich habe ganz neue Leser gewonnen, vor allem Teenager, die noch nie ein Buch in der Hand hatten«, sagt die Schriftstellerin Mica Naitoh, deren erfolgreichster Keitai-Roman *Der Liebeshimmel* heißt.

Georg Diez, Die Zeit

Environmental Impact

- Mobile phones contain many chemical elements
- Disposable technology paradigm
  - Usage lifetime often shorter than functional lifetime
  - Short upgrade cycles
- Millions of mobile devices discarded each year
  - Toxic electronic waste, ends up in landfills
- Sustainable mobile phone design
  - Nokia 3110 Evolve “Eco-Friendly Device”
    - Cover made of 50% renewable materials
    - Package 60% recycled materials
    - Low energy consumption
    - Energy-efficient charger

More on this topic: Elaine **Huang**, Khai Truong: Situated Sustainability for Mobile Phones, Interactions, 3+4/2008

Impoverished Interactions?

- Mobiles have tiny screens and keypads
- Overcome size limitations
  - Output: larger screens, pico projectors,
  - Input: multitouch, sensors
- Use alternative modalities
  - Output: auditive, tactile, auto-stereoscopic 3D
  - Input: speech, gestures, pressure
- Reduce need for interaction
  - Implicit interaction: by-products of normal behavior (e.g., distance-sensor in ear-piece)
  - Recognize context: location, calendar, Bluetooth
  - Recognize objects: RFID tags, 2D barcodes, image recognition

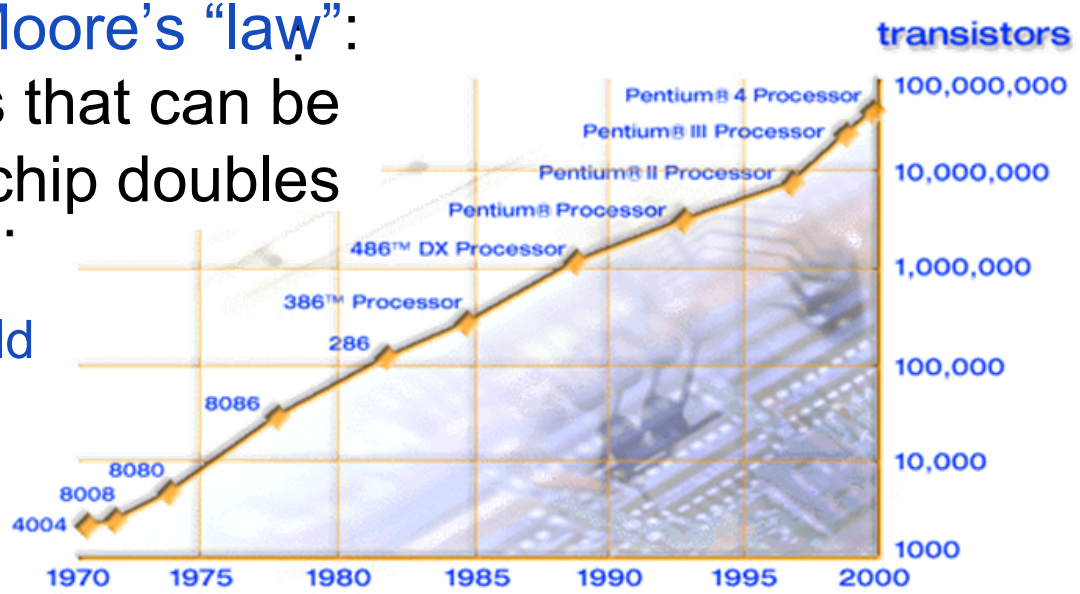
TECHNOLOGICAL ENABLERS FOR MOBILE COMPUTING

Technological Enablers for Mobile Computing

- Processing & storage
  - Cheap, fast, reliable, small, large capacity, energy efficient
  - Moore's Law
- Networking
  - Cheap, fast, reliable, global, local, wireless, ad-hoc, low power
- Displays
  - Cheap, small, high quality, energy efficient, integrated
- Sensors & actuators
  - Cheap, small, accurate, invisible, many types

Processing and Storage

- Microelectronics and Moore's "law": number of components that can be integrated on a single chip doubles every 18 months
  - Likely to continue to hold for at least a decade
  - Chip sizes decrease
  - Clock rates increase
  - Memory chips have higher capacities



- Energy per unit of computation falls
  - Size and energy consumption often more important than processing power

1 zoll 8GB (2007)
1 zoll 340 MB (2001)
2 TB USB drive for <99€

Networking

- Wireless communication technologies for mobile devices
  - Medium to long-range communication
    - WLAN (range 100m, 11Mbps or 54 Mbps)
    - GSM (some tens of kbps)
    - UMTS (up to 1920 kbps)
  - Low power short range communication
    - Bluetooth (range 10-100m, 1 Mbps)
    - ZigBee (128 kbps)
- Sometimes just need to transfer a few sensor readings over a short distance
  - Energy

Output and Input Technologies

- Displays / Output devices
  - LCD screens
  - Loudspeakers
  - Vibrotactile motors
  - Handheld projectors

- Sensors as “eyes and ears” of mobile devices
  - Multitouch displays
  - Low-power MEMS sensors
    - Sound, acceleration, magnetic field, pressure, capacitance, temperature
  - CCD cameras
    - Powerful class of mobile sensors

Batteries

- Energy capacity does not grow exponentially

– Lead Acid	30-40 Wh/kg	toxic, large
– Nickel Cadmium	40-60 Wh/kg	toxic, memory effect
– Nickel Metal Hydride	60-120 Wh/kg	1990s, self-discharge
– Lithium-ion	100 to 250 Wh/kg	1991, flammable
– Lithium-ion polymer	130 to 200 Wh/kg	1995, flammable, moldable

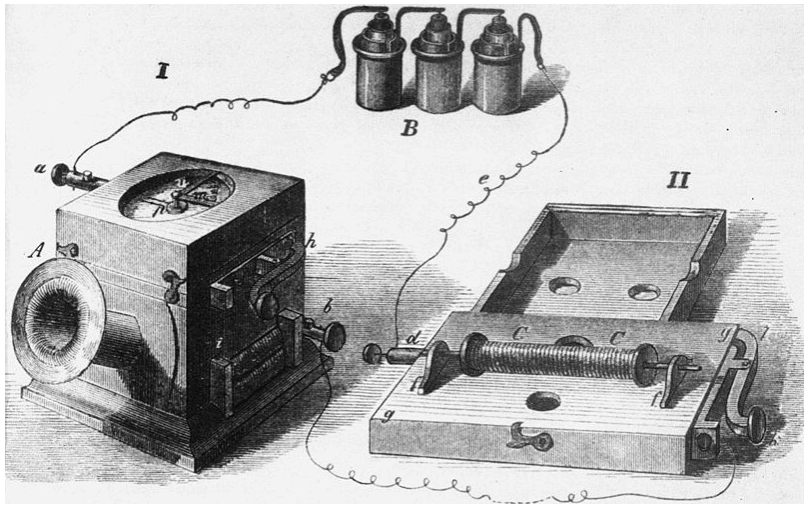
- Future
  - Zinc-air batteries — up to 470 Wh/kg — not rechargeable, used in hearing aids
  - Fuel cells?
  - Harvest energy from environment?

HISTORY OF MOBILE DEVICES

History of Mobile Devices

Johann Philipp Reis
(1834-1874)

- Johann Philipp Reis (1834-1874)
  - Self-taught scientist and inventor
  - 1859: Paper “On the Radiation of Electricity”, rejected, reviewer did not believe in the idea
  - Idea of sound transmitted by electricity
    - *„Über die Fortpflanzung von Tönen auf beliebige Entfernungen durch Vermittlung des galvanischen Stroms“*
    - *„Über Telephonie durch den galvanischen Strom“*
  - 1861: First telephone prototype
    - one-way
    - 100m transmission distance
    - poor sound quality
  - Had difficulty to interest investors
  - Sold devices for 8-12 Taler



History of Mobile Devices

- Alexander Graham Bell saw early Reis telephone in 1862
  - His father encouraged him to improve it
- 1876 telephone patented by Alexander Graham Bell
  - February 14, 1876: "Improvement in Telegraphy" was filed at the USPTO
  - A few hours later Elisha Gray filed "Transmitting Vocal Sounds Telegraphically"
  - Bell was the 5th entry of that day, Gray was 39th

Alexander Graham Bell
(1847-1922)

ALEXANDER GRAHAM BELL, OF SALEM, MASSACHUSETTS.

IMPROVEMENT IN TELEGRAPHY.

Specification forming part of Letters Patent No. **174,465**, dated March 7, 1876; application filed February 14, 1876.

To all whom it may concern:

Be it known that I, ALEXANDER GRAHAM BELL, of Salem, Massachusetts, have invented certain new and useful Improvements in Telegraphy, of which the following is a specification:

In Letters Patent granted to me April 6, 1875, No. 161,739, I have described a method of, and apparatus for, transmitting two or more telegraphic signals simultaneously along a single wire by the employment of transmitting-instruments, each of which occasions a succession of electrical impulses differing in rate from the others; and of receiving-instruments, each tuned to a pitch at which it will be put in vibration to produce its fundamental note by one only of the transmitting-instruments; and of vibratory cir-

ally breaking the circuit. The current produced by the latter method I shall term, for distinction sake, a pulsatory current.

My present invention consists in the employment of a vibratory or undulatory current of electricity in contradistinction to a merely intermittent or pulsatory current, and of a method of, and apparatus for, producing electrical undulations upon the line-wire.

The distinction between an undulatory and a pulsatory current will be understood by considering that electrical pulsations are caused by sudden or instantaneous changes of intensity, and that electrical undulations result from gradual changes of intensity exactly analogous to the changes in the density of air occasioned by simple pendulous vibrations. The electrical movement, like the aerial mo-

History of Mobile Devices

- 1894 Guglielmo Marconi invents the radiotelegraph
  - 1909 Nobel Prize in Physics *"in recognition of contributions to the development of wireless telegraphy"*

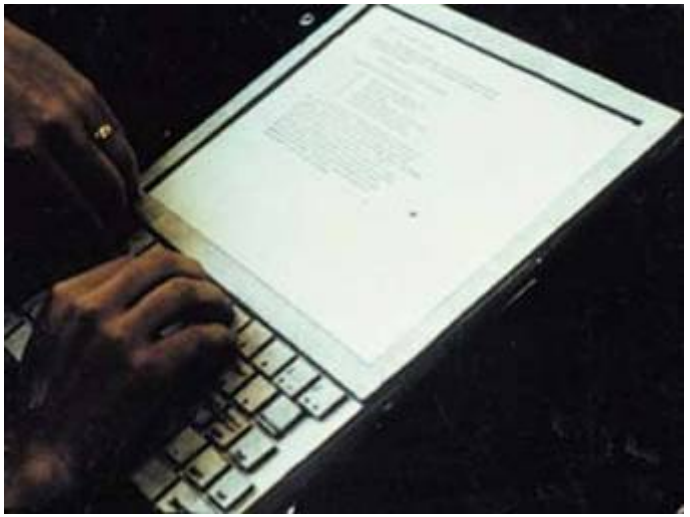
- 1921 combination of telephone and radio
  - Officers at Detroit Michigan Police Department communicate from petrol car to petrol car

History of Mobile Devices

- 1938 Canadian Alfred J. Gross invents the walkie-talkie (also invented telephone pager and cordless telephone)
  - *"I was born thirty-five years too soon. If I still had the patents on my inventions, Bill Gates would have to stand aside for me."*
- *1946 AT&T first commercial mobile telephone service for private customers*

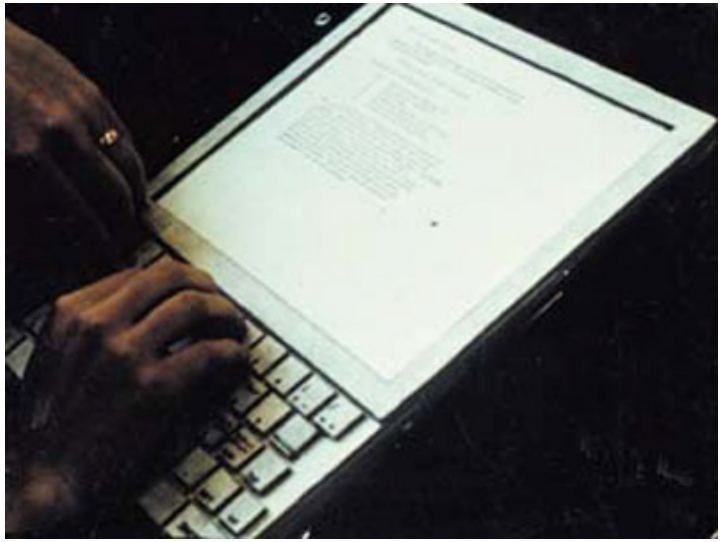
History of Mobile Devices

- 1962 Telstar first active communications satellite
  - Designed to transmit telephone and high-speed data communications
- 1968 Alan Kay's Dynabook
  - Vision of a portable computer
  - *"The Dynabook will have considerable local storage and will do most computing locally, it will spend a large percentage of its time hooked to various large, global information utilities which will permit communication with others of ideas, data, working models, as well as the daily chit-chat that organizations need in order to function. The communications link will be by private and public wires and by packet radio."*



http://www.artmuseum.net/w2vr/archives/Kay/01_Dynabook.html

Dynabook (1968)



- Vision of a portable computer
  - *"We realized it was going to be a matter of years until you could put all the electronics […] on the back of a flat panel display, which I later came to call the Dynabook. Back in 1968 when I made this cardboard model I thought of it as the machine of the future and started thinking about what would it be like for millions of people to have one of these machines."*
- Alan Kay, Adele Goldberg: Personal Dynamic Media, IEEE Computer, 1977
- http://en.wikipedia.org/wiki/Dynabook
- http://thinkubator.ccsp.sfu.ca/Dynabook/

History of Mobile Devices

- 1969 DARPA begins the Internet programme
- 1971 Ray Tomlinson invents electronic mail (including “@”)

- 1971 James Fergason invents Liquid Crystal Displays, first LCD watches
  - electro-optical effect discovered in 1962
  - 1970 “twisted nematic field effect” patented in Switzerland
- 1973 Sharp LCD calculator

History of Mobile Devices

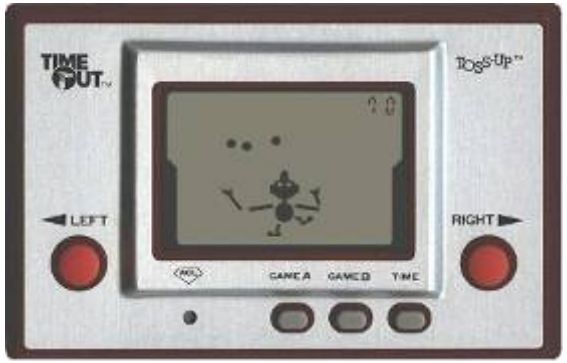
- 1972 Motorola prototype for Portable Radio Telephone “DynaTAC” (Dynamic Adaptive Total Area Coverage)
  - First mobile phone call April 3, 1973
  - DynaTAC 8000x first mobile telephone
    - could connect to the telephone network
    - could be carried about by the user

Martin Cooper (considered as the inventor of the mobile phone)

- 1978 Commercial mobile phone service in Japan by NTT
  - First city-wide cellular network
- 1979 Sony Walkman TPS-L2

History of Mobile Devices

- 1980 Nintendo “Ball”
  - First commercially successful mobile LCD screen game



- 1982 Digital phone exchange in Europe

- 1984 Psion 1
  - First PDA (personal digital assistant)
  - Clock, calendar, address book, calculator

History of Mobile Devices

- 1987 text message service is launched in Japan
- 1989 first of 24 GPS satellites of current constellation is put into orbit (Block II)
- 1992 first mobile phone for digital networks
  - Motorola International 3200 (500g)
- 1993 Apple Newton MessagePad 100
  - 5.5" screen, 240x320 pixels, touch screen

History of Mobile Devices

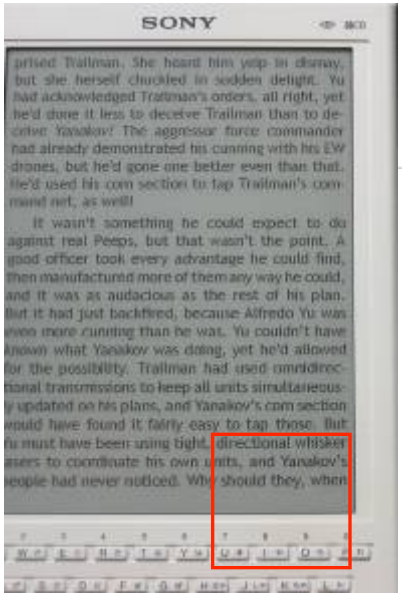
- 1996 Palm Pilot
  - 4" screen, 160x160 pixels
- 1996 Nokia Communicator smartphone

- 1999 DoCoMo lauches i-mode
  - First mobile Internet service

- 2000 first Bluetooth phone
  - Ericsson T36
- 2000 first camera phone
  - Sharp J-SH04
  - 110k pixel CMOS sensor

History of Mobile Devices

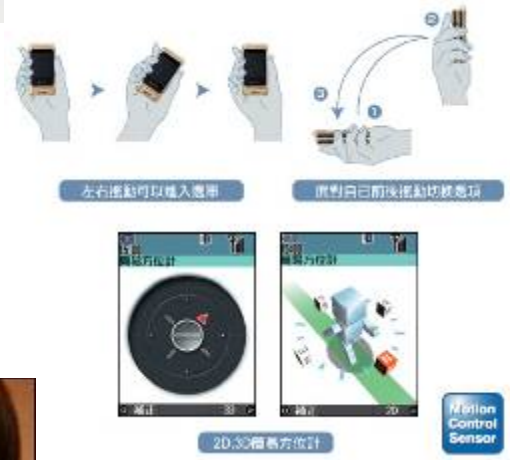
- 2001 debut of the iPod
  - 2" screen, 160x128 pixels, 10000 songs
- 2002 number of mobile phone subscribers exceeds number of landline subscribers
- 2004 PDA with OLED screen
  - Sony Clie VZ-90
  - 3.8" screen, 460x320 pixels
- 2004 first device using e-paper
  - Sony LIBRIé ebook reader
  - 6" screen, 800x600 pixels, 170 dpi



History of Mobile Devices

- 2004 Playstation Portable
  - 4.3" 16:9 wide screen, 480x272 pixels

- 2005 first mobile phone with integrated motion control sensor
  - Sharp V603SH
  - 2.4" screen, 320x240 pixels



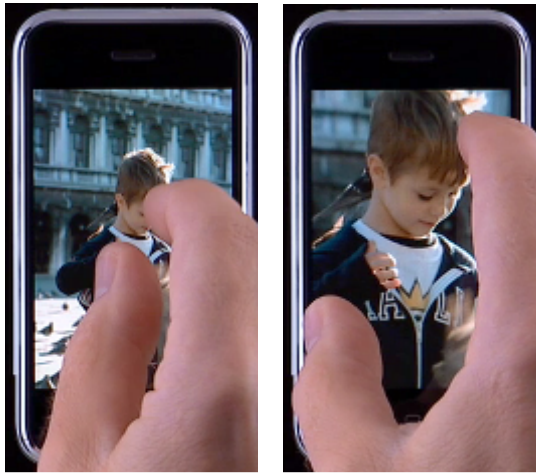
History of Mobile Devices

- 2006 Nokia 6131, first NFC-enabled phone
  - NFC: Near Field Communication
  - sharing, pairing, transactions between two devices in close proximity (a few cm)
  - mobile payments, credit card information
  - get more information, read NFC tags on museum exhibits or retail displays
  - share contacts, photos, songs, applications
  - pair Bluetooth devices

History of Mobile Devices

- 2007 iPhone
  - GSM EDGE, WiFi, Bluetooth
  - 3.5" screen, 320x480 pixels
  - Multi-touch display, no keypad
  - Accelerometer to sense orientation
  - Slide and multi-touch interactions

sliding

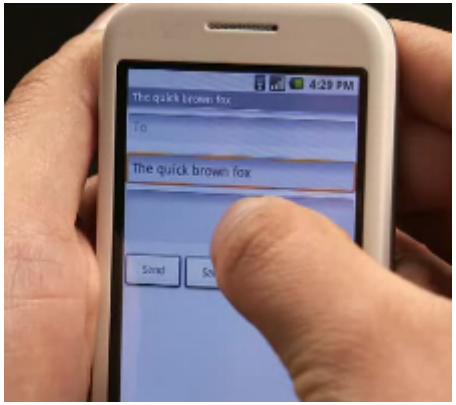


multi-touch (“pinch out”)

cover flow

History of Mobile Devices

- 2008 Android
  - T-Mobile G1 announced
  - **SDK 1.0 released**
  - Android open sourced under Apache's open source license
- 2005
  - Google buys startup company "Android Inc."
  - Work on Dalvik VM starts
- 2007
  - Open Handset Alliance announced (http://www.openhandsetalliance.com)
  - "Early Look" SDK



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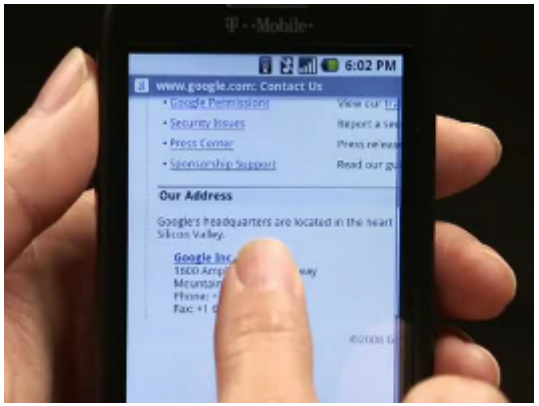
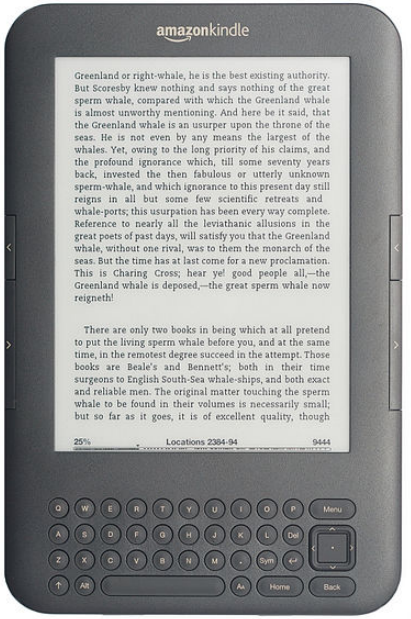


Browser links

History of Mobile Devices

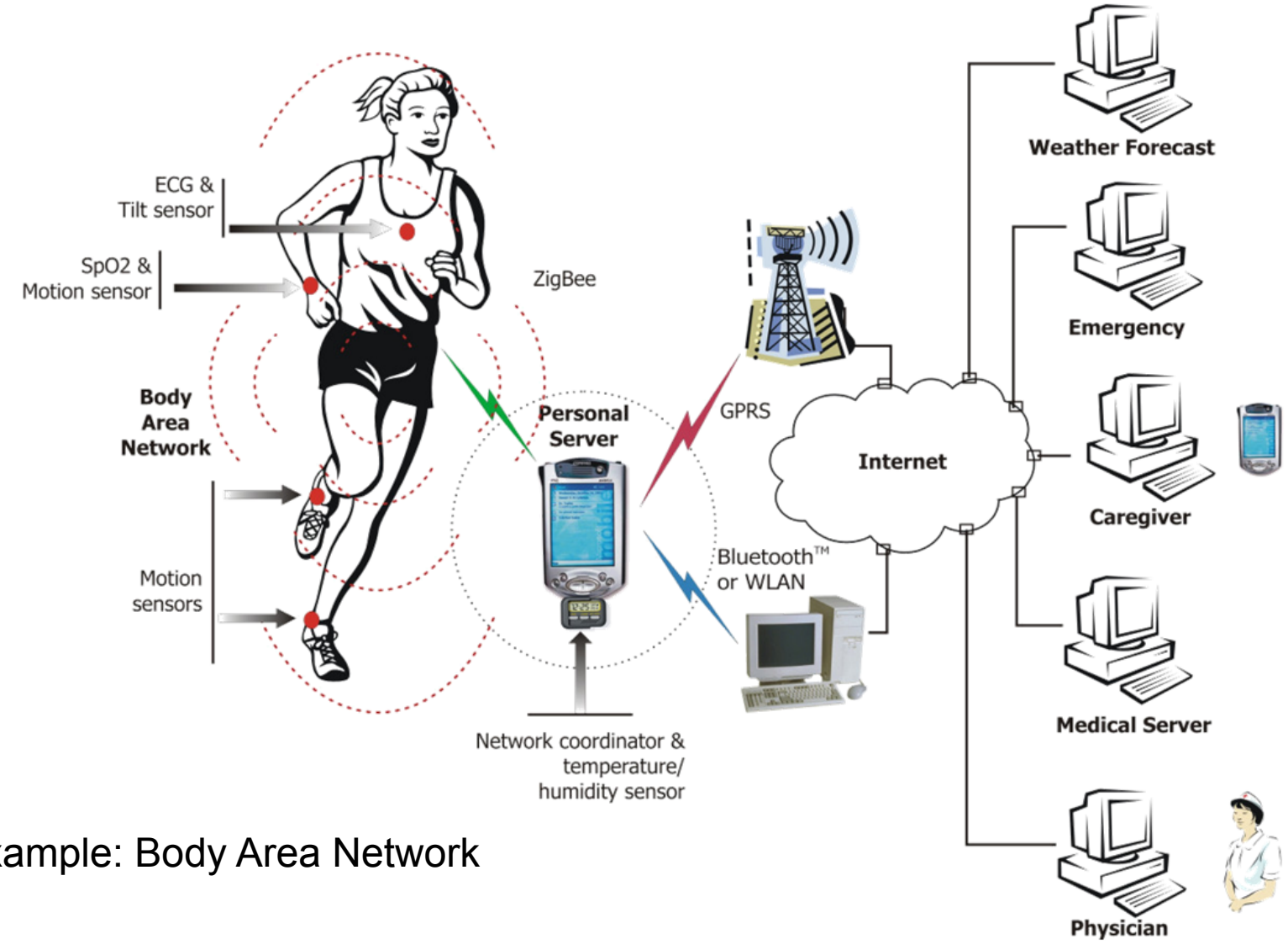
- 2007 Amazon Kindle
  - E-book reader by Amazon
  - Browse, buy, download, read e-books
  - Newspapers, magazines, blogs, etc.
  - Internet access via Wi-Fi / 3G included
  - E-Ink display, 1200x824 pixels, 16 grays
  - Very lightweight: 241g
- 2010 iPad
  - Tablet computer, 10 finger multitouch
  - 75% of tablet computer sales end of 2010
  - 83% tablet computer market share in 2011
  - 1 GHz processor, 1024x768 pixel screen
  - Weight: 600g



What's next?

- What HCI problems are unsolved?
- What is the biggest technical problem?
- What functionality is missing?
- What aspects of mobile devices can be improved?
- What materials are likely to get used?
- What modalities should be served?
- What application areas have not been addressed yet?

Future Communication – The Cloud



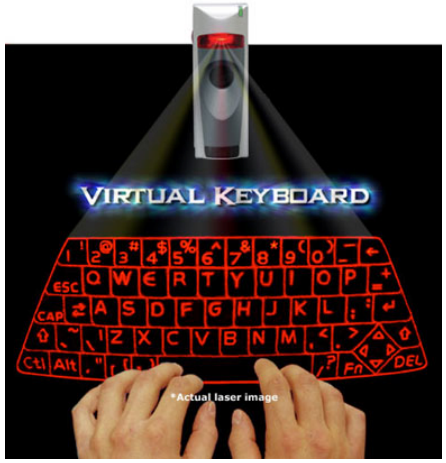
Example: Body Area Network

Future Sensing and Context Recognition

- Sensors for explicit and implicit interaction
- Example: mobile phone
  - Microphone and camera
  - Acceleration sensors
- Today: For entertainment (control music player, sports applications)
- In the future: Context recognition and intelligent behavior of the mobile device

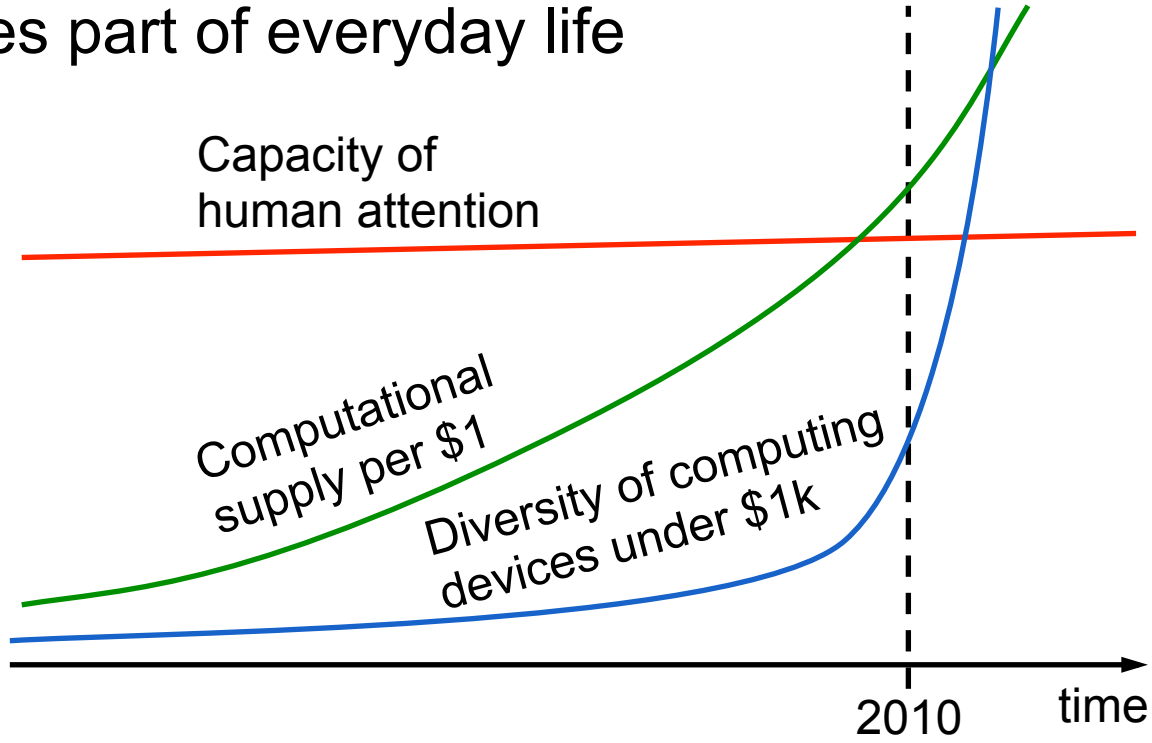
Future Display Technologies

- E-paper
- Flexible displays
- Projection
- Head-mounted displays
- Wall displays
- Tabletop displays



“Computational Surplus”

- Classical limitations of computing systems (processing, storage, bandwidth) are less and less the limiting factor
- UI design becomes discriminating feature
- Interaction becomes part of everyday life



adapted from: Lee: In Search of a Natural Gesture, XRDS, summer 2010, 16(4)

The End