Chapter 1

The history of wearable computing

Recap

Slide Wearable Computing:

- Properties of wearable computing
  - Unobtrusive
    - mobile, small, lightweight, no wires
    - body-wearable (sometimes in clothing)
  - Supporting a primary (work) task
    - Don’t disturb, be useful all the time
  - casual use, context-aware, "‘smart"’

1.1 Wearable Computing History

1.1.1 Timeline

<1-2>[label=tl1] **Slide Timeline I:**

1268 Eyeglasses mentioned by Roger Bacon

1510 Pocket Watch invented by Peter Henlein in Nürnberg (“Nürnberger Ei”)

1665 Robert Hooke calls for augmented senses

Slide Nürnberger Ei:

3>tl1

The main idea behind wearable computing is the augmentation of human capabilities by wearing devices. In this sense, the first “wearable” devices were eyeglasses and pocket watches, augmenting the human capability to see and to track time.

from `http://wearables.www.media.mit.edu/projects/wearables/timeline.html`

1268 (F) Earliest recorded mention of eyeglasses Roger Bacon made the first recorded comment on the use of lenses for optical purposes. However, by that time reading glasses made out of transparent quartz or beryl were already in use in both China and Europe.

1510 Pocket Watch invented by Peter Henlein in Nürnberg (“Nürnberger Ei”)

1665 (F) Robert Hooke calls for augmented senses Micrographia preface 1665: "The next care to be taken, in respect of the Senses, is a supplying of their infirmities with Instruments, and as it were, the adding of artificial Organs to the natural... and as Glasses have highly promoted our seeing, so ’tis not improbable, but that there may be found many mechanical inventions to improve our other senses of hearing, smelling, tasting, and touching."

The invention of the pocket watch had important influences on industrialization, maritime navigation, logistics, even social life and politics. The so-called longitude problem was under investigation for centuries and only the ship chronometer and later the pocket watch provided a working solution and revolutionized maritime navigation, leading to a new structure in international trade, maritime warfare and new political structures in europe.

The existence of ubiquitous pocket watches made it possible to create railway timetables and established the virtue of punctuality in everyday life. It also took timekeeping out of the hands of the official entities such as city magistrates, churces and land owners and transformed it into a comodity. The machinized and ubiquitous timekeeping transformed the life of most people in the soon-to-be-so-called industrialized nations. The importance of time keeping and the significance of pocket watches is illustrated by the example that pocket watches were a status symbol, first of wealthy and powerful, then of middle-class men, pocket watches were often inherited from father to son or given to a son on special occasions such as first communion, confimation, coming of age (Volljährig werden) or wedding.

Slide Timeline II:

1907 Aviator Alberto Santo-Dumont commissions the creation of the first wrist watch by Louis Cartier

1945 Vannevar Bush (MIT) proposes the idea of a “memex”

1960 Manfred Clynes coins the word "Cyborg"

1966 First wearable computer: Ed Thorp and Claude Shannon: Analog computer for roulette wheel prediction.

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from `http://wearables.www.media.mit.edu/projects/wearables/timeline.html`

1945 (F) Vannevar Bush proposes the idea of a "memex" in his article "As We May Think" (MIT)
While Bush thought the memex would be desk-sized rather than wearable, it is an early mention of the augmented memory. "Consider a future device for individual use, which is a sort of mechanized private file and library. It needs a name, and to coin one at random, “memex” will do. A memex is a device in which an individual stores all his books, records, and communications, and which is mechanized so that it may be consulted with exceeding speed and flexibility. It is an enlarged intimate supplement to his memory."

1960 (F) Manfred Clynes coins the word "Cyborg" Manfred Clynes and co-author Nathan Kline first coined the phrase "Cyborg" in a story called "Cyborgs and Space" published in Astronautics (September 1960). The term was used to describe a human being augmented with technological "attachments". The story has since been reprinted in "The Cyborg Handbook" edited by Chris Hables Gray.

1966 (C) Ed Thorp and Claude Shannon reveal their invention of the first wearable computer, used to predict roul
The system was a cigarette-pack sized analog computer with 4 push buttons. A data-taker would use the buttons to indicate the speed of the roulette wheel, and the computer would then send tones via radio to a bettor’s hearing aid. Though the system was invented in 1961, it was first mentioned in E. Thorp, Beat the Dealer, revised ed. in 1966. The details of the system were later published in Review of the International Statistical Institute, V. 37:3, 1969. Thorp also disclosed a similar system for beating the Wheel of Fortune gambling game in LIFE Magazine, March 27, 1964, pp. 80-91.

Slide Timeline III:

1967 Hubert Upton invents analogue wearable computer with eyeglass-mounted display to aid lipreading

1972 Alan Lewis invents a digital camera-case computer to predict roulette wheels

1977 CC Collins develops wearable camera-to-tactile vest for the blind

1977 (C): HP releases the HP 01 algebraic calculator watch

Slide HP-01:

Image from www.hpmuseum.org

1967 (C) Hubert Upton invents analogue wearable computer with eyeglass-mounted display to aid lipreading
Hubert Upton designed an analogue wearable computer as an aid for lip-reading. Using high and low-pass filters, the system would determine if a spoken phoneme was a fricative, stop, voiced-fricative, voiced stop, or simply voiced. An LED mounted on ordinary eyeglasses illuminated to indicate the phoneme type. The LEDs were positioned to enable a simple form of augmented reality; for example, when a phoneme was voiced the LED at the bottom of the glass illuminated, making it seem as if the speaker's throat was glowing. The work was presented at the Conference on Speech-Analyzing Aids for the Deaf, June 14-17, 1967, and was subsequently published in Upton, H, "Wearable Eyeglass Speechreading Aid," American Annals of the Deaf, V113, 2 March 1968, pp. 222-229.

1972 (C) Alan Lewis invents a digital camera-case computer to predict roulette wheels (Cal Tech)
Like Thorp and Shannon's system, Lewis used a radio link between data taker and

bettor. The data-taker used the computer to predict the roulette wheel, then whispered the prediction via radio link to the bettor's hearing-aid radio-receiver.

1977 (C) CC Collins develops wearable camera-to-tactile vest for the blind (Smith-Kettlewell) The result of ten years research, C.C. Collins of the Smith-Kettlewell Institute of Visual Sciences developed a five pound wearable with a head-mounted camera that converted images into a 1024-point, 10" square tactile grid on a vest. The system was tested as a visual prostetic for the blind. See "Mobile Studies whith a Tactile Imaging Device," C.C. Collins, L.A. Scadden, and A.B. Alden, Fourth Conference on Systems & Devices For The Disabled, June 1-3, 1977, Seatle WA.

1977 (C): HP releases the HP 01 algebraic calculator watch (Hewlett-Packard) The HP 01 calculator watch had 28 tiny keys on the watch face. Four keys were raised for easy finger access (date, alarm, memory and time), and two were recessed but could still be operated with the fingers (read/recall/reset and stopwatch). The remaining keys were meant to be pressed with a stylus that snapped into the clasp of the bracelet. See http://www.hpmuseum.org/hp01.htm

Dynamic Calculating:

> Another example of how the HP-01 integrated time and calculations was "dynamic calculating" in which the watch continuously updated a time-based calculation. (For example rather than having it display the amount of time spent on the phone, it could be set to continuously display the amount of money spent.) To set up a dynamic calculation, the user pressed S to start the stopwatch and then pressed the multiply or divide key, the hourly rate and "=". The display then showed the cost. The user could move back and forth using S for current time and = for current cost.

from http://www.hpmuseum.org/hp01.htm

Slide Timeline IV:

1978 Eudaemonic Enterprises invents a digital wearable computer in a shoe to predict roulette wheels

1979 Sony introduces the Walkman

1981 Steve Mann designs backpack-mounted computer to control photographic equipment

1984 William Gibson writes Neuromancer

1987 The movie Terminator is released

1978 (C) Eudaemonic Enterprises invents a digital wearable computer in a shoe to predict roulette wheels (Eudaem

Using a CMOS 6502 microprocessor with 5K RAM, Eudaemonic Enterprises (Doyne Farmer, Norman Packard, and others) created a shoe computer with toe-control and inductive radio communications with between a data taker and better. This is the only known roulette machine of the time to show a statistical profit on a gambling run, though they never made the "big score." See The Eudaemonic Pie, Thomas A. Bass, Houghton Mifflin Company, 1985.

1979 (F) Sony introduces the Walkman (Sony) Sony introduces the Walkman, a commercial wearable cassette player. Later products would include Music CD-players.

1981 (C) Steve Mann designs backpack-mounted computer to control photographic equipment While still in high-school Steve Mann wired a 6502 computer (as used in the Apple-II) into a steel-frame backpack to control flash-bulbs, cameras, and other photographic systems. The display was a camera viewfinder CRT attached to a helmet, giving 40 column text. Input was from seven microswitches built into the handle of a flash-lamp, and the entire system (including flash-lamps) was powered by lead-acid batteries.

1984 (F) William Gibson writes Neuromancer This book founded the genre of Cyberpunk, the dystopian future in which humans are augmented with computer implants.

1987 (F) The movie Terminator is released Of special note are the scenes from the point-of-view of the Terminator cyborg, with text and graphical information overlayed on top of the real world.

Slide Timeline V:

1991 Doug Platt debuts his 286-based "Hip-PC"

1991 CMU team develops VuMan 1 for viewing and browsing blueprint data

1991 Mark Weiser proposes idea of Ubiquitous Computing in Scientific American

1993 Thad Starner starts constantly wearing his computer, based on Doug Platt's design and writes the first version of the Remembrance Agent

1993 BBN finishes the Pathfinder system, a wearable computer with GPS and radiation detection system

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1991 (C) Doug Platt debuts his 286-based "Hip-PC" (Select Tech) Doug Platt's system was a shoebox-sized computer based on the Ampro "Little Board" XT module. The screen was a Reflection Technology Private Eye display and the keyboard was an Agenda palmtop used as a chording keyboard attached to the belt. It included a 1.44 megabyte floppy drive. Later versions incorporated additional equipment from Park Engineering. The system debuted at "The Lap and Palmtop Expo" on April 16th, 1991.

1991 (C) CMU team develops VuMan 1 for viewing and browsing blueprint data (CMU) Students in a Summer-term course at Carnegie Mellon's Engineering Design Research Center developed the VuMan 1, a wearable computer for viewing house blueprints. Input was through a three-button unit worn on the belt, and output was through Reflection Tech's Private Eye. The CPU was an 8 MHz 80188 processor with 0.5 MB ROM. See http://www.cs.cmu.edu/afs/cs.cmu.edu/project/vuman/www/home.html

1991 (F) Mark Weiser proposes idea of Ubiquitous Computing in Scientific American (Xerox PARC) Ubiquitous Computing proposes a world in which most everyday objects have computational devices embedded in them. Weiser's Landmark article, The Computer for the 21st Century appeared the September 1991 issue of Scientific American, pp 66-75.

1993 (C) Thad Starner starts constantly wearing his computer, based on Doug Platt's design (MIT)
Starner had attempted previous wearables based on both a TRS-80 model 100 and a SPARC Workstation, but never got them working reliably. When he heard Doug Platt give a talk at the MIT Media Lab he shifted over to Platt's system based on a 286 chip. In June '93, Platt and Starner custom made Starner's first working system with parts from a kit made by Park Enterprises, a Private Eye display, and the Twiddler chording keyboard made by Handykey. Many iterations later this system became the MIT "Tin Lizzy" wearable computer design. See http://wearables.www.media.mit.edu/projects/wearables/lizzy/ Thad Starner writes first version of the Remembrance Agent augmented memory software [MIT] The Remembrance Agent (RA) was an automated associative memory that would recommend relevant files from a database, based on whatever notes were currently being written on a wearable computer. The systems was integrated into Emacs, and later was rewritten as part of continuing research by Bradley Rhodes. See http://www.media.mit.edu/ rhodes/Papers/remembrance.html

1993 (C) BBN finishes the Pathfinder system, a wearable computer with GPS and radiation detection system (BBN
BBN's Pathfinder system was completed in Fall 1993, and included a wearable computer, Global Positioning System (GPS), and radiation detection system.

Slide Timeline VI:

1993 Feiner, MacIntyre, and Seligmann develop the KARMA augmented reality system

1994 Mik Lamming and Mike Flynn develop "Forget-Me-Not," a continuous personal recording system

1994 Edgar Matias debuts a "wrist computer" with half-QWERTY keyboard

1994 Steve Mann starts transmitting images from a head-mounted camera to the Web

1997 Creapôle Ecole de Création and Alex Pentland produce Smart Clothes Fashion Show

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Slide Wearable Computing Fashion:

Image from http://www.media.mit.edu/wearables/lizzy/out-in-the-world/beauty/intro.html

1993 (F) Feiner, MacIntyre, and Seligmann develop the KARMA augmented reality system (Columbia)
Steve Feiner, Blair MacIntyre, and Dorée Seligmann at Columbia University developed KARMA: Knowledge-based Augmented Reality for Maintenance Assistance. Users would wear a Private Eye display over one eye, giving an overlay effect when the real world was viewed with both eyes open. KARMA would overlay wireframe schematics and maintenance instructions on top of whatever was being repaired. For example, graphical wireframes on top of a laser printer would explain how to change the paper tray. The system used sensors attached to objects in the physical world to determine their locations, and the entire system ran tethered from a desktop computer. See http://www.cs.columbia.edu/graphics/projects/karma/karma.html

1994 (C) Mik Lamming and Mike Flynn develop "Forget-Me-Not," a continuous personal recording system (Xero
The Forget-Me-Not was a wearable device that would record interactions with people and devices and store this information in a database for later query. It interacted via wireless transmitters in rooms and with equipment in the area to remember who was there, who was being talked to on the telephone, and what objects were in the room, allowing queries like "Who came by my office while I was on the phone to Mark?"

1994 (C) Edgar Matias debuts a "wrist computer" with half-QWERTY keyboard (UofT)
Built by Edgar Matias and Mike Ruicci of the University of Toronto, this "wrist computer" presented an alternative approach to the emerging HUD + chord keyboard wearable. The system was built from a modified HP 95LX palmtop computer and a Half-QWERTY one-handed keyboard. With the keyboard and display modules strapped to the operator's forearms, text could be entered by bringing the the wrists together and typing. The system debuted at the CHI-94 conference in Boston, and is now being productized under the the name "half keyboard". See http://www.dgp.toronto.edu/people/ematias/papers/chi96 The same technology was used by IBM researchers to create a "belt computer" – see: http://www.almaden.ibm.com/cs/user/inddes/halfkb.html

1994 (F) Steve Mann starts transmitting images from a head-mounted camera to the Web (MIT)
S In December 1994, Steve Mann developed the "Wearable Wireless Webcam." Webcam transmitted images point-to-point from a head-mounted analog camera to an SGI base station via amateur TV frequencies. The images were processed by the base station and displayed on a webpage in near real-time. (The system was later extended to transmit processed video back from the base station to a heads-up display and was used in augmented reality experiments performed with Thad Starner.)

1997 (F) Creapôle Ecole de Création and Alex Pentland produce Smart Clothes Fashion Show
The fashion show was a design collaboration between the students and faculty of Creapôle Ecole de Création (Paris) and Prof. Alex Pentland (M.I.T., Boston), with the goal of envisioning the impending marriage of fashion and wearable computers. Beginning in April 1996, designs were iterated and clothes produced, with the final runway fashion show was held at the Pompidou Center in Paris in February 1997.

1.2 Scientific Sources

Slide Scientific Sources:

Conferences Cutting-edge research

Journals Established Research

Books “Textbook” knowledge

Research Groups Lots of information, unreviewd

1.2.1 Conferences

Slide The first conferences:

1996 DARPA sponsors “Wearables in 2005” workshop http://www.darpa.mil/MTO/Displays/Wear2005/index.html (no longer online, seen web archive link on course website)

1996 Boeing hosts a small wearables conference in seattle

1997 CMU, MIT and Georgia Tech co-host the ISWC’97

1996 (F) DARPA sponsors "Wearables in 2005" workshop This July, 1996 workshop brought together industrial, university and military visionaries to work on the common theme of delivering computing to the individual.

1996 (F) Boeing hosts wearables conference in Seatle Boeing hosted a small conference on wearable computing August 19-21, 1996. In attendance were researchers and administrators from industry, academia, and independent laboratories. Several vendors of displays, speech recognition systems, and full wearable computers were also present. There were 204 people registered for the event.

1997 (F) CMU, MIT, and Georgia Tech co-host the first IEEE International Symposium on Wearables Computers CMU, MIT, and Georgia Tech co-hosted the IEEE International Symposium on Wearables Computers in Cambridge, MA October 13-14, 1997. The symposium was a full academic conference with published proceedings and papers ranging from sensors and new hardware to new applications for wearable computers. There were 382 people registered for this event.

Slide ISWC:

- Since ’97 (Cambridge,Boston,MA)
- ISWC 07 back in Boston

Slide IFAWC:

- Since 2004
- IFAWC07 in Tel Aviv
- IFAWC08 not yet fixed

Slide Other conferences:

- Pervasive
- Percom
- Ubicom
- several workshops on specific topics: IWSAWC, NWUI

1.2.2 Journals

Slide Journals:

- IEEE Pervasive Computing
- Elsevier Pervasive and Mobile Computing
- Springer Personal and Ubiquitous Computing

1.2.3 Research Groups

Slide MIT:

Image from http://www.media.mit.edu/wearables/history.html

Slide MIT:

- MIT “Borglab”
- Part of the Media Lab
- http://www.media.mit.edu/wearables/
- Home of MIThril http://www.media.mit.edu/wearables/mithril/

Slide MIThril:

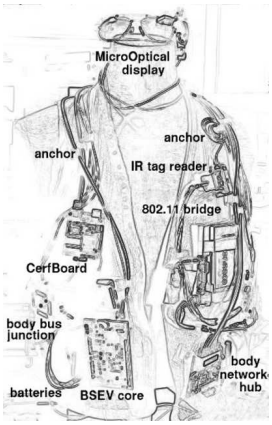

Image from http://www.media.mit.edu/wearables/mithril/photos.html

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Slide CMU:

- Dan Siewiorek, Asim Smailagic
- http://www.ce.cmu.edu/ wearables/
- Home of VU-Man http://www.ices.cmu.edu/design/VuMan.html
- Project AURA http://www.cs.cmu.edu/ãura/

Slide Toronto:

- Steve Mann
- Philosophy of Wearable Computing
- Cooperation with artists
- http://www.eyetap.org/

Slide Georgia Tech:

- Thad Starner
- Focus on mobile HID

Slide ETH:

- http://www.wearable.ethz.ch/
- Gerhard Tröster
- QBIC Wearable Computer

Slide Other places:

- IBM LinuxWatch http://www.research.ibm.com/WearableComputing/
- Univ. Passau: Paul Lukowicz
- Univ of South Australia: Bruce Thomas http://people.unisa.edu.au/Bruce.Thomas
- Lancaster University: Hans Gellersen, Embedded Interactive Systems http://eis.comp.lancs.ac.uk/index.php
- TU-Darmstadt: Bernd Schiele, Multimodal Interactive Systems http://www.mis.informatik.tu-darmstadt.de/
- TZI Bremen

Summary

Slide Summary:

- History: Young field with old roots
- Science: International Research, mainly conferences
