Chapter 1

Overview of the course

1.1 Overview

Slide Wearable Computing - Overview:

Course: Wearable Computing

VAK: 03-799.01

Time: Mo, 13-15

Place: 1.51 TAB (ECO5)

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Slide Overview of the course:

- What is wearable computing?
- Building blocks of wearable computing
  1. Hard- and Software
  2. Wearable Human Computer Interfaces
  3. Context-Aware Computing

- Wearable computing research
- Wearable computer engineering

Slide The Rules:

1. Good scientific practice:
   (a) Be precise and clear in statements. This is no literature class!
   (b) Use scientific sources. (Journalistic articles aren't. Wikipedia isn't.)
   (c) Cite! Plagiarism of ANY source is forbidden!
   (d) Cooperate within limits: Talking OK, Copying not!
   (e) Always use your own words.
2. Homework
   (a) in groups, group size ≤ 3, no exceptions
   (b) Fixed groups

Slide The Grading :

1. Homework + Fachgespräch
   (a) At least 30% of the points of each problem sheet
   (b) Homework grades serve as initial group grade
   (c) Individual short oral exam to verify individual contribution.
2. Modulprüfung
   (a) Homework recommended but points have no influence
   (b) Longer oral exam

1.2 Introduction

1.2.1 A short historic overview

Since almost 30 years, Moores law holds: Computers become smaller, cheaper and have more memory and there are more computers. There has been a structural change in the

way computers are used: From central computing centres (IBM predicted that there would be about 10 computers worldwide) to desktops and on to embedded systems (about 15 Microprocessors in every car, two in every mobile phone, ...)

Computers became portable, thus leading to a new way how they are used.

Previously, the computer was a tool to complete a specific task, nowadays, most computers are hidden in devices and are used not as a computer but as something else. Most processors biult today are used in so-called embedded systems. These are computer systems that work inside other systems, often without human intervention and with hardly recognizable human machine interfaces. The anti-lock brake system of a modern car may serve as an example. It prevents the wheels of a car from "locking", i.e. from a complete stop while the car is still moving as a completely stopped wheel cannot be used for steering. The embedded system typically uses the wheel speed of the car and a switch at the brake pedal as input, its output is a signal controlling the valve at a brake cylinder located at the wheels that reduces the brake force at the wheel when opened.

Mobile computer systems become more and more a part of everyday life. Starting out as pocket calculators, electronic organizers and digital wristwatches about 30 years ago, they nowadays come in various forms such as bike computers, mp3 players, PDAs, portable navigation systems and more. But the most popular form of a mobile computer is nowadays the mobile phone. A typical mobile phone nowadays is even a multiprocessor system with one cpu dedicated to protocol and signal level processing and a second one for user interface and application software.

Wearable computing are an extension of the concept of a mobile computing. The main difference is that the "normal" mobile computer requires its user to operate it explicitly, e.g. taking the phone and calling someone. A wearable computer is a device that implicitly works with the user, it is always on, perceives the users action and the environment through sensors and automatically supports its user when needed. The term "wearable computing" has been coined to illustrate that the computer is used like a piece of clothing. A jacket that I wear protects me from the rain and cold all the time without need for installation, configuration, activation, etc.

Slide Wearable Computing?:

- Evolution of computer hardware

  1950s Central computing facilities, Batch processing
  1960-1980 Timesharing, "'mini"'-computers
  1980s Personal Computers
  1989 Nintendo Gameboy
  1990 GSM Mobile Phones
  1992 Apple Newton PDA

Slide Wearable Computing?:

- Evolution of computer hardware

1992 IBM Smartphone (sold by BellSouth in 1993)
1996 Digital Camcorder (Sony Digital8, MiniDV)
1998 MP3 Player (MPMan, Diamond Rio,...)
1999 Bluetooth SIG: Personal Area Network

Slide Wearable Computing?:

- Evolution of computer users

1950s Experts build computers and use them
1960s Computer companies: Commercial use
1980s "'Geek"' user: Desktop, Home use (communication, games)
1990s "'Everyone"' user: Mass Medium (Internet, Games)
2000s "'Everywhere"' User (Notebook, PDA, Mobile Phone,...)

Slide Wearable Computing?:

- Evolution of computer uses

1950s Special tasks, special computers
1960s Business Support (Accounting)
1980s Business, Information (BTX), Entertainment (video games)
1990s Information (internet), Communication (e-mail, chat)
2000s Mobile information and communication, casual use (SMS, WAP)

1.2.2 A first Definition

Slide Is this wearable computing?!?:

"‘Wearable"’ mobile phone?

Slide Is this wearable computing?!?:

> Can you imagine hauling around a large, light-tight wooden trunk containing a co-worker or an assistant whom you take out only for occasional, brief interaction. For each session, you would have to open the box, wake up (boot) the assistant, and afterward seal him back in the box. Human dynamics aside, wouldn’t that person seem like more of a burden than a help? In some ways, today’s multimedia portables are just as burdensome.

Steve Mann

Slide Is this wearable computing?!?:

Socially acceptable?

Slide So what’s Wearable Computing?:

- Support the user (during a primary task)
  - Don’t *disturb* the user
  - Provide useful functions *all the time*
- Seamless integration
  - Into existing processes and tasks
  - Into environment and social context

1.3 Examples

1.3.1 Engineering: Symbol Wearable

Slide An Example: Symbol Wearable:

> In January of 1995, a major customer, the United Parcel Service (UPS), challenged Symbol Technologies to create a Wearable Data Collection device for their package loaders to use.

(Stein et al: Development of a Commercially Successful Wearable Data Collection System, ISWC'98)

Slide Symbol Wearable: Requirements:

- Package loaders scan barcodes on packages
- Existing solution: Symbol APS3395 (from 1992): Three components (Display/Keyboard, CPU, Scanner) interconnected by wires
- fatigue-free scanning, 5.5h operation time
- improve hygiene, operation, reliability

Slide Symbol Wearable: Challenges:

- Ergonomics and Hygiene: safe, comfortable, unobtrusive
- Miniaturisation of computer and scanner
- Power management: 5.5h with single battery
- Ruggedization - Operation in hostile environment

Slide Symbol Ws 1000:

Image from Symbol Technology Inc.

Slide Design Process:

- "‘interactive design process"’: user testing, feedback
- Observation, Interviews, Scientific Literature
- concept scetches
- creating mockups
- user tests with mockups

Slide User testing and feedback:

- Interviews with many users, male and female
- Main concerns: comfort for wide range of body sizes, ruggedness, user safety, hygiene/cleanliness
- Design challenge: One Device for different hand and arm sizes, connecting "‘soft goods"’ to hard plastic

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Slide Scientific input:

- Physiological studies: arm, hand, fingers in neural position most of the time
- Study of potential disease transmission: synthetic cloth materials for soft goods
- Ergonomic Evaluation in Lab: six subjects, simulation of UPS tasks

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1.3.2 Philosophy: Personal Imaging and Humanistic Intelligence

Slide Steve Mann:

Image from eyetab.org website

Slide Humanistic Intelligence:

> HI is a new information processing framework in which the processing apparatus is inextricably intertwined with the natural capabilities of our human body and intelligence. [. . .] Devices that embody HI are worn continously during all facets of ordinary day-to-day living. Thorugh long-term adaptation thex begin to function as a true extension of the mind and body

Steve Mann, Intelligent Image Processing

Slide Features of HI:

- Relies on the existence of the human user
- operational constancy (always on)
- interactional constancy (inputs and outputs potentially always on)
- HI does not necessarily mean user-friendly, user learns from the device
- WearComp as means of realizing HI

Slide WearComp Constancy:

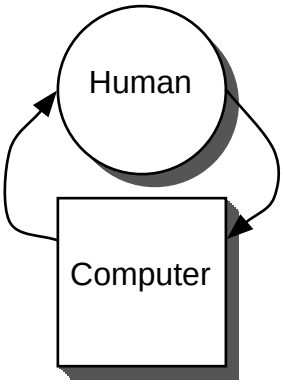


Image from Steve Mann: Intelligent Image Processing, Pg 5. Fig 1.1

Slide WearComp Augmented Intelligence and Augmented Reality:

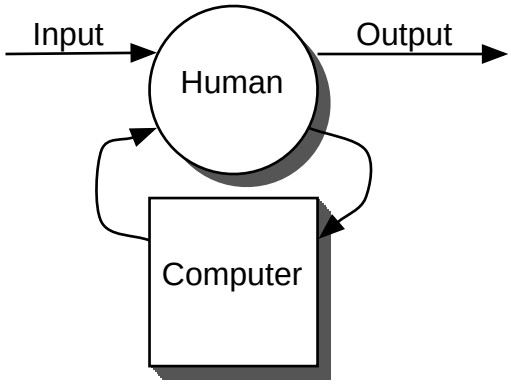


Image from Steve Mann: Intelligent Image Processing, Pg 5. Fig 1.1

Slide WearComp encapsulating the user:

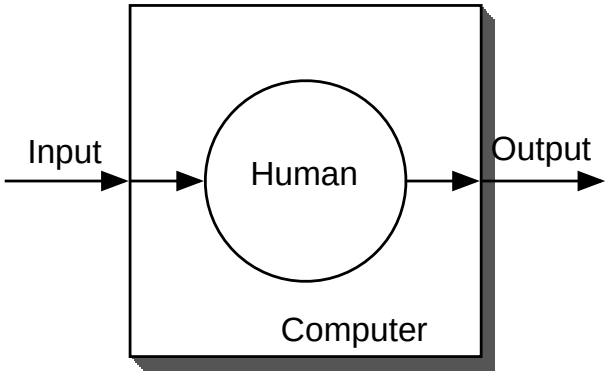


Image from Steve Mann: Intelligent Image Processing, Pg 5. Fig 1.1

Slide WearComp encapsulation with Constancy and AR:

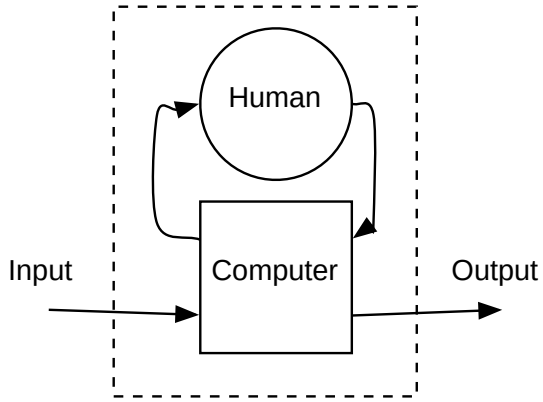
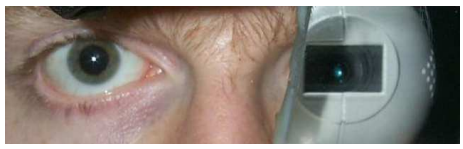


Image from Steve Mann: Intelligent Image Processing, Pg 5. Fig 1.1

Slide Personal Imaging:



> Human beings optain their main sensory information from their visual sytem. [. . .] A computationally mediated visual reality is a natural extension of the next-generation computing machines. [. . .] This will not be done by implanting devices into the brain [. . .] , but rather by noninvasingly “tapping” the highest bandwidth pipe into the brain, namely the eye.

Steve Mann, Intelligent Image Processing Image from Steve Mann’s eyetap.org website

1.4 Wearable Computing Research

Slide Research on Wearable Computing:

- Hardware
- Software
- Human Computer Interaction
- Context Recognition
- Cooperation (human-human and human-machine)

Slide Research on Hardware:

- <1-> Size, weight, shape 2>

Image from ETH Zürich

- <3-> Energy source and management, heat dissipation 4>

Image from Wearable Computer from Quantum3D, ISWC06, H. Kenn

- <5-> Communication (radio, infrared, bus systems), Input (keys, gestures, voice), Output (screen, audio, touch) 6>

Image from ETH wearable computing exhibit, ISWC06, H. Kenn

- <7-> Integration (textile, cleaning/washing, connectors) 8>

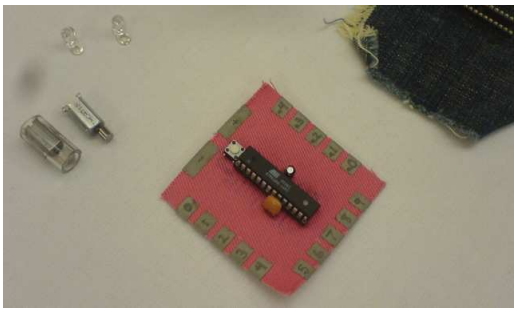


Image from Textile integration, Leah Buechley, ISWC06, H. Kenn

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Slide Research on Wearable Software:

- <1-> Embedded Systems: Programming Language, Operating System
- <2-> Software Engineering: Software Structure, Engineering Method
- <3-> Distributed Systems: Service Architecture, Unreliability
- <4-> AI Techniques: Adaptivity, Knowledge Representation, Learning

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Slide Research on Wearable Human Computer Interaction:

- <1-> User Studies: Interaction, Interruption, Physical Tasks
- <2-> Adaptivity: I/O Devices, Multimodality, Context-awareness
- <3-> Evaluation: Guidelines, Standards

Slide Research on Wearable Context Awareness:

- <1-> Sensor Signal Analysis: from Sensor to low-level context
- <1-> Localization: outdoor, indoor, sensor fusion, mapping
- <2-> High-level Context recognition: combination of low-level contexts
- <3-> Task Recognition: temporal sequences

- <4-> Learning Contexts: Supervised, Unsupervised machine learning

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Slide Research on Wearables for cooperation:

- <1-> Human-Human: Situational Awareness
- <2-> Human-Machine: Common “world model”
- <3-> Cooperation: Working towards a comon goal
- <4-> Example: Robocup Rescue

1.5 Conclusion

Slide Research Problems:

- System engineering: How to build it? (so that it’s useful?)
- Human Machine Interaction: How can it be used?
- Context-awareness: How does it know what’s going on?
- Augmenting human capactiy: Building better cyborgs?
- …

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"’
- Engineering discipline or cyborg philosophy?
