LCC 3710
Principles of Interaction Design

Week 11

Class agenda:

- Readings
- UbiComp, Wearables
- Group Activity

Readings

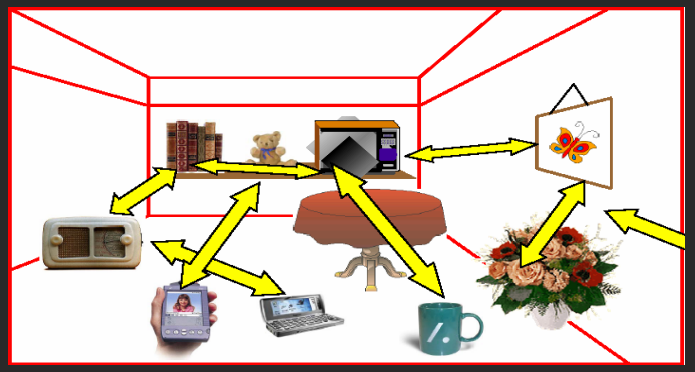
Weiser, Mark (1991). "The Computer for the 21st Century" in *Scientific American*.

Starner, Thad (2001). "The Challenges of Wearable Computing: Part 1" in *IEEE Micro*, July-August 2001.

Ubiquitous Computing

Yesterday's computers filled rooms ...

… So will tomorrow's



Ubiquitous Computing

Definitions

Ubiquitous computing is the method of enhancing computer use by making many computers available throughout the physical environment, but making them effectively invisible to the user. (Mark Weiser)

Ubiquitous computing, or calm technology, is a paradigm shift where technology becomes virtually invisible in our lives. (Marcia Riley)

Some Principles

The purpose of a computer is to help you do something else, so the best computer is a quiet invisible servant

Technology should remain calm:

Can computing technology be as easy to use as literacy technology?

Difficulty does not stem from UI problems

The idea of the *personal* computer is the problem

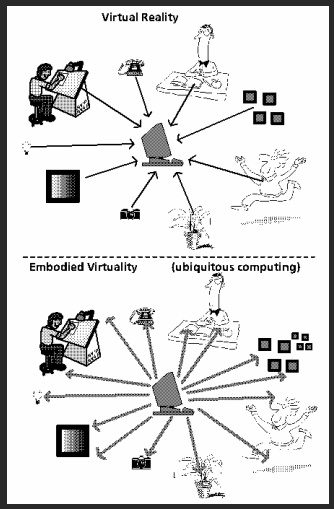
Virtual Reality & Embodied Reality

Virtual Reality

Immerses us in simulated world

Ubiquitous Computing

Invisibly enhances real world



UbiComp Technologies

Computational media everywhere — the environment becomes a computer

Technology

- Wall-sized displays
- Laptops, palmtops, PDAs
- Active badges, smart watches, wearable computers
- Computers in doors, walls, garages, cars, refrigerators, ...

Sensing context

- Who? What? Where? When? Why?

UbiComp Applications

Applications

- Intelligent and adaptive systems
- Health care, e.g. for seniors
- Telephone forwarding
- Social and community awareness

Social issues

- Privacy and monitoring, security
- Impacts of recording

Some Research Themes

Transparent interfaces

Awareness of context

Capture experience

Transparent Interfaces

Hide their presence from user, provide interaction between user and application

- Natural interactions... Gesture recognition, speech recognition, free form pen interaction, computational perception etc.
- Yet currently... keyboard and mouse are still the most commonly used interfaces

UbiComp needs flexible interfaces, varied interfaces that can provide similar functionality

Context Awareness

Context is information about the environment with which the application is associated

- E.g. location and time

A context aware application can capture the context, assign meaning to it, and change its behavior accordingly

UbiComp needs applications that are context aware and allow rapid personalization of their services

Automated Capture

To capture our day-to-day experience and make it available for future use.

Constraints:

- Multiple streams of information
- Their time synchronization
- Their correlation and integration

UbiComp needs automated tools that support capture, integration and future access of info.

Xerox PARC UbiComp

Computing by the inch, foot and yard

Tabs – size of a pack of cards

- Personalized and carried with you

Pads – size of a piece of paper

- Scrap computers, antidote to "windows"

Boards – yard size

- Large displays for groups of people

Videos:

Intro, pads, tabs, interaction, summary
(http://nano.xerox.com/hypertext/weiser/UbiMovies.html)

Today: PDA, tablet PC, smart board

Technology Research

Hardware technologies

- Processors, memories
- (Wireless) networking
- Sensors, actuators
- Power
- Packing and integration
- Potentially: entirely new technologies (optoelectronics, biomaterials)

Software technologies

- Operating environments
- Networking
- Middleware
- Platform technologies
- User interfaces

Example 1

VTT Soapbox

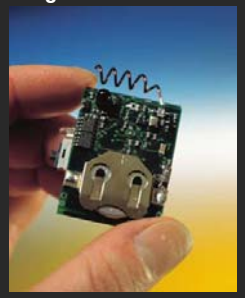
- Developed at VTT Electronics, Finland

Basic board:

- Bidirectional, single channel 868 MHz short range radio
- Microcontroller
- Real-time clock
- Calendar circuit

Sensor board:

- 3-axis acceleration sensors
- Electronic compass
- Light sensor
- Optical IR-based proximity detector



Example 2

Smart Badge

- Developed by HP Labs / Royal Institute of Technology (KTH)

Hardware

- Intel SA1110 processor and SA1111 coprocessor
- Audio CODEC
- IR module
- Accelometer
- Temperature
- Humidity
- Light

http://www.it.kth.se/~maguire/badge4.html

Example 3

Berkeley Smart Dust: COTS Dust

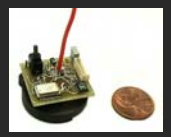
Designed for testing communication and sensing capabilities of large numbers of nodes

- Devices that incorporate communications, processing, sensors, and batteries into a package about a cubic inch in size

Potential applications include fire detectors, espionage, earthquake monitoring, people tracking

http://www-bsac.eecs.berkeley.edu/archive/users/hollar-seth/macro_motes/macromotes.html

weC
RF 916.5 MHz OOK
10kbps 20 meter range
Sensors: light, temperature



Mini Mote
RF 916.5MHz OOK
10kbps 20 meter range
Sensors: temperature

Example 4

RFID Tags

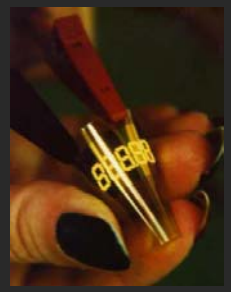
- A remotely readable tag that replies an incoming RF signal with some data
- RFID has been around for some 10 years, but high tag prices have limited its use

Example 5

FOLED (Universal Display Corp)

- Organic light emitting devices that are built on flexible substrates such as plastic or metallic foil (~ 1 mm thick)
- Applications are emerging (e.g. curved or flexible displays)

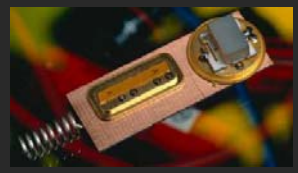
Video Clip

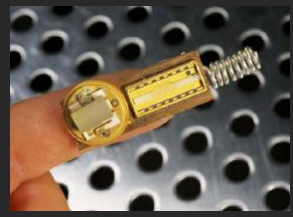


Example 6

Standalone Smart Sensors

- No external power supply, energy from the actuation process
- Piezoelectric and pyroelectric materials transform changes in pressure or temperature into energy
- RF signal is transmitted via an antenna (20 m distance)





Wearable Computing

Portability and Mobility

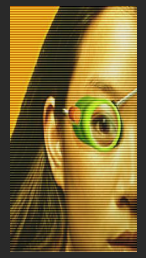
Portability refers to how easy it is for you to carry around your technology

Mobility encompasses what you have the ability to do with your technology while carrying it around

Wearable Computers

Small portable computers designed to be worn on the body during use

- Mediate non-computer activities without interfering with the user's everyday tasks
- Generally integrated into the user's clothing or attached to the body, e.g. wristband
- May be integrated into everyday objects worn on the body, e.g. wrist watch or hands-free cell phone
- Differ from PDAs, which are designed for hand-held use



Portable while operational
Hands-free
Sensors
Attention-getting
Always-on

Input/Output

Input

- "keyers" (e.g. Twiddler) and trackballs
- Gesture, speech recognition, context awareness sensors

Output

- Displays, lights, sound, haptic interfaces
- Mediated reality (augmented, diminished, or otherwise modified reality) systems can also be considered wearable computers.

Applications & Uses

Personal/Recreational Use

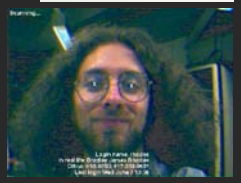
- Email/text/video messaging, note taking
- Audio/video entertainment

Professional Use

- Constant contact with advisors/secretaries
- Commuting/working on the move
- Desktop applications
- Military applications

Disability aids

- Navigation, obstacle recognition
- Face recognition, vision enhancement



Research Questions

The image of humans interacting with a wearable computer has been found all over science fiction

Is it practical?

- Many design constraints
- E.g. Size, power consumption...

Expectations falling short currently

Current "works in progress" will surely develop into more usable devices in the future

Steve Mann circa 1981

Evolution of Wearables

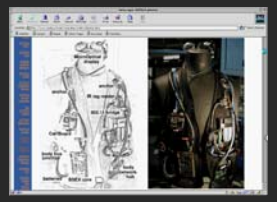
Academic Research

Thad Starner @ Georgia Tech

Steve Mann @ U of T ECE

Sandy Pentland @ MIT Media Lab

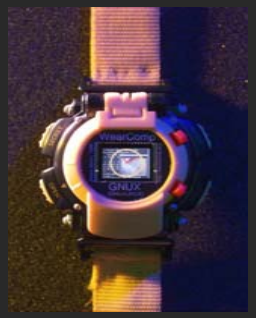
Wearable Research @ CMU HCI Institute



Wristwatch Computer Videophone

"Dick Tracy" style watch

- Created by Steve Mann, University of Toronto, 2000
- Combination wristwatch and imaging device
- Send and receive video over short distances



Gait Shoe

Wearable device for gait tracking

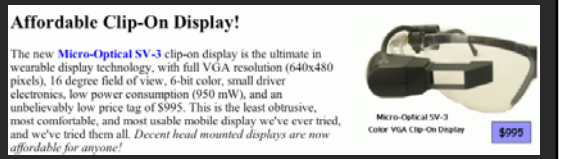
- **Joe Paradiso, MIT Media Lab, 2002**
- **On-shoe device used for continuous and real-time monitoring of gait**
- **Provides information about the 3D motion, position, and pressure distribution of the foot**
- **Medical applications, e.g. investigating the effects of physical therapy on subjects with Parkinson's disease at Massachusetts General Hospital (MGH) BioMotion Lab**

Video Clip

Commercial Development

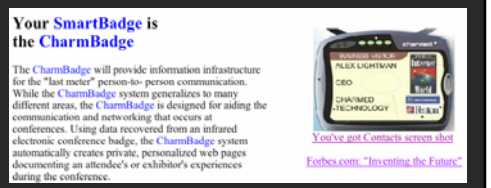
Commercial Development

Commercial Developments



Charmed Technology

Matias Corp.



Group Activity

Design for the Real World

In groups of three or four, think about how human interactions with the following real-world objects could be in some way enhanced by computation:

1. a refrigerator
2. a chair
3. a door

Develop and sketch out an idea for how to computationally enhance each of these objects.

Some particular questions to consider:

- What is the purpose of each object? What is its physical form?
- How do we interact with each object currently?
- What feedback do the objects provide when we interact with them?
- What would be the purpose of adding computation?
- What might be the sensing approach and feedback?
- How can consistency be maintained when computation is added?

Present your ideas to the class.