Instrumented Environments

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Topics Today

- Wearable Computing
  - Input
  - Output
  - Platforms
  - Steve Mann
  - MIThrill
  - Wearcam
- Augmented Reality
  - Milgram’s Mixed Reality continuum
- Lecture summary
- Lecture evaluation

Wearable Computing

- Small and wearable computer
- Wearable -> hands free (otherwise portable ;-)
- Sensors onboard
  - Cameras, temperature sensors, microphones, GPS
- Unobtrusive displays
  - Wrist watch
  - Clip-on for glasses
- “Always on”
  - Sense the environment and observe user actions

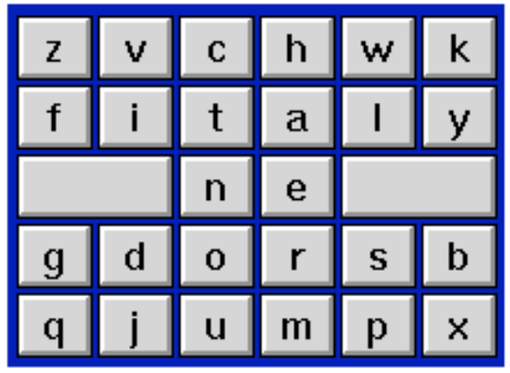
Goals of Wearable Computing

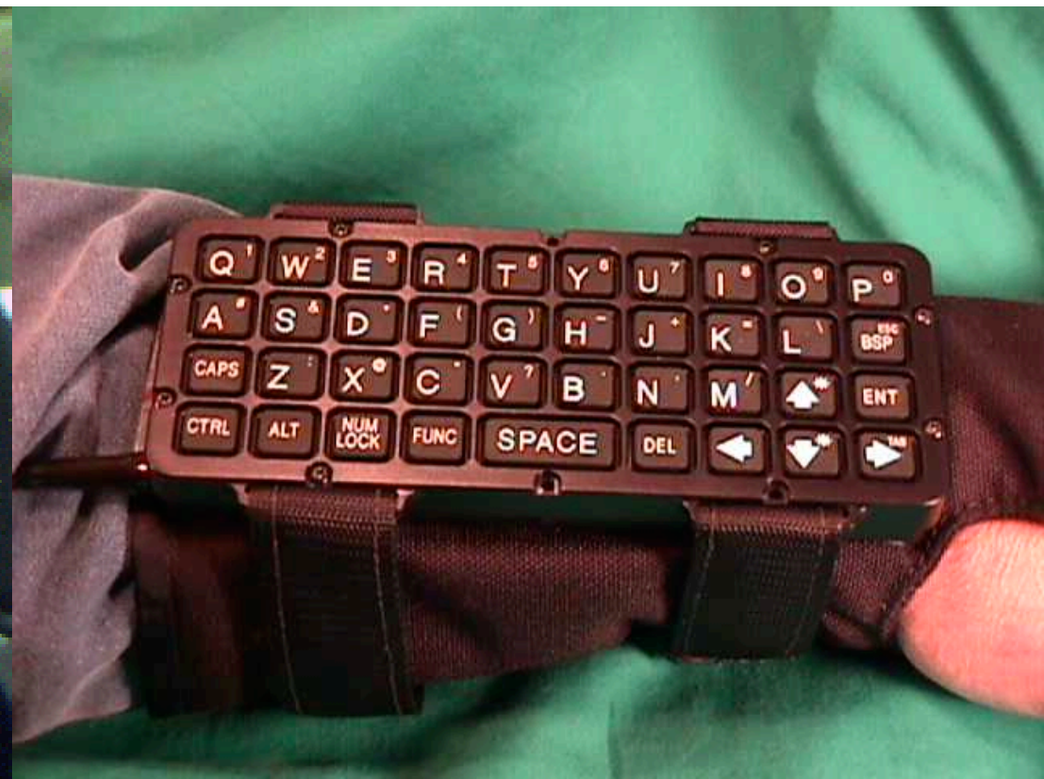
- Personal assistant (general purpose)
  - Internet access
  - Remind of dates and tasks
  - Handle large Databases (lexicon access, document management)
- Specialized devices
  - Museum guide
  - City and Campus guides
  - Maintenance and surveillance tasks

Wearable Input: Keyboards

(images from left to right)

- Twiddler (www.handykey.com/): chord keyboard
- WearClam (www.robots.ox.ac.uk/~wmayol/WearClam/)
- WristPC Keyboards (L3 Systems)
- Fitaly keyboard (1-finger System)





Output (Examples)

- Clip-on glasses (Micro Optical Corp.)
- Retina displays
- See e.g., TekGear for more
- www.tekgear.com

Hardware and OS Platforms

- Chips and embedded platforms
  - See chapter on HW toolkits
- PDAs: Palm, Sony, HP/Compaq, Sharp
- Tiqit Computers (www.tiqit.com/)
- Origami UMPCs (http://origamiproject.com/)
- Subnotebooks, Webpads, tablets

CharmIT (www.charmed.com)

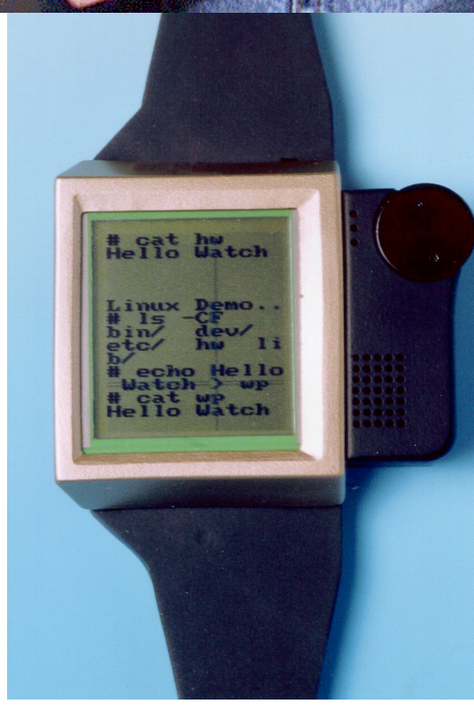
- MIT Media Lab spin-off
- Complete „wearable“ system bundle
  - PC class hardware
    - Transmeta Crusoe processor
    - 20GB hard disk
    - 8hrs battery life (differing info)
  - Linux operating system
  - Clip-on display
  - Finger mouse
  - Carrying bag

Some Research Projects

- MIT (MIThril, startle cam)
- CMU (VUMAN, Navigator)
  - www.wearablegroup.org
- Univ. of Bristol (Cyberjacket)
  - wearables.cs.bris.ac.uk
- ETH Zürich (WearArm together with MIT)
  - www.wearable.ethz.ch

Commercial Research

- IBM wearables (pictures on the right)
- I-wear (http://www.i-wear.com/)
  - Siemens, Philips, Samsonite, adidas, starlab.org
  - Intelligent Clothing
  - Antennas integrated into clothing
- Xybernaut
- Matsucom onHandPC
- IBM Linux wrist watch



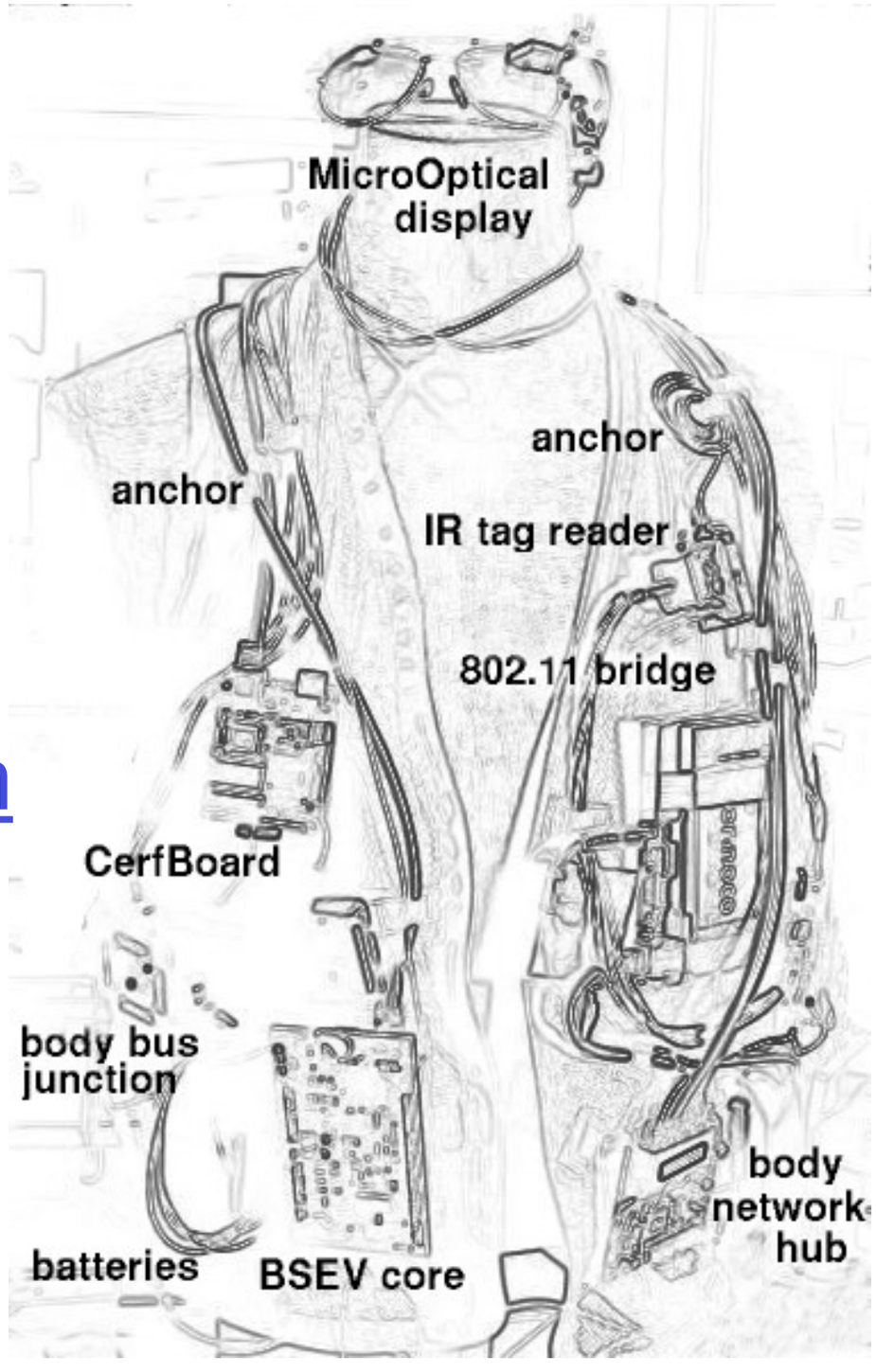
Some „Wearable“ Products

- Apple & Burton „Amp Jacket“ (2003)
  - Includes Apple iPod MP3 player
  - Player control keys integrated in sleeve
  - $500 without iPod

- Infineon & O‘Neill „Hub Jacket“ (2004)
  - Includes custom unit which…
    - Contains a 128MB MP3 player
    - Acts as a bluetooth headset for mobile phones
  - Player and phone control integrated in sleeve
  - €550 including player/headset electronics

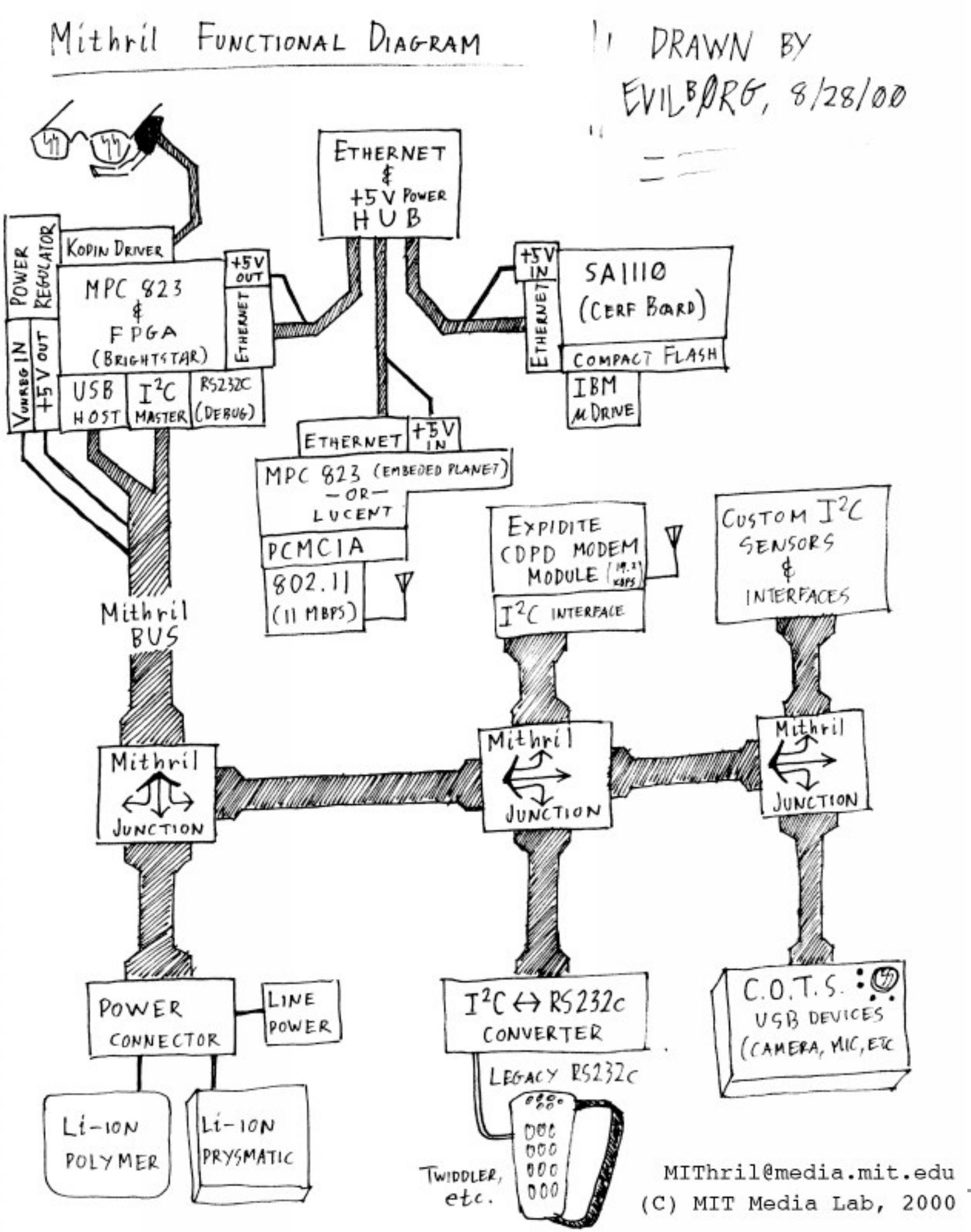
MIT Wearables

- MIThril
- Platform to develop wearable computing applications
- www.media.mit.edu/wearables/



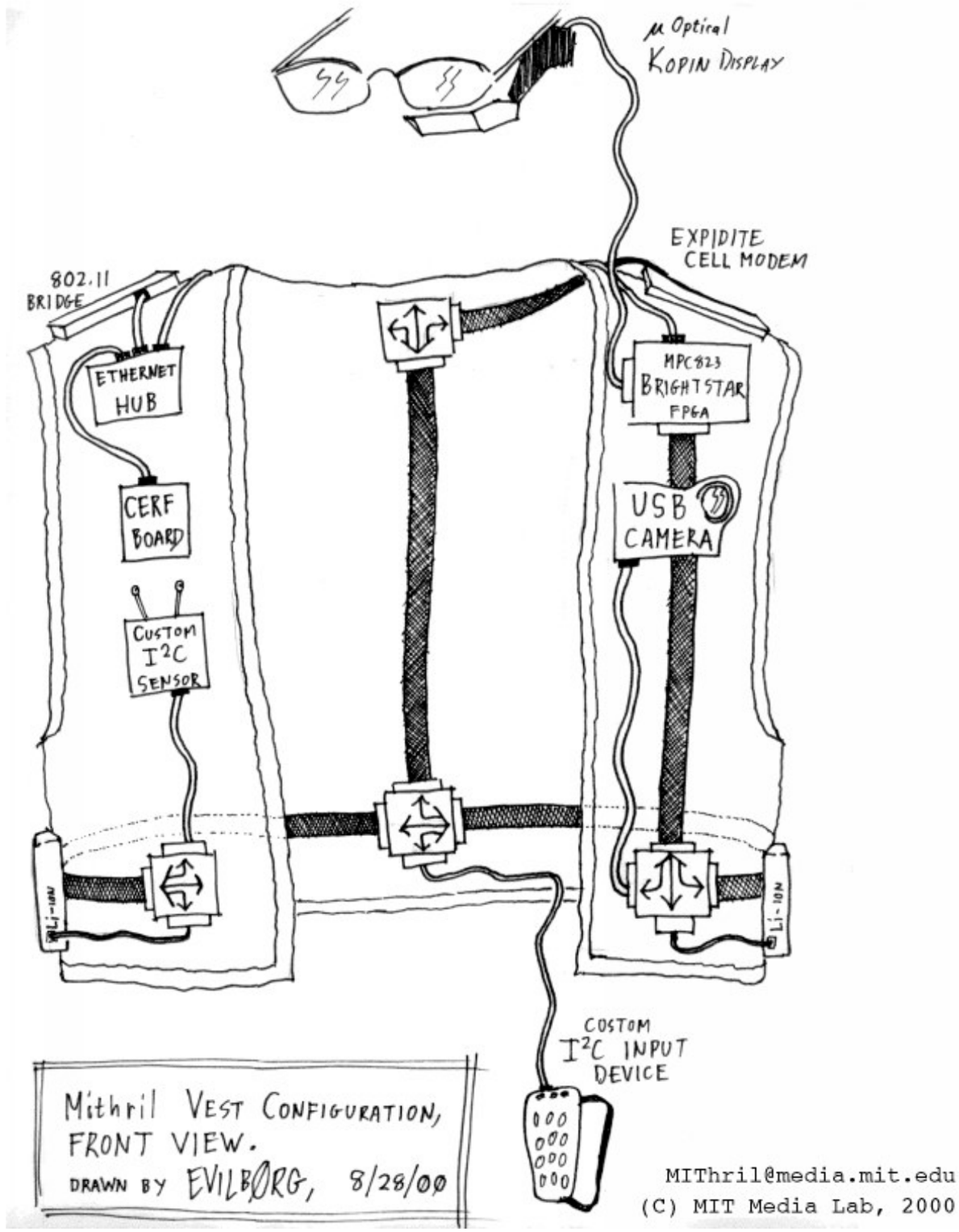
MIThril Architecture

Head of group:
Sandy Pentland



MIThril Architecture (2)

- CERF single board computer
- Brightstar Linux
- 802.11 bridge
- SAK data acquisition
- MIThril networking:
  - Body network
    - Ethernet, TCP/IP
  - Body bus
    - USB, I2C



First Applications

- Internet services:
  - Web browsing
  - Image transmission
  - Email

- Signal processing
  - Step recognition
  - Temperature, skin conductivity

Further Applications

- Concentrate on context sensing and classification
- E.g.: the Memory Glasses
  - Try to associate pictures with places
  - Provide users with information tagged to their actual location

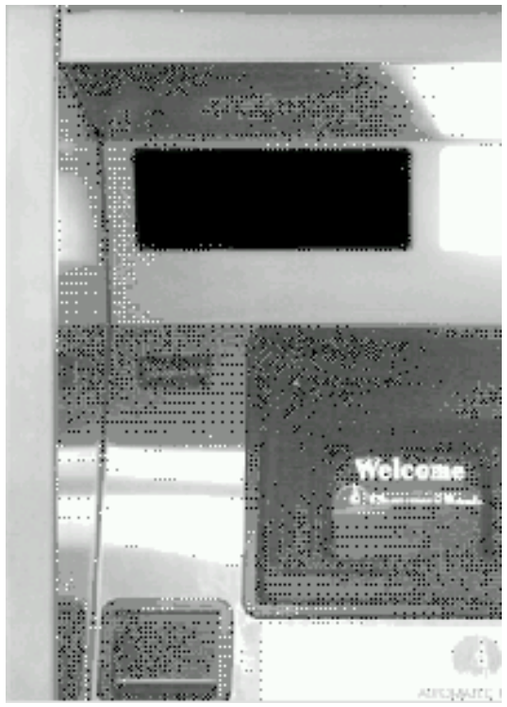
“Smart Clothing” in Research

- http://wearcam.org/smart_clothing/
- Reduce amount of single devices with similar functionalities

  (mobile phone, Organizer, Wrist watch, recorder, walkman, Camcorder, calculator, etc.)
- Laptops and PDAs need too much attention
- Smart Clothing helps to counterbalance public cameras

Why not Smart Places ?

- Expensive infrastructure
- Problems to trust the infrastructures



History of Smart Clothing

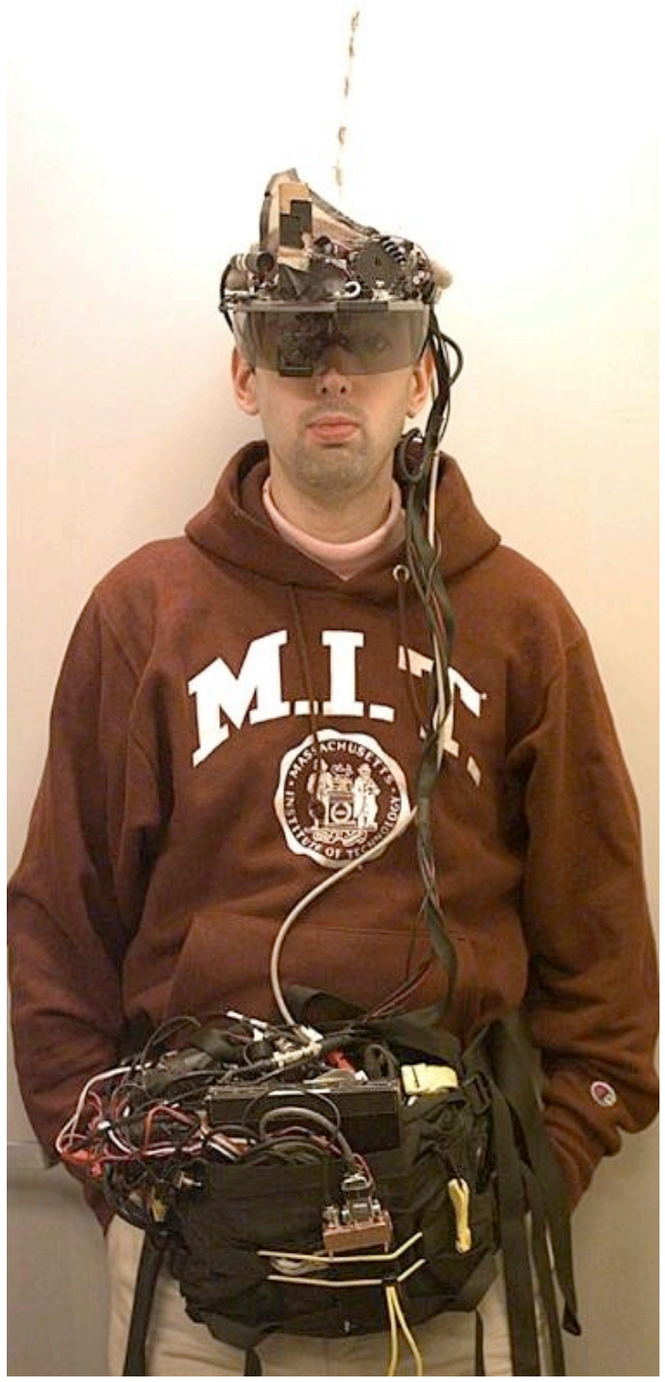
- 1968 (Ivan Sutherland) :
  - First visions of head mounted displays

- 1970s :
  - (Amateur radio) : Communication with mobile transceivers
  - (the Eudaemons) : First wearable computer, embedded in a shoe. Helped to play roulette.

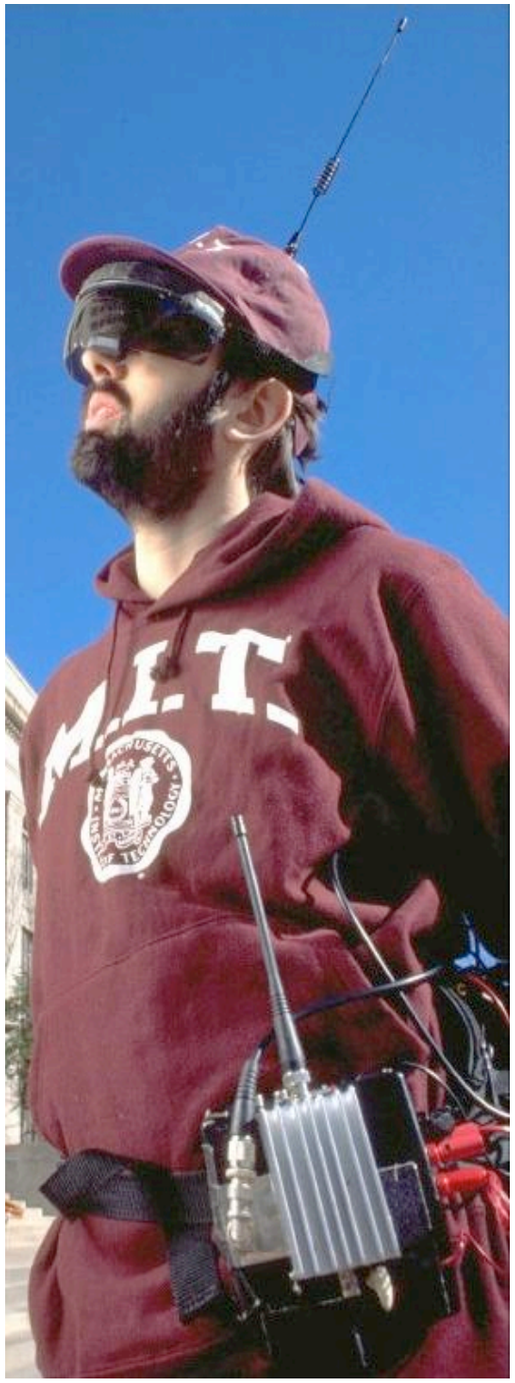
Steve Mann’s Inventions

- 1980:
  - Tools for artists
  - 1,5-inch CRT attached to a bicycle helmet
  - Two antennas for transmission
  - Battery lamp to be used in the dark
  - CPU in the backpack
  - Remote server for more complicated operations

- 1990s :
  - Miniaturization :
    - Camcorder → 0,6-inch CRT
    - Laptops → all calculations on the body
  - Permanent internet access:
    - Receive/send emails
    - Use mobile camera to run web server.



- 1995:
  - VR-Displays allow first mediated reality scenarios
  - Small, wearable and wireless webcam



- 1999 :
  - Goggles :
    - 24-bit color display
    - camera
    - microphone
    - loudspeaker
  - Internet connection:
    - WLAN, GPRS, UMTS
  - Infrared sensors and radar enhance perception.
  - Biometric measurements
    - Pulse
    - Breathing
    - Skin conductivity

- Smart shoes sense
  - Acceleration
  - Step forces
- Analog → digital Converter
  - To process biometrical data
- Smart underwear
- Input device: Combination of keyboard and mouse

Smart Underwear

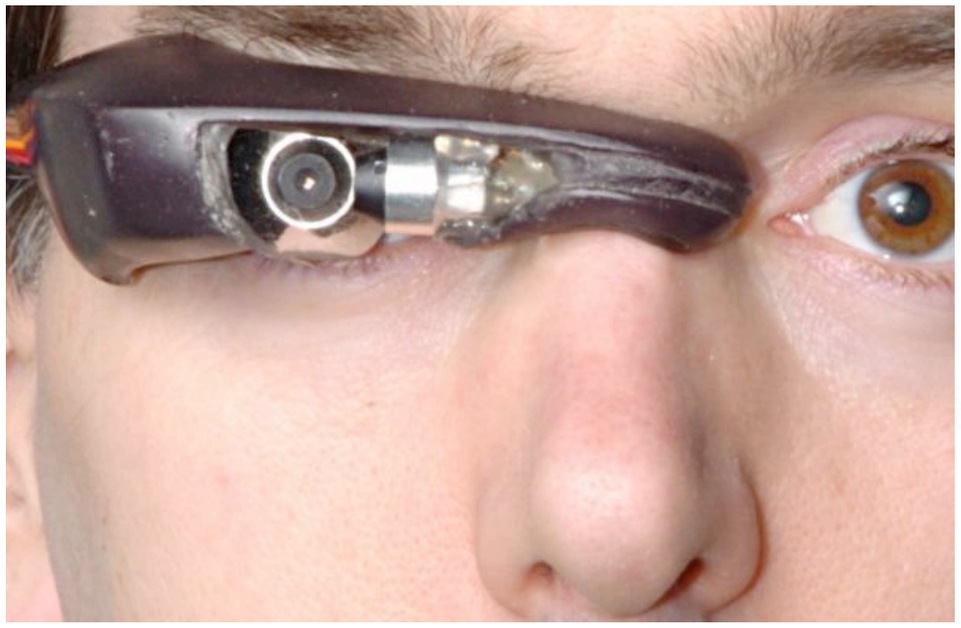
wearcam.org/smart_clothing/node4.htm

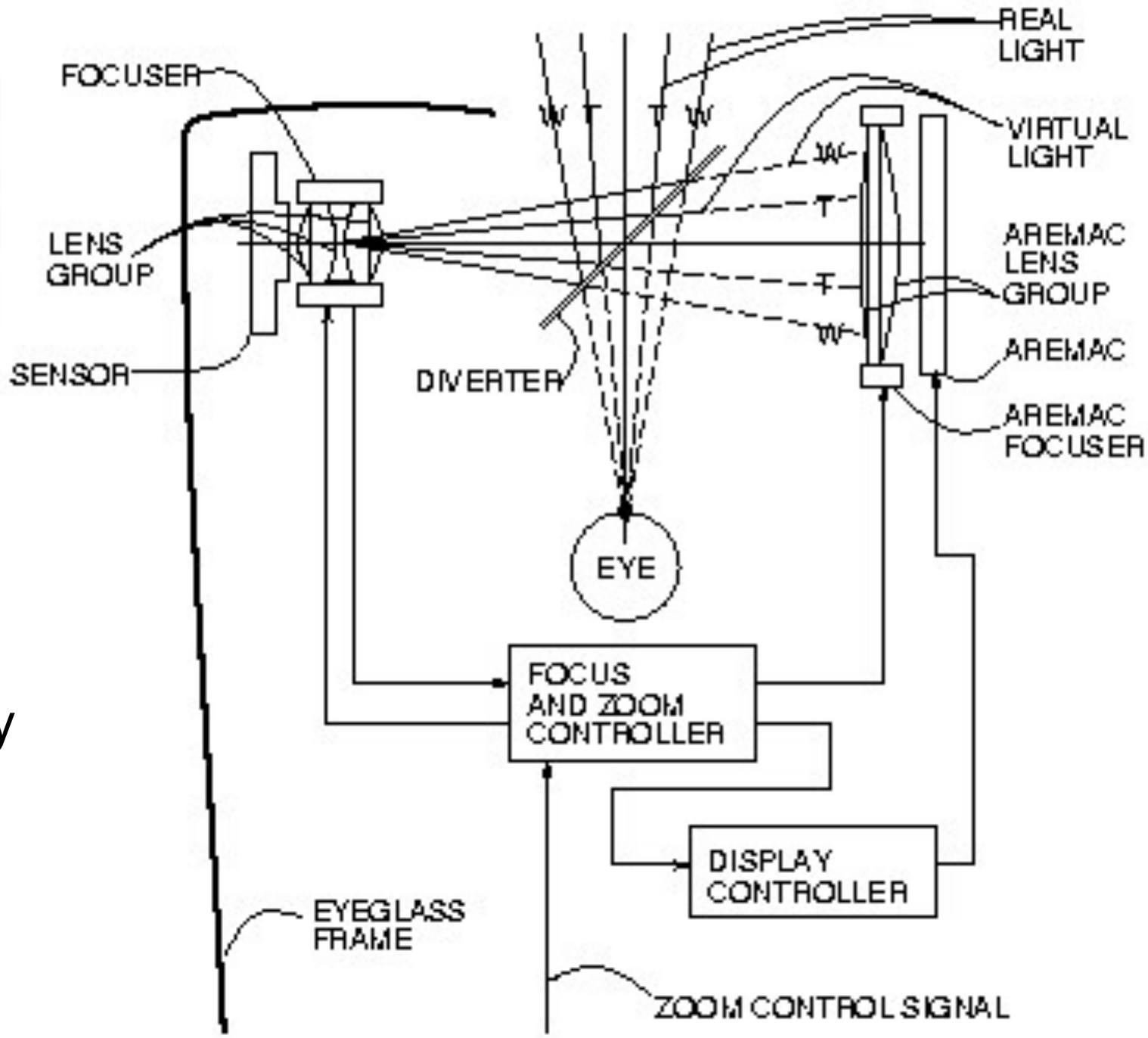
- Regulation of heating and air conditioning
- Sensors (sweat), Transmitter and antenna are worn in the underwear
- Monitor health
  - EEG and EKG
  - Respiration
  - alert physician

Expected Future Developments

- More bio sensors
  - Medical devices integrated into clothing
  - Store and process data locally
  - Impact:
    - Patient has all his medical information/data in his hand.
    - Misuse of information is reduced
    - Better emergency handling
    - Information is always up-to-date
    - No requests for certain information

Eyetap Device

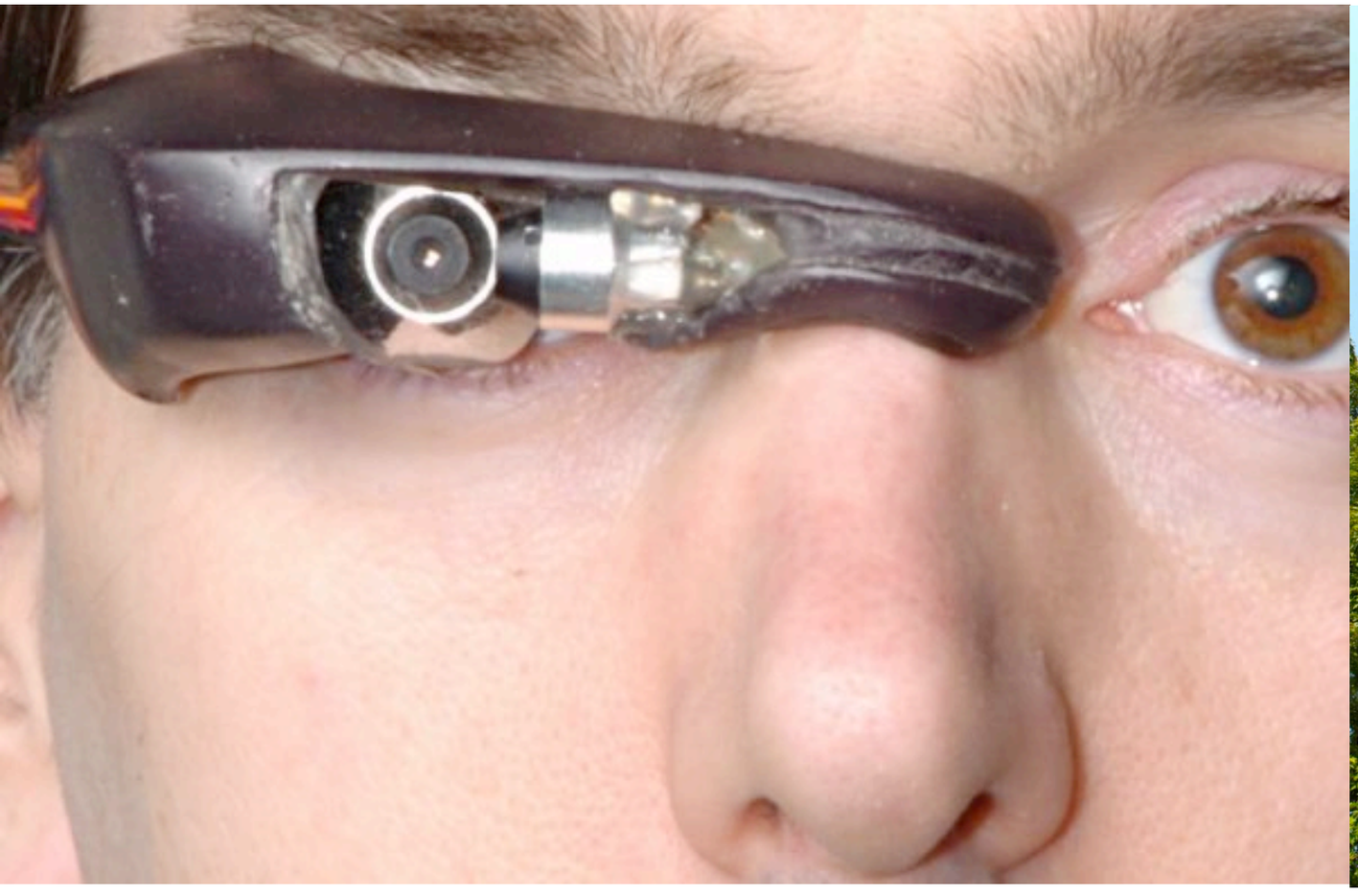
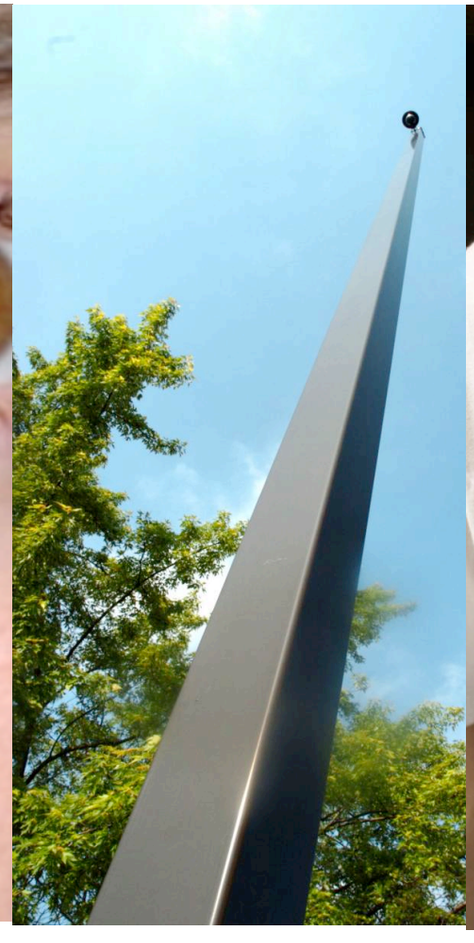




- http://www.eyetap.org/
- Computer mediated reality
- modify visual perception
  - Augment
  - Diminish
  - Alter

WearCam platform

- http://wearcam.org/
- Permanently recording images of the environment
- Concept of “inverse surveillance”

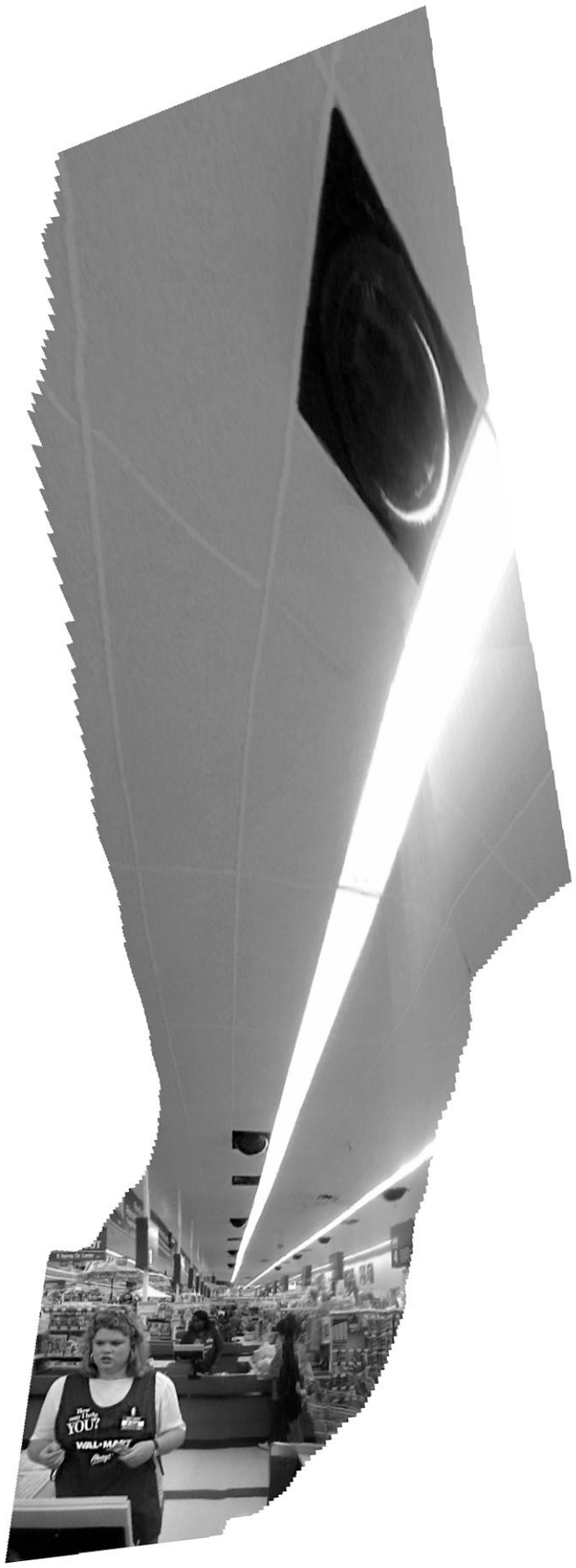




WearCam applications

- Edgertonian Eyes :
  - Periodic freezing of images (1/10.000 sec.)
  - Results:
    - While driving : Stronger perception of repeating image pattern (rails running along)
    - Rotating objects : rotate more slowly fore- or backwards (similar to strobe-light effect)
    - Non moving images are easier to remember (e.g. faces)

WearCam applications

- Deja vu
  - Storing streams of images
  - Compare stored images with actual image to detect if the user is moving in circles.
  - Notify user, if he comes to a “known” location.
- “Visual Clew”
  - Memorize stack of images while walking
  - Use images to find your way back

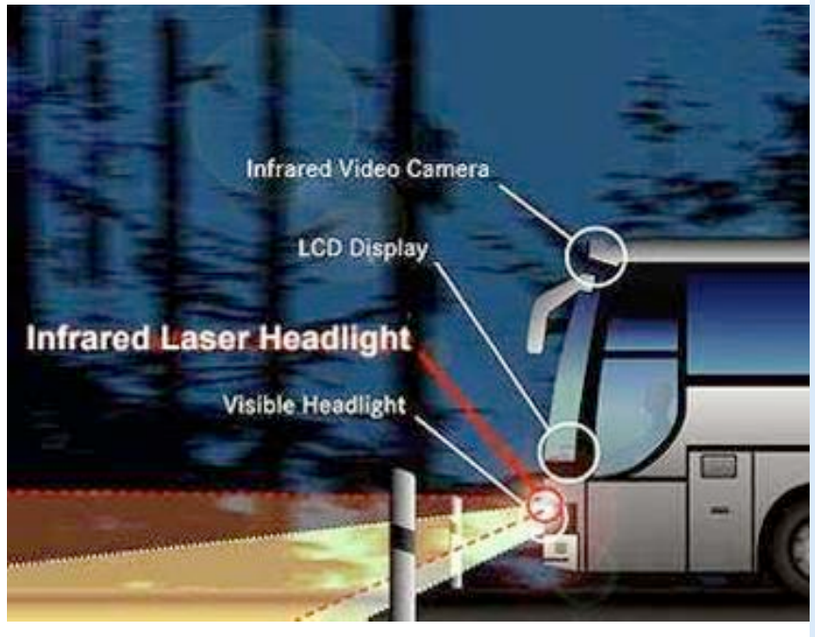


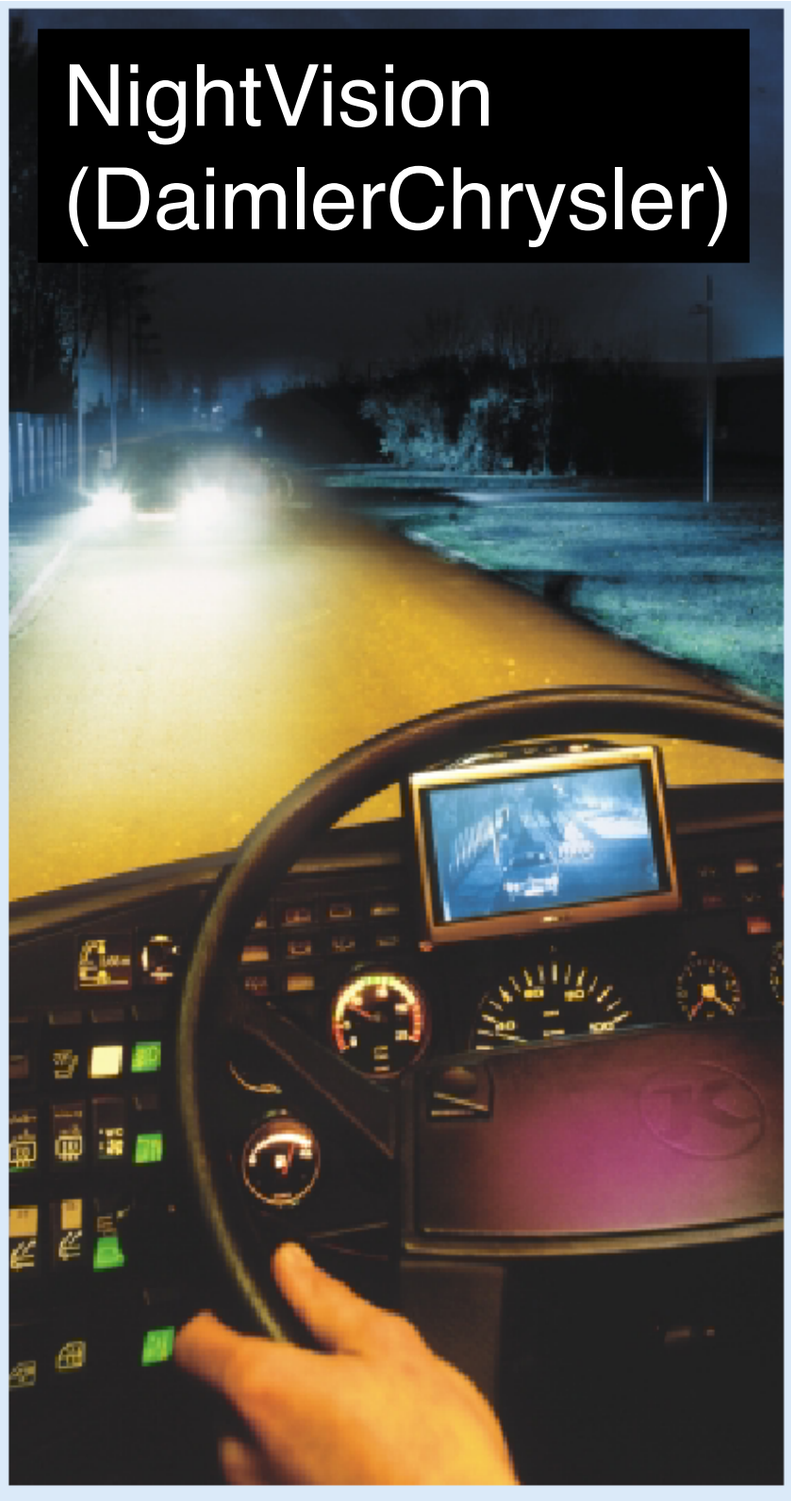
- High resolution imaging
  - Merge different perspectives into one image
  - Compose very large images out of small ones

- Wearable Face-Recognizer :
  - Recognition of faces
  - Use online and local databases
  - On positive match:
    - Tag and track person
    - Add more information (address, email, etc..)

Enhancing perception

- Reading aids
  - Strong enhancement of focus
  - Edge detection
  - Light enhancement



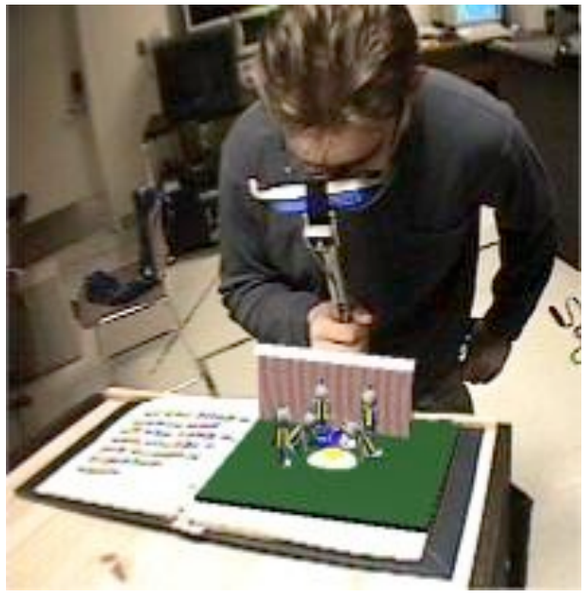


Milgrams Virtuality Continuum

- Milgram & Kishino: *A taxonomy of mixed reality visual displays*, IEICE Transactions on Information Systems, Vol E77-D, No.12 December 1994.
- Mixed Reality (MR) is a common term for
  - Augmented Reality – AR
  - Virtual Reality – VR

From Reality to Virtuality

Reality



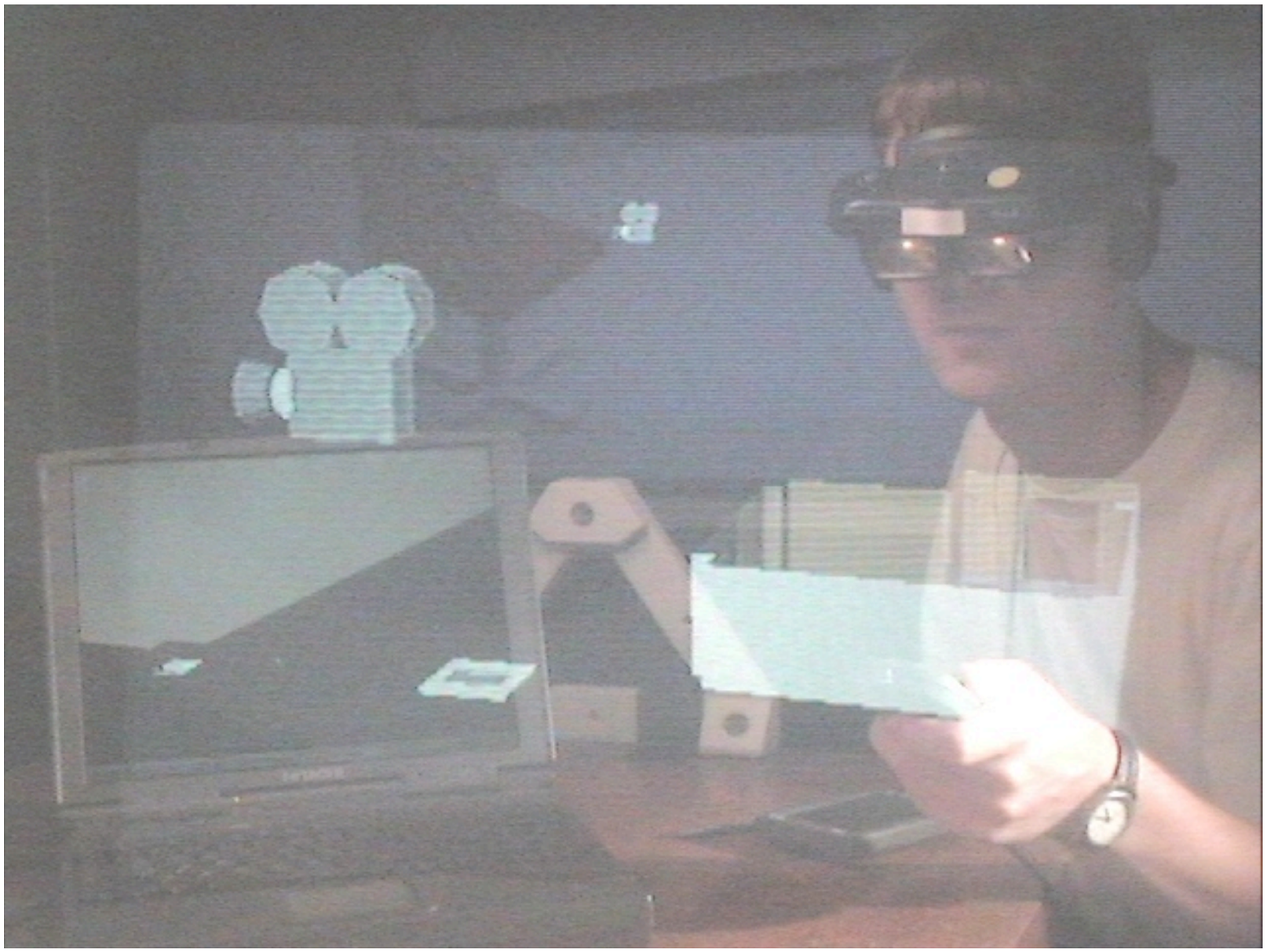
Augmented Reality – AR

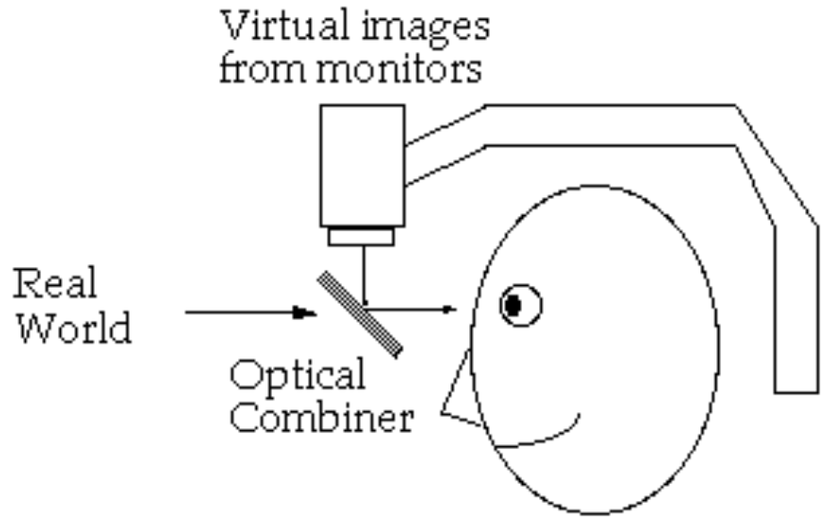
Augmented Virtuality

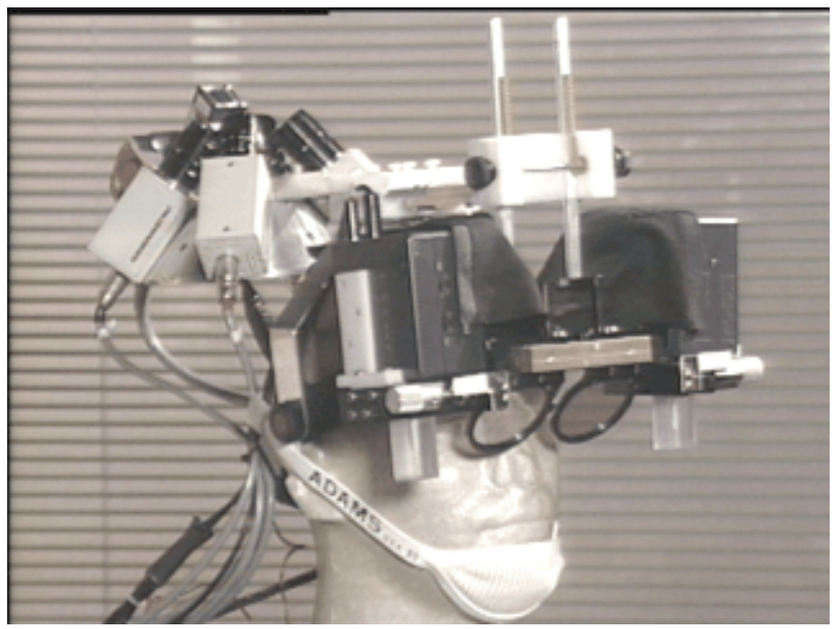
Virtual Reality – VR

[Regenbrecht et al. 2003, Billinghurst 2002]

Augmented/Mixed Reality







- See lecture next semester

Lecture summary

Class top level structure

- Intro & Motivation
- Base technologies
  - Displays
  - Sensing & Tracking
  - networking
  - HW & SW toolkits
- Interaction in IE
  - context
  - interaction styles
  - Tangible & Ambient UI
- Related fields
  - wearable computing
  - augmented reality
- Summary

Base technologies: hardware

- Displays
  - small, med, large
  - projection, steerable
  - touch screens/input
  - digital ink, e-paper
- Sensing
  - Cameras, microphones
  - RFID, NFC
  - IR, BT
- Tracking
  - Optical: markers & markerless
  - Acoustic: active & passive
  - Radio: GPS, WLAN
  - hybrid: Cricket
  - Magnetic
  - Load sensing, Floor tiles
  - Tracking Meta-techniques
    - sensor fusion
    - temporal filtering
    - Dead reckoning
- Networking
  - IR
  - WLAN/BT/custom RF
  - 1-wire bus, Pin&Play
- hardware toolkits
  - SmartIts
  - Motes
  - [...]
  - Phidgets

Base technologies: SW & modeling

- Device descriptions
  - JINI, UPNP, [...]
- Architectures
  - tuple spaces/event heap
  - (multi-) blackboards
  - pipe-and-filter
- SW architectures in research systems
  - BEACH,
  - Stanford irOS
- Context modeling
  - context toolkit
  - genius loci & numen
  - [...]

Interaction in instrum. environments

- direct physical interaction
- tangible interaction
- implicit interaction
- ambient UIs
- interface agents
- interaction models
  - strictly tool-based
  - automation, assisted living
  - proactivity, intelligent agents

Example Systems

- Xerox ParcTab
- Active Badges
- OXYGEN, i-room
- FhG Roomware
- Rekimoto Continuous work spaces
- Microsoft Research projects
- [...]

Related fields, Summary

- IE vs. wearable computing
- IE vs. AR

- Summary, hints for exam questions

- Demos of exercise projects