Wearable Computing
Past, Present and Future

Presented by Jeremiah Scholl, with help from Mikael Drugge
Overview

- Purpose
- The early days
- Definition and users
- Technology and gadgets
- Real life applications
Purpose

- Why are you here today?
  - Get introduced to wearable computing.
  - What exists, what can be done today?
  - What is the current state of the art?
  - Where are we heading?
The Early Days

“How did it start?”
In the Beginning...
This is a photography.
How do you create a scene like this?

That's what a guy named Steve Mann was also thinking about... 1970s
mdr, 2003-8-23
Steve Mann

- 1970s, pre-laptop, early computer era.
- Building computers he could wear.
- Inventor of wearable computing.
Steve Mann - Biography

- 1991: Started the "Wearable Computing Project" at MIT.
- 1995: World’s first covert wearable computer - camera and display concealed in ordinary eyeglasses.
- 1997: PhD from MIT in the field he himself had invented.
- Today, 2003: Works at University of Toronto.
Steve Mann - Evolution

- Evolution of Mann’s wearable computers.

Steve Mann’s “wearable computer” and “reality mediator” inventions of the 1970s have evolved into what looks like ordinary eyeglasses.
Mention some anecdotes about the pictures:

a) 4cm CRT monitor. Antennaes transmit video, processed at a remote location, sent back.

b) Apparatus for painting with light.

c) 1.5cm CRT monitor.

d) ...

e) Glasses with camera and display concealed. Twiddler used as input device.

Mikael Drugge, 2003-8-25
Definition and Users

“What is it and why use it?”
What is a Wearable Computer?

- Laptop?
  - ...in a backpack?
  - ...with a head-mounted display?
- PDA?
- Commercial system?
- Off-the-shelf components?
- Wrist watch?
What is a Wearable Computer?

- Wrist watch running Linux and XFree86.
- Clock and video conferencing application.

- What a wearable computer is depends on your definition...
  - But it must be wearable!
Why use Wearables?

- They are **wearable**!
  - Always with you, not as easily forgotten.

- Instant access, information anywhere.
  - Laptop requires time to prepare for use.
  - PDA requires use of both your hands.

- Wearables can become a part of you.
  - Transparent use, not just "a thing".
The question that the previous slide brings forward is rather simple - Why use wearables? What do they have to offer that other computers have?

Mikael Drugge, 2003-8-25
Who uses Wearables today?

- Technicians
  - Blueprints, etc.
- Field workers
  - Access to information given by remote experts.
- Military personnel
  - Soldiers, monitoring health, equipment, etc.
  - Maps and terrain.
  - Infrastructure (sewers, roads) in urban areas.
- Researchers
For example, in an aircraft there is limited space.
Mikael Drugge, 2003-8-25
Who will use Wearables in the future?

- Medical workers?
- Firefighters?
- Police department?
- Warehouse clerks?
- Regular people?
- You?
Medical workers. We mention this later on...

Fire fighters. Mention how it could work like.

Police department. Speculate. WLAN coverage?

Warehouse clerks. "Do we have this in store?"
Mikael Drugge, 2003-8-25
Technology and Gadgets

“What do you want to wear today?”
What do you need for a wearable computer?

- Depends, but these parts are common
  1. Head-mounted display.
  2. Camera recording view.
  3. Audio, e.g. speaker and mic.
  4. Input device, e.g. keyboard.
  5. The computer itself.
Head-mounted Display (HMD)

- Small screen, typically covering one of your eyes.
- Works like an ordinary monitor, providing an image floating in the air in front of you.
- LCD or TFT technology.
  - Used to be a real CRT in the old days.
Head-mounted Display (HMD)

- **Transparent displays**
  - Allows augmented reality, where virtual information overlaps the real world.

- **Opaque displays**
  - Less sensitive to the background noise.

- **State of the art.**
  - Smallest.
  - Advanced.
Camera

- Any small camera.
  - Ordinary web camera.
  - Custom made camera.

- Suitable placement
  - Head, follows user’s gaze.
  - Shoulder, more stable.
### Input device

- **Keyboard**
  - Canesta’s IR keyboard.
  - Arm-strapped keyboard.
  - FrogPad.
  - Twiddler chording keyboard.

- **Mouse**
  - Twiddler, again.

- **Maybe we need to use something else?**

- **BrainGate**
Input device

- **Gestures**
  - The Gesture pendant ->
    - For controlling smart homes
    - Fingers for dialing numbers
- **Voice recognition**
  - Suitable at times, but not as a generic solution for everything.
- **Multi-modal interfaces**
  - Combining several types of input, e.g. voice and gestures.
- **What else??**
Output device

- **Sight** – Visual output
  - HMD, wrist watch...

- **Hearing** – Audio/sound/speech/music.
  - Speakers, earplug/headset...

- **Touch** – Tactile feedback
  - Example: The radar vest, allowing a person to “feel” objects in the surrounding.

- **Taste and smell** – Not that common, yet.
The Computer itself

- Anything small but powerful enough!
  - Laptop or TabletPC
  - PC104 (a small PC)
  - Xybernaut
  - PDA, iPAQ, Toshiba
  - Or something else...
Network connection

- Benefits of having a network
  - Access to the Internet.
  - Communication.
- Wireless network connection
  - WaveLAN, IEEE802.11b
  - GPRS or UMTS (3G)
  - Bluetooth
  - Infra-red
Putting it all together...

- Now you have all gadgets you need.
  - But how do you connect them?

- Wires
  - Having too many wires can become rather cumbersome.
  - Solution: Integrate into the normal clothing.

- Wireless
  - Comfortable, but easier to eavesdrop on.

- Body network
  - Send signals by using your human body as a conduit.
    - Stick your finger in your ear for audio
  - E.g. a Twiddler which is only usable when in your hand.
Powering the wearable

- Power is a significant problem!
  - You don’t want to drag a power cable behind you...
  - All devices consume power.
    - Tradeoff between functionality and power.
  - Batteries never last long enough.
    - E.g. a laptop can run ~2-4 hours.
    - The Nobel Prize awaits.

- Important problem, how to solve it?
Human powered devices

- Typical power consumptions
  - Desktop computer, 100W
  - Laptop computer, 10W
  - Embedded CPU, 1W

- Human body uses ~120W.
  - We need, let’s say, 5W for a wearable.
  - What if we could tap into this power...
Human powered devices

- Examples of human power availability
  - Body heat, 0.6 – 4.8W (wetsuit clothes)
  - Breath, 0.4 – 2.5W (pressure mask)
  - Blood pressure, 0.2W (turbine)
  - Limb motion, 0.3 – 1.5W (pulleys)
  - Finger motion, 0.019W (keyboard typing)
  - Walking, 5 – 8W (shoe generator)

- Walking is the best method so far.
Commercial wearables

- Why build it yourself?
- Motorola and Frog Design’s “Offspring” concept.
  - No longer makes “mobile phones”
- Steve Mann and Siemens are also working on a product line.
- The market is still not very big.
  - Resembles the early days of personal computing.
  - Much do-it-yourself and hacking.
Our lecture so far...

- Now you should have some idea of
  - Who invented wearable computing?
  - What is a wearable computer?
  - What do you need to build one?
  - What technology exists today?

- Next big question...
  - What can it be used for?
Break...

After the break: Real life applications, research issues, enhancing your vision, buying sofas, augmented memory, a giant’s eyes, building villages, etc...
Applications and Use in Real Life

“What can be done, really?”
What can you do with a wearable computer?

- Everything a regular computer can do.
- However, the context differs.
  - You wear it and can move around.
  - The wearable computer is exposed to different environments and contexts.
  - Limitations in terms of hardware.
  - This makes a big difference...
Applications

- Mediated Reality
  - Experiencing the world through the computer.
  - Allows computer to process the sensory cues before reaching the user.
    - E.g. block commercial billboards.

- Augmented Reality
  - Overlaying virtual information on the real world.
    - E.g. allow architects to build virtual houses.
    - E.g. the AR Quake or AR Pacman game.

- Both realities can enhance your senses.
Augmented Reality Pac Man
Applications - Augmented Memory (1/2)

- Trivial example, finding your way.
  - "Where did I park my car?"
- Camera on your body records the way.
- Replay helps you find your way back.
  - Only key events need to be recorded.
  - Example: Intersections at a car park.
Applications - Augmented Memory (2/2)

- Elderly or people with poor memory.
  - Remember name and face of people.
    - Image processing can recognize a face and map it to the person’s name and affiliation.
  - How should it be presented?
Applications – Aiding the Visually Disabled (1/3)

- Some forms of low vision can not be alleviated by use of ordinary glasses.
- Solution?
Applications – Aiding the Visually Disabled (2/3)

- User wears non-transparent glasses with integrated displays, experiences the world through a camera.
- Computer processed video stream.
  - Enhance contrast.
  - Adjust colors.
  - Night vision.
  - Enlarged view.
Applications - Aiding the Visually Disabled (3/3)

- Fisheye lens for reading text.

- Remapping around blind spots.
Applications - Additional Vision Tricks (1/2)

- "Edgertonian" eyes
  - Freeze-frame effect, fast shutter.
  - This enables
    - Reading text on a tire of a speeding car.
    - Clearly seeing the rotor blades of a helicopter.
    - Counting the number of bolts holding an airplane rotor together in mid-air.
    - Plus lots of other interesting effects.
In addition to the more down-to-earth uses for enhanced vision by use of video processing...

"Edgertonian eyes", like going to Kåren and experience stroboscopic lights, sort of... But with another use for it.

Mikael Drugge, 2003-8-25
Applications – Additional Vision Tricks (2/2)

- Giant’s eyes.
  - Enhances depth perception of distant objects.
But not very practical to use in everyday life,
I guess...
Mikael Drugge, 2003-8-25
Applications – A-Life, Avalanche Rescue (1/2)

- Help rescue avalanche victims.
- Survival chance
  - 92% after 15 minutes.
  - 30% after 35 minutes.
- Time is not the only factor
  - Orientation, head up or down.
  - Air pockets, air channels.
- How can wearables help rescuers?
Say something about small town villages, how they differ compared to the Big Cities. Advantages...

The scary situations, assault, robbery, triggered by non-natural readings.

This kind of "safety vest" exists today.
Mikael Drugge, 2003-8-25
Applications - A-Life, Avalanche Rescue (2/2)

- Each victim wears a small sensor.
  - Tilt sensor
  - Heart rate
  - Blood/oxygen saturation

- iPAQ gets readings.
  - Sorts and prioritizes.

- Rescuers get advice on where to start digging.
  - Increased survival.
Say something about small town villages, how they differ compared to the Big Cities. Advantages...

The scary situations, assault, robbery, triggered by non-natural readings.

This kind of "safety vest" exists today.
Mikael Drugge, 2003-8-25
Applications - Social software

Usually designed for urban settings.
Interface to groups or individuals.

- Safety net
- Friend finder
- Familiar Strangers
Applications - Safety Net, Creating Villages in the City

- Social network of wearable users.
- Biosensors monitor user’s body.
  - Heart rate, perspiration, breath rate.
  - Alert friends in case of abnormal values.
- Example
  - Start sending video in scary situations.
- Such "safety vests" exist already.
Say something about small town villages, how they differ compared to the Big Cities. Advantages...

The scary situations, assault, robbery, triggered by non-natural readings.

This kind of "safety vest" exists today.  
Mikael Drugge, 2003-8-25
Applications – Friend finder (1/3)

- Connects people with common interests.
- Works for you automatically while you walk around and meet people.
- Imagine you want to buy a sofa…
  - Look at sellers on a bulletin board?
    - Can you really trust those people?
  - From a friend of yours?
    - Trustworthy, but may not have a sofa.
  - From a friend of a friend of a friend?
    - Well, that’s an awful lot of persons to ask… So how do you solve that?
Applications - Network of Buyers and Sellers (2/3)

- Use wearable computers!
- Buyer announces, electronically
  - “I want to buy a sofa.”
- Someone else announces
  - “I have a sofa to sell.”
- When meeting with a friend, you exchange your shopping lists.
Applications - Network of Buyers and Sellers (3/3)

X wants a sofa!

Z sells a sofa

X can now buy the sofa from Z

X wants a sofa!
Familiar strangers

- Who are familiar strangers?
  - People that “know” each other from a common location but that choose to ignore each other.

- Information about familiar strangers may help us gain information about our surroundings.
Conclusions and Summary

“What have we learnt today?”
Conclusions and Summary

- Wearable computing
  - Invented by Steve Mann in the 1970s.
- Technology
  - HMD, I/O devices, networks, power, etc.
- Applications
  - Augmented memory.
  - Mediated reality.
  - Enhanced senses.
  - Avalanche rescue.
  - Market network.
  - Health-care.
- Research issues
  - Interaction, merging with pervasive computing.
  - Much more remains...