

# Wearable Computing

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# Introduction

- Basically interactive computer systems either automate tasks or aid people carrying them out
- Wearable systems are mostly for the latter but also utilized in communication between people
- Three ways of interaction can be defined

Interaction with computer or other personal device

Interaction in an intelligent environment

Interaction with other people

# Current status

- There does not exist really wearable computers
- The most common prototype:
  - Head mounted display
  - A box shaped belt computer
  - GPS
  - Mouse or like as an input device
- "You don't wear a device, you carry it"



# Key features of a wearable system

- Eudaemonic criterion: The system is a seamless part of the user.
- Existential criterion: The locus of the control is within the user's domain and the system behaves as an extension to the user's mind and body.
- Ephemeral criterion: The system is always active when worn and the interactional and operational delays are non-existent.

# Two usage models -Tool model

- Assumes a vertical, industry or military market
- Wearable system contains one application program
- Is worn for a specific job, removed when the job is finished
- Precursor: rugged a heavily built military computer

# Two usage models - Clothing model

- Assumes to be worn all day long, clothing like
- Constant operation
- Widely-varied use; assistant in everyday activities
- Precursor: a mix of the laptop, the cellular phone and the PDA

# Two usage models - Criticism

- Simplified even if a clear application is defined
- Example: Smart clothing for the arctic environment
  - Tool integrated to the clothes :)
- Tool model:
  - System is active only when used
  - Concentrates on user interface design
- Clothing model:
  - Concentrates mainly on new approaches in HW design

# Guidelines for wearability

- Placement (where on the body it should go)
- Form language (defining the shape)
- Human movement (consider the dynamic structure)
- Proxemics (human perception of space)
- Sizing (for body size diversity)
- Attachment (fixing forms to the body)

# Guidelines for wearability, cont.

- Containment (considering what's inside the body)
- Weight (as its spread across the human body)
- Accessibility (physical access to the forms)
- Sensory interaction (for passive or active input)
- Thermal (issues of heat next to the body)
- Aesthetics (perceptual appropriateness)
- Long-term use (effects on the body and mind)

# Interaction and input devices

- Depends on application
  - Text oriented (quite rare in wearable computing)
  - Graphics oriented
- Depends on output
  - HMD
    - both hands can be used for input
  - Hand held
    - preferably one-handed operation
  - Audio only
    - both hands are free for other tasks

# Categories of input devices by application (broad)

- **Allow text entry**

Keyboards

- Conventional
- Chord
- Software

Voice

- **Allow pointing, object selection, movement**

Pointing devices

- Mouse
- Joystick
- Pen

Touchscreen

# Wearable keyboards

- **Conventional**

Effective on text input

Two-handed operation

Big -Simply reducing the size makes the keys too small and close together

- **Chord**

Only four or five keys - one or more pressed at once

One-handed operation

Extremely compact

Social resistance high

Fatigue

- **Software**

Soft buttons and touchscreen

Two-handed operation

Actual KB not needed

Another input device needed anyway



# Speech recognition

- Good for hands-occupied situations
- Recognition errors
- Restricted vocabulary of command words
- The system has to be trained
  - strong accents
  - a cold
  - emotion
  - background noise
  - confidentiality
- With wearables the environment is dynamic!

# Mouse and joystick

- **Mouse**
  - Familiar to the users
  - One-handed operation
  - Conventional mouse SITS ON THE DESK -> Trackball better with wearables
  - Trackball requires no additional space, but long movements are difficult
  - Mouse is easily integrated into the clothes
- **Joystick**
  - Takes up very little space
  - One-handed operation
  - Inexpensive, robust
  - At least belt mounted joysticks used in wearable systems



# Pen input in wearable computing

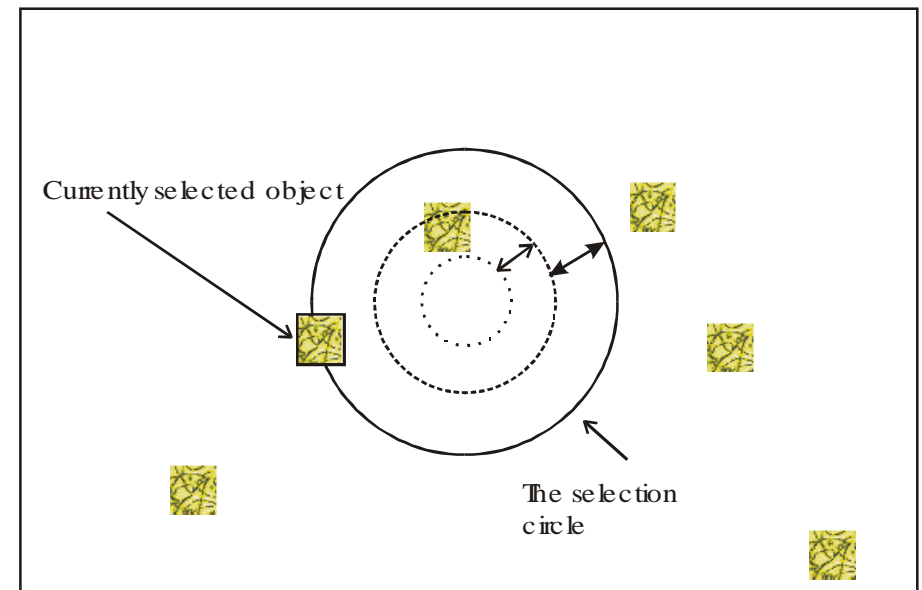
- Intuitive and simple way of interacting
- Two-handed operation
- Small and easy to use
- Approach does not have to be altered when moved from text input to sketching diagrams
- Inaccurate (mistakes in recognizing letters)
- Limitation on speed

# Evaluation of input mechanisms

- An experiment investigating the functionality and usability of three input devices on a wearable computer
  - Forearm mounted KB
  - Virtual (soft) KB
  - Chord KB (Twiddler)
- Twelve subjects, three weeks
- Icon manipulation, text entry and file save
- After six hours all devices familiar to the users
- The forearm KB fastest (all tasks)
- Improvements in the input device performance would require the design of more suitable graphical use interfaces

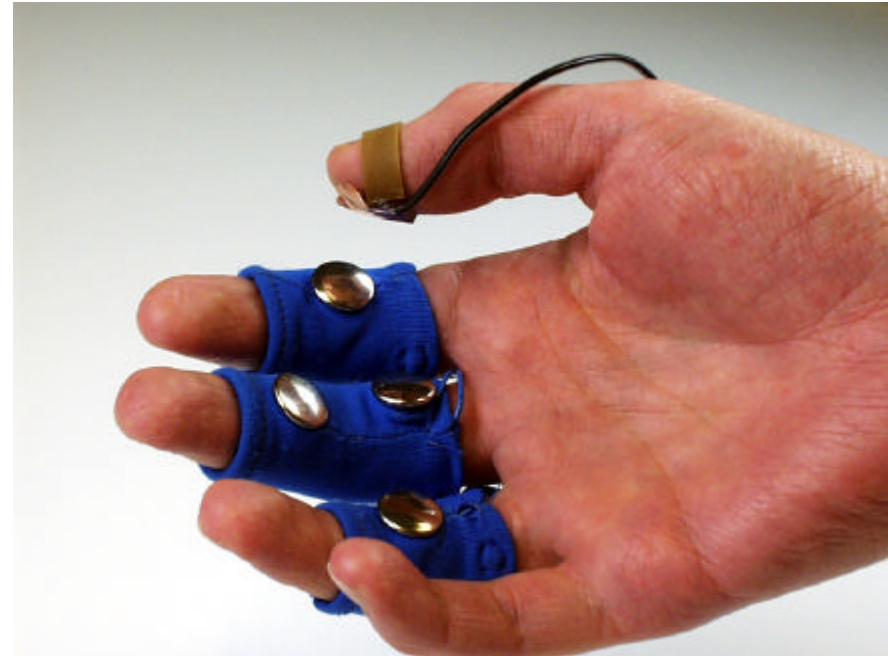
# Our examples: 1D selection

- An object is selected from two dimensional screen by using one dimensional interaction technique
- Based on circular representation: the user may change the radius of the circle
- Object lying under the arc of the circle can be selected
- 1D is easier to control than 2D
- Can be used for instance in map applications



# Our examples: N-fingers

- Buttons in forefinger, middle finger and ring finger are pressed by thumb
- Usability studies showed that this interaction technique is faster in cursor control than the conventional keyboard
- Paper submitted to 'Interacting with computers', will be published in this year



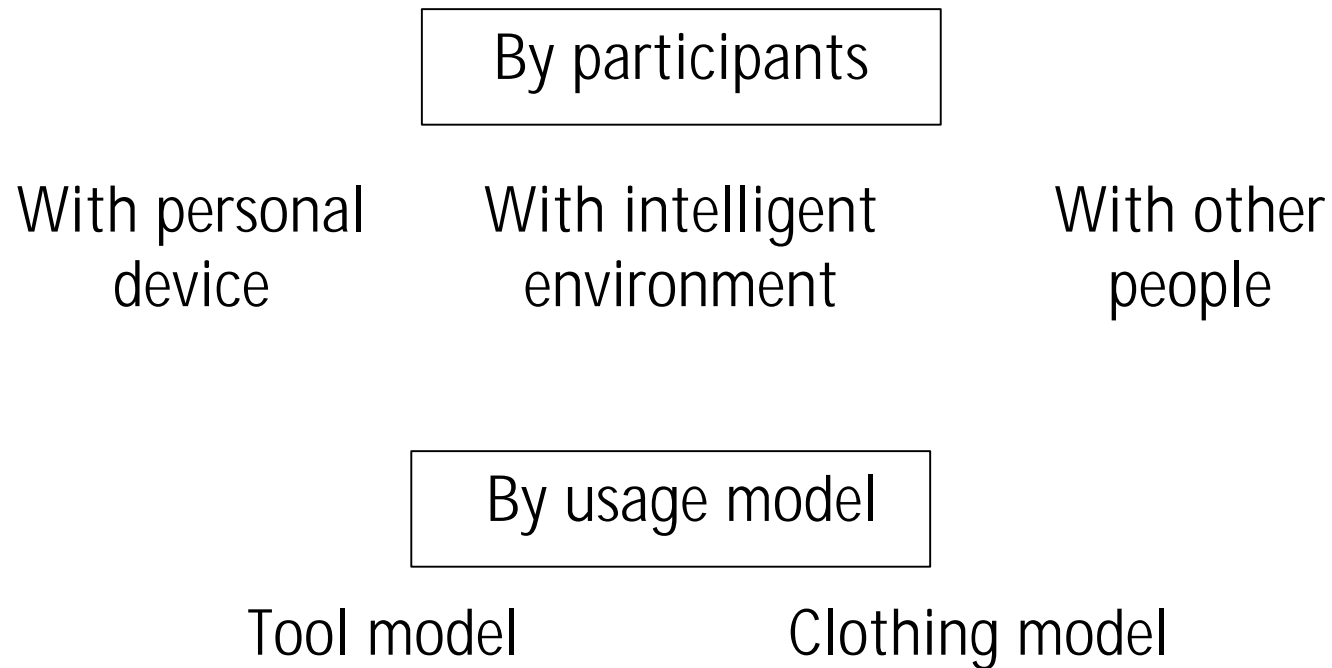
# Our examples: Context compass

- Is used with HMD equipped wearable computer
- The point of interest is selected by turning the head (The activation is button controlled)
- The compass on the screen shows the objects belonging the current context
- Usability studies conducted



# Summary

- Interaction classification



# Summary

- Input device classification

By application

Text oriented

Graphics oriented

By output

HMD

Hand held

Audio only

# Summary

- Interaction with wearable **personal device**, **intelligent environment** utilized with that device and wearable aided **communication with other people** should be:

natural and intuitive

socially acceptable

fashionable

# References

- This lecture is primary based on the proceedings of the International symposium on wearable computers, especially on following papers / presentations
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