

UbiCom Book Slides

Chapter 5 Human Computer Interaction

HCI: Overview

This part (a) first discusses:

- What is Human Computer Interaction or Interfaces (HCI) and why we need good HCI for human interactive systems?
- What is a sub-type of HCI, implicit HCI (iHCI), how is it differentiated from conventional explicit HCI (eHCI) and why do we need this to enhance pervasive computing?
- How to use eHCI in some common types of device?
- How to use iHCI in (mobile and static) devices that are not permanently attached to humans?
- How to use iHCI in (mobile and static) devices that accompany humans through being surface-mounted (wearable) or embedded (implants)

Chapter 5 Related Links

- iHCI is a type of context-awareness for the human environment (Chapter 7)
- Human behaviour models of intelligence (Chapter 8)
- Social & other consequences of making devices more human and more intelligent (Chapter 12)

HCI: Overview

The slides for this chapter are also expanded and split into several parts in the full pack

Part A: eHCI Use in some common smart device types

Part B iHCI for accompanied smart devices

Part C: iHCI for wearable & implanted smart devices

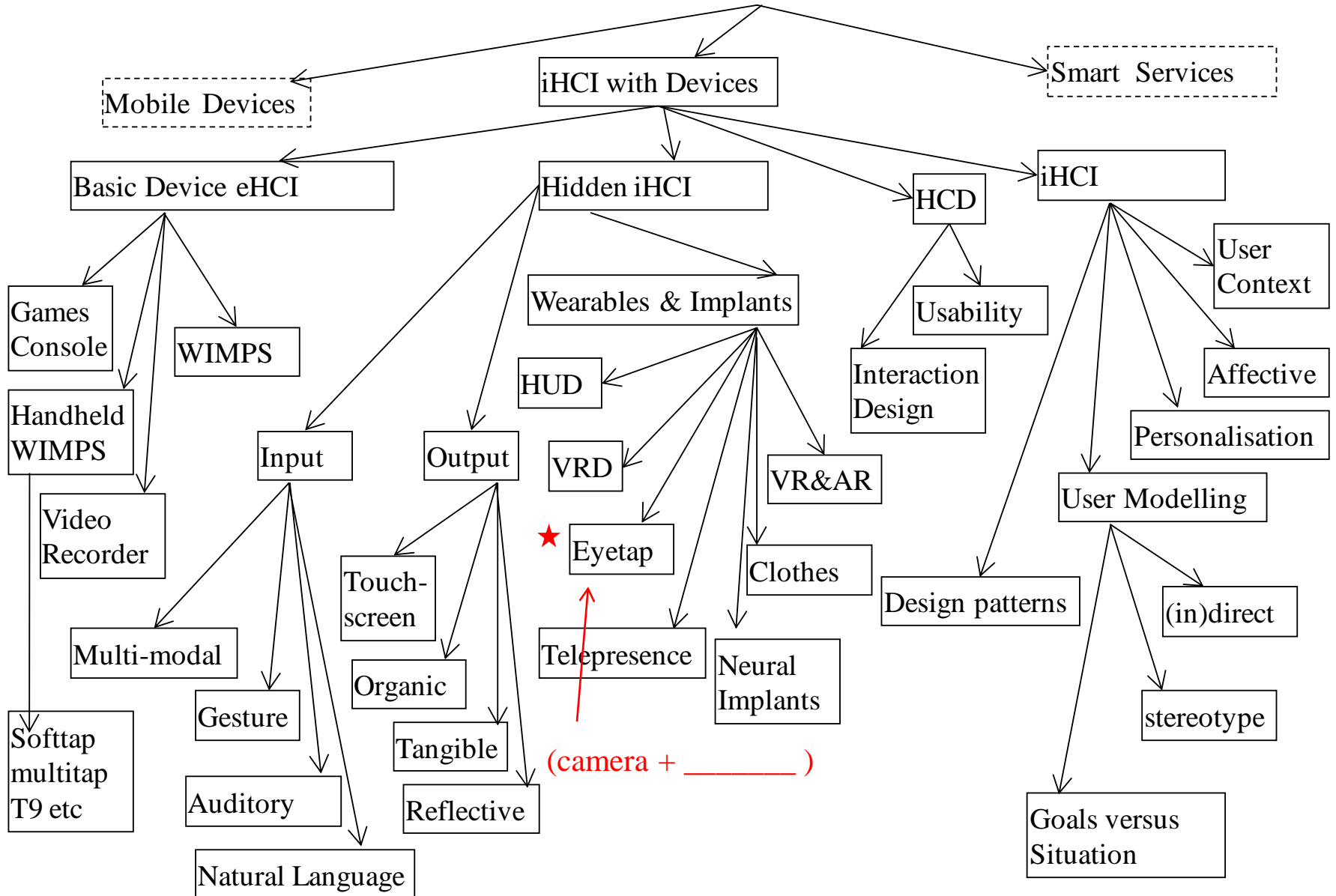
Part D: Human Centred Design

Part E: User Models and iHCI Design

HCI: Overview

- **HCI, eHCI & iHCI** ✓
- eHCI use in 4 Widely Used Devices
- iHCI use in accompanied smart devices
- iHCI use in wearable and implanted smart devices
- Human Centred Design (HCD)
- User Models: Acquisition & Representation
- iHCI Design

Smart Devices



HCI: Introduction

- Term HCI, widely used, since onset of Personal Computing era in 1980s.
- However groundwork for field of HCI started earlier, during onset of the industrial revolution
- Tasks became automated and powered-assisted
- -> triggers an interest in studying human-machine interaction
- Some tasks require little human interaction during operation, e.g., clothes-, dish- washing etc
- Other tasks are very interactive, e.g., face washing, playing the violin, etc

H,C & I

Basic concepts of HCI are:

- Humans: single or multiple with diverse physical and _____ abilities, interacting cooperatively or _____
- Computers/devices: PC and computing devices including dust, tabs, pad, and board
- Interaction: via _____ or manipulation of virtual objects (windows), or _____ interaction such as speech and gesture

HCI: Motivation

- Machines (systems) aid human performance, but systems that interact poorly with humans will be a poor human aid.
- Need design models & process that are (user) interactive
- The motivation for HCI is clear; to support more effective use (Dix, 2004a) in three ways
 - *Useful*: accomplish a task that the _____ requires to be done (_____)
 - *Usable*: do the task easily, naturally, _____ (_____)
 - *Be used*: enrich the user experience by making it attractive, engaging, _____ (_____)

HCI: Usability vs. Usefulness

- Success of a product depends largely on ?
The user's experience with how _____ and how _____ it is
- Summarised as Heckel's law and Heckel's inverse law:
 - *Heckel's law*: the quality of the user interface of an appliance is relatively unimportant for its adoption if the perceived value is _____
 - *Heckel's inverse law*: the importance of the user interface of an appliance for its adoption is _____ proportional to the perceived value
- What this law expresses ?
Although the _____ of the UI is important, the overriding concern is the _____ of the device itself

Explicit HCI (eHCI)

- eHCI design: explicit interaction during a device's normal operation.
- What are the Dominant eHCI Uis? _____

Pure eHCI

- Context-free
 - users must repeat and _____ same application access every session even if every session repeats itself
- Focus on H2C (Human-to-Computer) Interaction
 - the focus is on the human having _____ of the system (a mental _____) rather than the system having a _____ of individual user

eHCI versus Natural Interaction

- Natural interaction
 - human uses _____ to interface with artifacts rather than via some tools
- Natural interaction and familiarity and expertise
- Familiarity with use of tool is cultural and subjective
 - If familiar with tools, via tool is more natural such as writing text using a _____ instead of with a pen
- Note also Natural Interaction linked to use of iHCI
 - Clapping hand to turn a light can be misunderstood with clapping for showing an _____

iHCI

- Concept of implicit HCI (iHCI)
- Proposed by Schmidt (2000)
 - Defined as “an action, performed by the user that is not primarily aimed to interact with a computerized system but which such a system understands as input”.
- Our definition of iHCI bit different:
 - inputs with an implicit or implied context,

iHCI

- iHCI is more about C2H (Computer to Human) Interaction
- iHCI assumes a certain Model of H user
- Model of H used as additional input
- Need to share implicit context between human and system
- Implicit interaction naturally supports hidden device design.
- Implicit interaction requires that the computer has a certain understanding of user's behavior in a given _____, which is an additional _____

eHCI + iHCI or iHCI vs eHCI

- E.g. A person entering a dark room for getting an object and needs to turn on the light
- eHCI, usability design?
 - locate the switch reachable and _____ it
- Alternative iHCI design?
 - turn on the light _____ by sensing the existence
- Shift from eHCI design to also include iHCI design will be a key enabler for effective UbiCom systems

iHCI: Challenges

- Complex to accurately and reliably determine user context.
Why? Because of
 - _____ of the user and environment
 - _____ inference of user behavior
 - time required to build an accurate _____ of the user

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How Device Interfaces & Interaction Varies

Devices can be characterized according to?

- _____ and _____

UI and HCI Designs for 4 Common Devices

- PC
 - Mobile Phone
 - Games Console but many sub-types
 - TV / Projectors
-
- How does the UI and HCI design differ between these?

UI Type: Personal Computer Interface

- Windows: 1945 by Bush, MEMEX system
- 80's: command _____ UI
- 90's: WIMPS (Windows, _____, _____, and _____ device) and direct manipulation interface
- Adv of WIMPS: the order of multiple commands can be more ad hoc and no need of _____ing the command

PC UI use in Mobiles

- Using a conventional PC UI approach won't be optimum for mobile computing & ubiquitous computing - need a different approach, Why? Because
 - the display area is _____, disallowing several _____ and difficult to put and locate windows and _____

UI Type: Mobile Device Interfaces

- PC / WIMPS models not so suitable for mobile (one handed) devices, Why not?
 - Instead of inbuilt device _____, the device can be attached to different kinds of external input _____ available in the environment such as displays, keyboards, and internet at fixed hotspots to which user can _____ in their mobile devices

Mobile Device Interface: Limited I/P

How to support mobile user and small size of input?

- Pressing same key multiple times leads to different input (_____ keypad)
- Dictionary-based _____ text method (T9)
- Fastap keypad: smaller key (for alphanumeric) raised at the _____ of a key (for numeric)
- _____ key: meaning of one left and one right key at the top of keypad to be determined by info on the screen
- Internal _____ device: tracker pad, roller pad, mini-joystick, arrow key
- Auditory interface: _____ recognition

Mobile Device Interface: Limited O/P

How to overcome limited output?

- Haptic interface use, e.g., vibration to signal incoming call
 - Vibration can _____ to denote different info
- Maximising use of small screen: _____, switching screen
- _____ displays
 - uses _____ to act as a tangible UI, which determine the _____ of the device in relation to the user, and display different information according to it
- Foldable displays
 - using _____ display
- Filter information so receive and display _____ information, e.g., using Personalisation(Chapter 7) Personal Agents (Chapter 8)

UI Type: Games Console Interfaces

- Games consoles: an important driver and can contribute to UbiCom in a number of ways.
- Computer games have often acted as an incubator for many innovations driving computing. How?
 - In 1971, computer had no monitor but punch card, paper tape. For game console, TV monitor was used, which later became computer monitor
- Many different types of Games Console Interface
 - 8 generations of console: currently 8th (2012-) with _____, one handed wireless wand-type console; 3rd (1983-2003) is _____

Games Console Interfaces: D-pad

- How does the D-pad controller work?
 - 1980, 8-direction D-pad, four-way digital cross, two or more action button, thumbstick for 2D input

Games Console Interfaces: 3D Gesture-Based

- How does the 3D Gesture-Based controller work?
 - Containing micro-sensor for _____ and _____ detector to sense 3D position
- Use of MEMS/ Sensors (Chapter 7)
- Use of gesture recognition (see later)

UI Type: Control (Panel) Interfaces

- Different Types of remote controllers depending on how remote the controller is:
- User approx. co-located with device being controlled
 - Like _____
- User not co-located with device being Controlled
 - Like _____

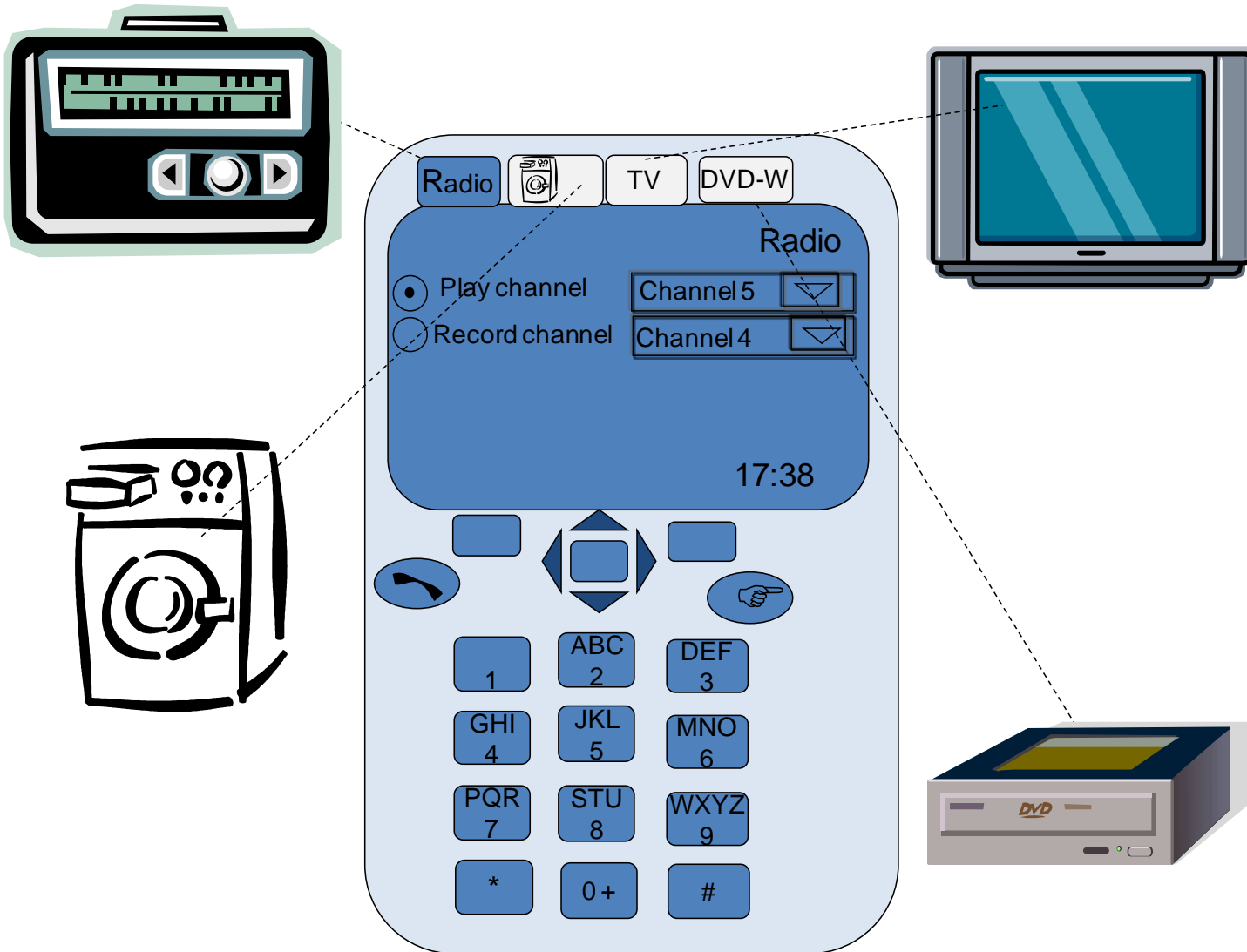
UI Type: Localised Remote Control Interfaces

Characteristics

- Input controller and device separation
- Input device interfaces
- Wireless link between input control device and device

UI Type: Localised Remote Control Interfaces

- But profusion of remote control devices which have overlapping features
- Is it necessary to have a specialised controller per consumer device?
- Problems?
 - cumbersome for handling _____ controllers
 - _____ing control
- How to solve this?
 - _____ controller, networked devices



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iHCI use in Accompanied Smart Devices: Topics

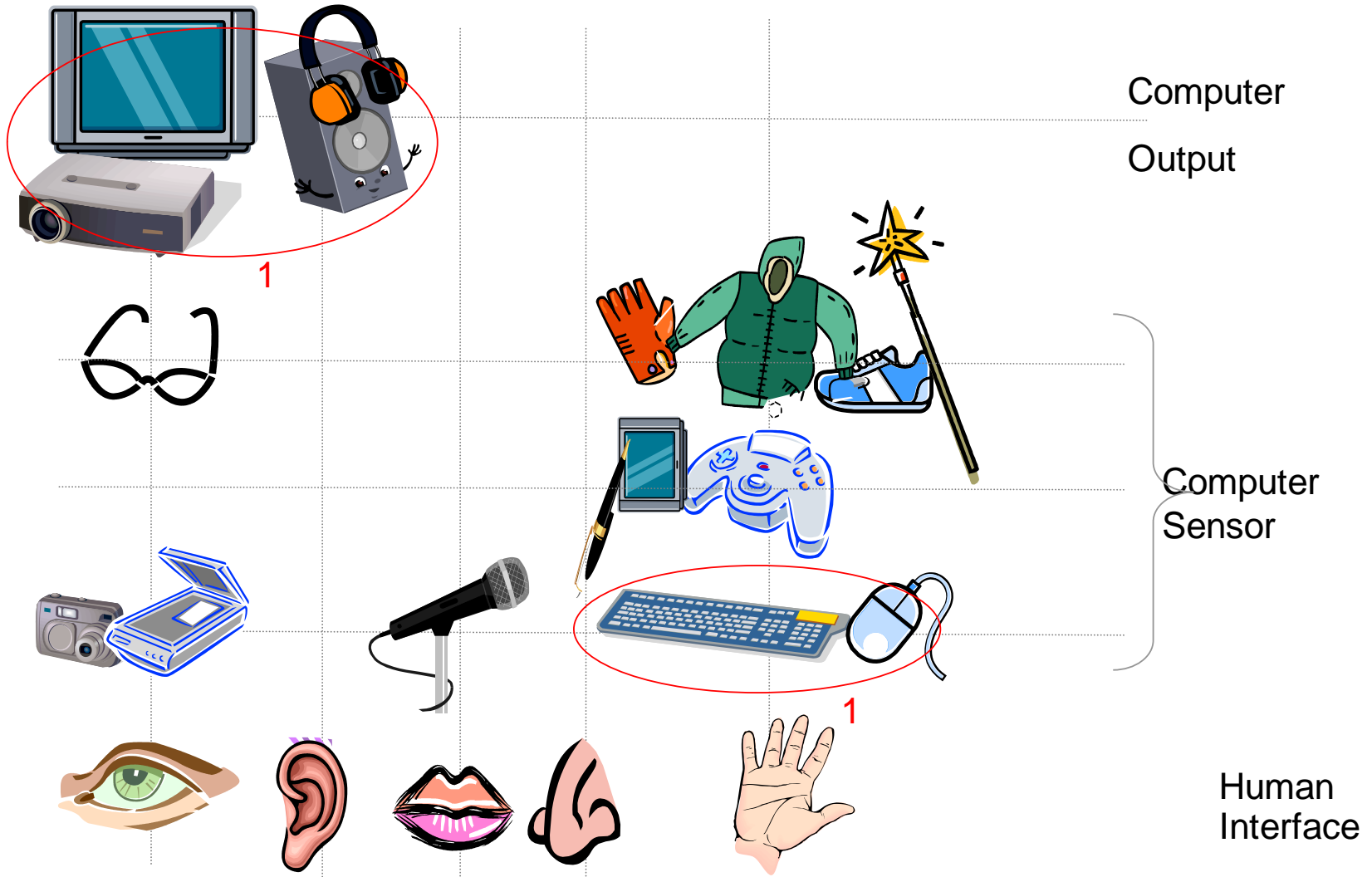
- Single vs. Multi-Modal Visual Interfaces
- Gesture Interfaces
- Reflective versus Active Displays
- Combining Input and Output User Interfaces
 - ???
- Auditory Interfaces
- Natural Language Interfaces

Single vs. Multi-Modal Visual Interfaces

- Mode of human interaction uses human senses? Which?
 - Sight, touch, hearing, smell, _____

- Interactive ICT systems have modalities that mimic human senses. What?
 - _____ (sight), _____ and pointer (touch, haptic), _____ (hearing), _____ sensor (smell, taste)

Computer input & output modalities



Single vs. Multi-Modal Visual Interfaces

- Many interactive ICT systems use single visual mode of output interaction. Problems?
 - _____ human as the world becomes more digitally interactive
- Solutions?
 - _____ sensory channels to increase the _____

Multi-Modal Interaction Design: challenges

- Integrating multiple modes is complex. Why?
 - Because the signals are in _____ forms and fused at different levels such as data, feature, and decision

Multi-Modal Interaction: Design

Two main approaches

- Data for each modality can be processed separately, then combined at the end.
 - Not good since human often employs individual modalities which are _____ and _____
- Data for each modality can be processed & combined concurrently
 - The signals need to be processed in a joint _____ space

Gesture Interfaces

What are *Gestures*?

- Expressive, meaningful body motions
- Involving physical movements. Which?
 - _____; hand and arm; head and face; _____
- With the intent of conveying meaningful information about interacting with the environment.

Gesture Interfaces

- What are the main types of human gestures?
 - hand and arm; head and face; body
- How can gestures be sensed?
 - _____ device like glove or body suits
 - attaching _____ (accelerometer, gyroscope) to the body
 - camera and computer _____ tech
 - _____ to support telepresence and telecontrol

Gesture Interfaces: Classification

Gestures can also be classified into

- 2D versus 3D
 - 2D: _____-sensitive planar surface
 - 3D: _____ device with accelerometer, gyroscope
- Contactful versus Contactless
- Directly sensed versus indirectly sensed

Gesture Interfaces: Applications

- 1st basic contact based gesture interfaces?
 - pen-based using light-pen in 60's
 - Apple Newton PDA (1992)
- From the mid 2000s, contact less gestures being used in several types of games consoles, mobile phones, cameras, etc.

Gesture Interfaces: Applications

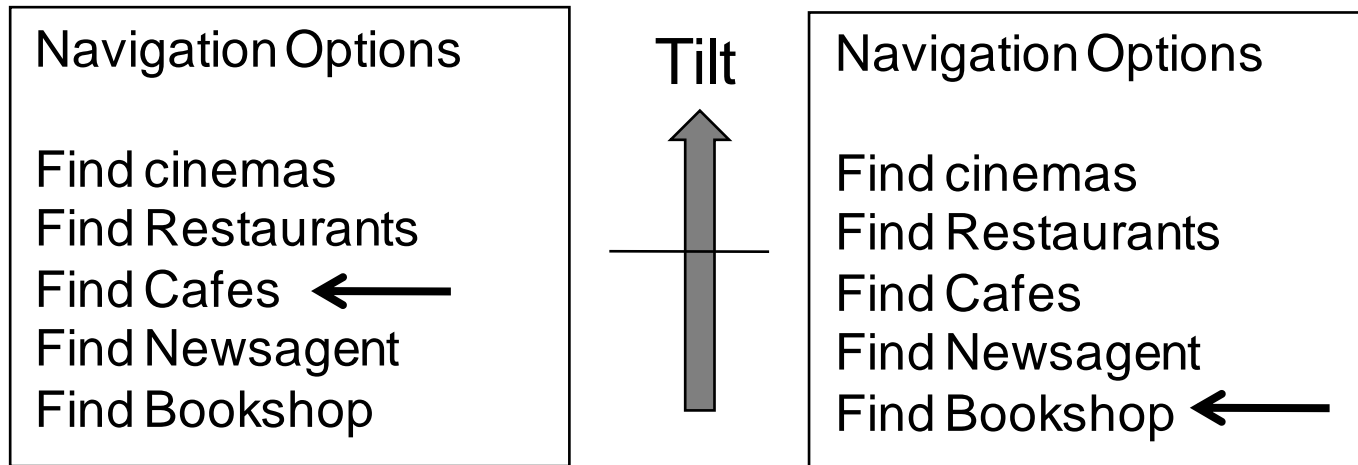
- 1st basic contact based gesture interfaces?
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Gesture Interfaces: Applications



Gesture: Rotate or flip hand
Action: Rotate or flip image

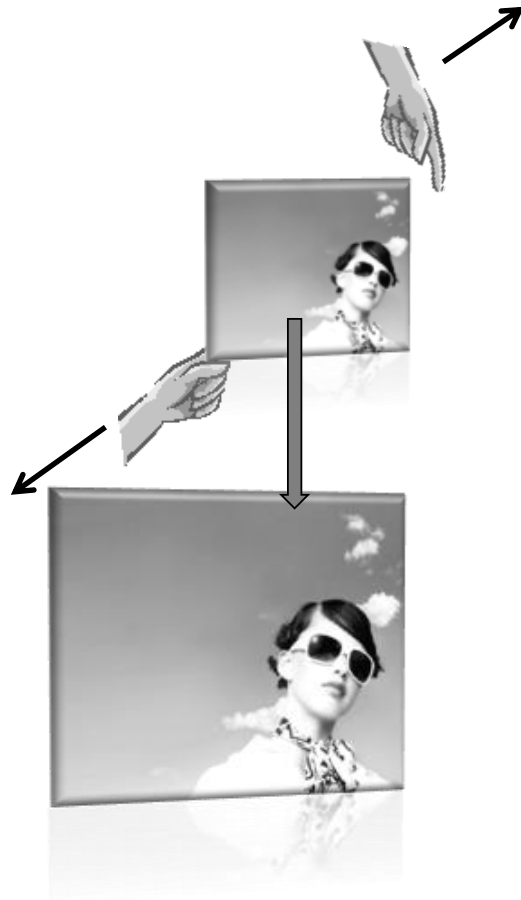
Gesture Interfaces: Applications



Gesture: tilt display away

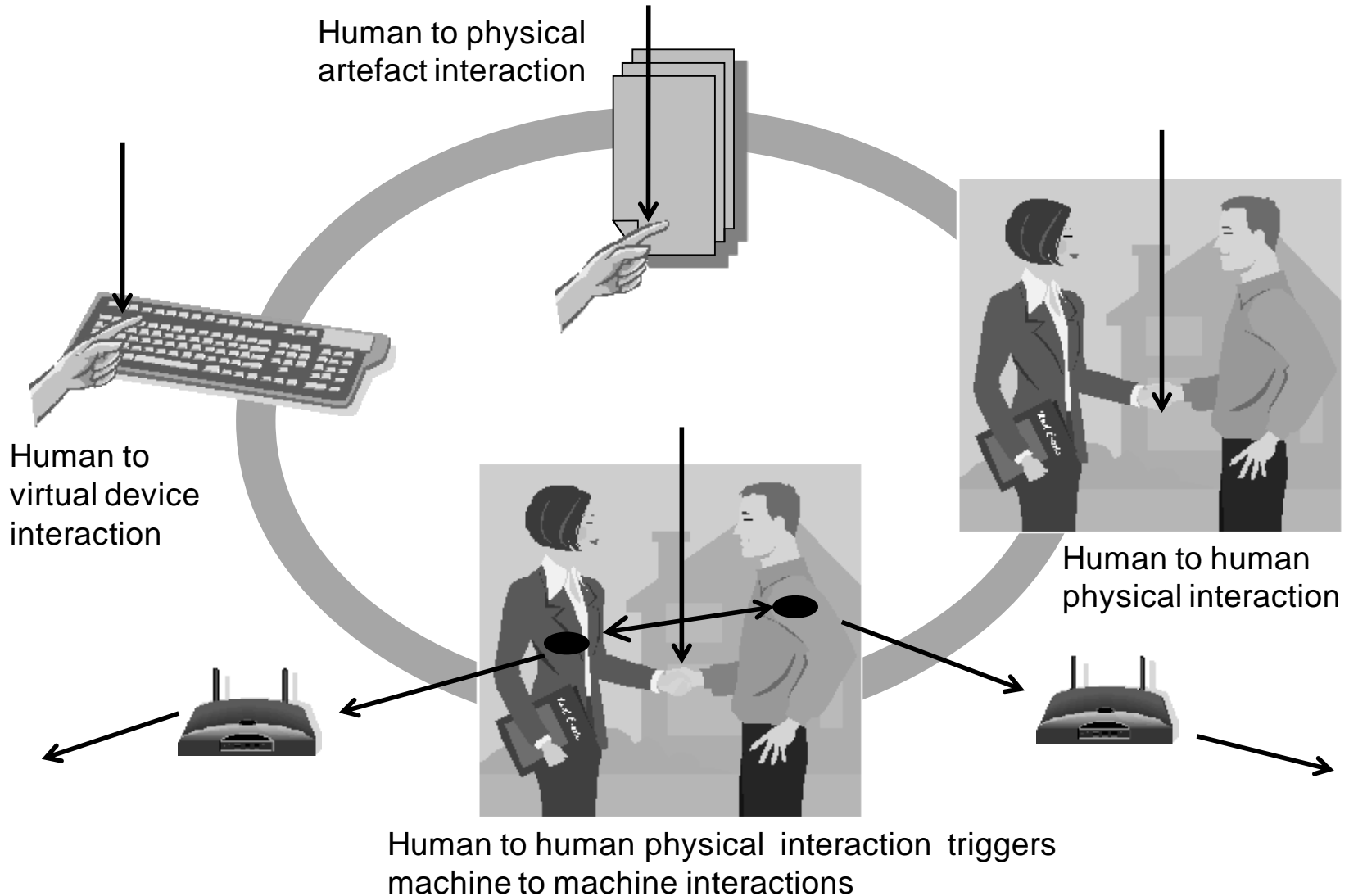
Action: Menu selection moves up

Gesture Interfaces: Applications



Gesture: Two finger stretch
Action: Stretch image

Gesture Interfaces: HCI->HPI->HHI->HCI



Gesture Design: Challenges

- How the ICT system recognizes, classifies, defines the start/end of gesture and binds it with _____ objects (many-to-many mapping)
- Gesture is static (holding palm in a vertical position) or dynamic (horizontal cutting motion)
- Ambiguous and vary _____
- Solution for ambiguity, uncertainty, and variability of gesture
 - model with Hidden Markov Chain and _____ logic, but this causes _____ between gesture and its recognition
 - recognize each _____ of gesture as it happens by computing competitive differential observation prob (CDOP), the difference of observation prob between the gesture and non-gesture
- Gesture input is too _____