Intelligent Human Computer Interaction

HCI2 SoSe 2011

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Augmented Vision

- Novel solutions for visual interfaces
- Technology provider for the fields of
  - 3D real-time graphics
    - Human-centered visualization
    - Virtual and augmented reality
  - 3D computer vision & sensor interpretation
    - Tracking and scene reconstruction
    - User monitoring
- Various application domains
  - Virtual Engineering
  - Ambient Assisted Living (User monitoring)
  - Safety and Security
Some practical issues

Course outline – positioning within the field of HCI

Current trends / challenges

Preview of several topics of the lectures
Some questions…?

- You all heard the lectures
  - HCI
  - Computer Graphics

- Exercices
  - Do you have basics in Matlab?
4 ECTS credits

= 120h of work
Policies

- **Grading**
  - Only the final exam counts

- **Languages**
  - Written materials: German (except the introduction)
  - Lectures, discussions: German

- **Exam material**
  - Exam covers lectures and homework
  - Language is German
There is no textbook
- there will be some reading assignments
- go to the library once in a while

Course requires you to do literature research
- the exam will cover the material of the lectures and the exercises (incl. reading assignment)
- Look for additional material you research yourself
- you are responsible for selecting reliable sources
- ask in exercise-session when in doubt
Exercises & information

- [http://av.dfki.de](http://av.dfki.de) → Lecture → IHCI

- Exercise
  - Slot:
    - Room and time: 32/411
    - Tuesday: 15:30-17:00 (as required)

- Matlab as base tool
- Four large exercises
- Exercises are mandatory
4 exercise sheets in total

First exercise sheet (regarding Matlab) will be handed out on 10.05. (Deadline: 17.05.)
Afterwards a schedule of 2 weeks per exercise sheet is planned

You have to submit the exercise sheets for being allowed to take part in the exam

Exercises will not be corrected but solutions will be presented within the exercise sessions (check online – first session is: 24.05.2011)

Implementation will be in Matlab

SCI / RHRK account is therefore useful / necessary
Course outline
You heard lecture: Human Computer Interaction (Bachelor)

- Design Principles and Evaluation
  - Simplicity (reduce, organize, time, learn...)
- The Human
  - Senses: Eye, Touch/Haptic, Audio, Taste, Movements
- The Computer
  - Input devices, displays, keyboard systems...
- The Interaction
  - Human-Centered Design
  - Design Cycles (user task analysis, design, implementation, evaluation)
  - Interaction technologies (tracking and interaction devices)
HCI is a very broad topic !!!

At the crossing of
- Computer science
- Behavioral and cognitive science
- Design
- ...

Many views and interpretations of HCI
HCI in this course

- Definition of ACM:

  “Human-computer interaction is a discipline concerned with the design, evaluation and implementation of interactive computing systems for human use and with the study of major phenomena surrounding them.”

  ACM: Association for Computing Machinery
Application areas and scenarios

- Industry Design („hardware“)
  - Information systems, Navigation systems
- Internet
  - Web-sites, E-Commerce, Web Applications
- Software
  - Operating system, Desktop applications, Mobile applications, Computer games
Many concepts

Choice of the right *input and output* interface:
IHCI: many disciplines

Input channel

### Machine
- Sensory
- Signal processing
- Computer graphics
- Operating systems
- Programming language
- …

### Human
- Communication theory
- Graphic and industrial design disciplines
- Linguistics
- Social sciences
- Cognitive psychology
- Human performance analysis

Output channel
HCI in this course

- Measure capacity of the HC channel
  - Visual perception
    - Color
    - Forms
    - 3D Geometry
  - Sensory motor action
    - Interaction device
    - Motion and interaction

See Fitts’s law: application of Shannon information theory to human performance
More over, this course is about „Intelligent Human Computer Interaction“

- Intelligent in the sense that the machine interprets the human action and generates the correct answer.

- Intelligent interfaces:
  - Sensor + signal processing
  - Mathematical model + algorithms (learning, decision making…)
  - Display / Actuactors
Perceive – Reason - Act

Perceive
- Sensor processing

Reason
- Reasoning / Adaptation

Act
- Rendering

Sensor Data

Domain spaces
- Health care
- Consumer
- Machinery

Information

Action
Plan of the lectures

- Go in depth in the areas of
  - Visual Color Perception
    - Human color perception
    - Color models
  - Motion and Interaction: Advanced Interaction Devices
    - Basic: Fitts’s Law
    - Image-based hand detection
    - Visual-inertial technology (e.g. Wii)
    - Interaction devices & multi-touch displays
  - 3D Geometry Perception
    - Augmented reality as application field
    - Basics: ar-devices, displays, ar-system architecture
    - 3D geometry & camera modelling
    - Tracking technologies
We do not cover “design” much
- university, not trade school
- design is better taught in a hands-on lab course
- principles lay the foundation for understanding design

No history of HCI and computer interfaces
- WIMP, Window, Mouse…
  → Refer to the first HCI course
Why ICHI?
Moore’s Law

- Double performance every 18 months

- What the law really tells:
  - Computer are becoming
    - Faster
    - More powerful
    - Cheaper
  - More data is processed and available than in the past
Cognitive capacity of the human brain keeps constant…\(\rightarrow\) cognitive load!
More than 20 years ago…

- What almost not changed:
  - WIMP
    - Windows
    - Icons
    - Menues
    - Pointer
  - Screen size (higher…)

Paradigm change
Current trends

- Pervasive / Ubiquitous / Ambient Computing
  - Hardware development
    - Decreasing hardware costs
    - Miniaturization of hardware
    - Reduction in power requirements
  - Ubiquitous communication
  - Mass availability of computer graphics
  - Mixed media
  - Large and thin displays (digital signage)
  - Embedded computation
  - Virtual and Augmented reality
Ubiquitous[/pervasive] computing (ubicomp) is a post-desktop model of human-computer interaction in which information processing has been thoroughly integrated into everyday objects and activities. In the course of ordinary activities, someone "using" ubiquitous computing engages many computational devices and systems simultaneously, and may not necessarily even be aware that they are doing so. This model is in an advancement from the desktop paradigm.

This paradigm is also described as pervasive computing, ambient intelligence […]. When primarily concerning the objects involved, it is also physical computing, the Internet of Things [].

Ambient intelligence refers to the presence of a digital environment that is sensitive, adaptive, and responsive to the presence of people. Within a home environment, ambient intelligence will improve the quality of life of people by creating the desired atmosphere and functionality via intelligent, personalized inter-connected systems and services.

Ambient intelligence can be characterized by the following basic elements:

- Ubiquity
- Transparency (invisible, in background), and
- Intelligence

(www.philips.research.com)
Central technologies

- Output: Displays + graphics
- Input: the sensors
  - Touch-technology
  - Cameras
  - Miniature Inertial sensors (MEMS = Micro-Electro-Mechanical System)
Digital signage is a form of electronic display that shows information, advertising and other messages. Digital signs (such as LCD, LED or plasma displays) can be found in public and private environments, such as retail stores and corporate buildings.

Benefits:
- Easy exchange of the content
- Animations
- The signs can adapt to the context and audience (see “soft button”)
- User can interact
Smart Objects and Environments

Localization, Communication
GPS, GSM, Loran-C, RFID

Handling of data
Flexible screen
Intelligent paper

Smart Object

Sensors
Temperature
Shock
Humidity
Image processing

Identification
RFID

Process control
Control station

Quelle: Fraunhofer IFF
Examples
Interactive Walls for interactive TV/media

Awareness: Presence and Position

Quelle: Philips/HomeLab
Preview of the lectures
Color perception & Displays
Displaying an image: an example

- Example of a standard powerwall
  - 6m screen width
  - 2560x1024 Pixel (Panorama, 2 beamers side-by-side)

- 1 Pixel is 2,3mm big (width)
- Resolution of the human eye is 0,08 mm at a distance of 3 meter
- Required resolution should be 3 times higher

Possible solution: Tiled Displays
High-Resolution displays: HEyeWall

- HEyeWall@IGD:
  - 6 x 3 meter stereoprojection
  - 6 x 4 stereo images (1024 x 768 each)
  - 48 projectors
  - PC-Cluster (48 PCs)
  - 6144 x 3096 Pixel!
  - Very high brightness
  - At 0.5 m distance single pixels will not be visible anymore
High-Resolution displays: HEyeWall
This is a black image…
Example: Intra-projector calibration

- Falloff 25%
- Mid-Gray image
- Falloff 1,2%
Color and display calibration

- Inter-projector Calibration
How works a multi-touch display?
How works the Kinect?

- Basic on visual sensors
Motion Sensors
Kinect uses a motion sensor that tracks your entire body

Skeletal Tracking
As you play, Kinect creates a digital skeleton of you based on depth data
Human Monitoring: Inertial Measurements

Upper body tracking
Human Measurements
Interaction in virtual environment

[Images showing interaction with a virtual environment and data points on a graph]
Virtuality continuum (Paul Milgram)

Several classes of existing hybrid display environments can be found, which could reasonably be considered to constitute MR interfaces according to the ‘virtuality continuum’
Virtual Reality

Properties
- Real-time
- Interactivity
- Immersion
- Multi-modal Interaction

Immersion:
- The sensation of being part of the virtual world
Augmented Reality (AR): Basics

real

virtual

real

virtual
Augmented Vision: Maintenance

Demo 1 - Demo 1
Head-up display
What is a camera?

- Camera

- 3D → 2D projection
Fundamentals

Input video → Pattern recognition → Calculate 3D camera position & orientation → Registration of 3D virtual objects → Synthesis and render on input video
Augmented Reality for maintenance
Augmented reality / tracking
Mobile hand-held AR
AR & culture: ArcheoGUIDE

Philippeion

Zeus

Heraion
How did Olympia look like?
AR & hand interaction
Thank you for your attention!!
&
Next week:
Modelling of PC-interaction