Current Topics in Media Computing and HCI

Prof. Dr. Jan Borchers
Media Computing Group
RWTH Aachen University
Summer Semester 2015

http://hci.rwth-aachen.de/cthci
Goals

• Understand **ways to do research in HCI**

• Practice how to **retrieve** and **evaluate** information from the literature
  ⇒ Preparation for thesis and future research work

• Learn about **up-to-date developments** in Human–Computer Interaction and interactive multimedia from new books and recent conference/journal articles
Topics for 2015

• Research literacy (3.5 weeks)
  • Understanding HCI research approaches
  • Experimental research and user study protocol (case study: text entry techniques)
  • Statistics in HCI research (case study: midair input techniques)
  • Publication and peer-review process

• Research topics (7.5 weeks)
  • Research in coding and IDEs
  • Touch and tangibles on large interactive surfaces
  • Augmented reality in HCI
  • Gestural and stroke input: from touch screens to midair
  • HCI design patterns
  • Interactive e-learning
  • Personal fabrication and personal design
Current Topics in Media Computing and HCI

• Audience
  • M.Sc. Computer Science
  • M.Sc. Media Informatics
  • M.Sc. Software Systems Engineering
  • B.Sc. Computer Science (extra credit / carry-over)
  • B.Sc. / M.A. Technical Communication (with focus on CS/HCI research)

• Prerequisite: DIS I
  • In our lectures, assignments, and exams we assume that you know DIS I
Literature Sources

• Recent (usually last 2 years) conference papers
  • CHI, UIST, ITS, DIS, Ubicomp,…
  • Older seminal papers included

• Recent journal articles
  • TOCHI,…
Literature Sources

• Recent books
  • Research Methods in HCI (Lazar et al., 2010)
    Recommended reading for more details about evaluation methods — especially if you are going to do your thesis at our chair!
  • Research Methods for the Behavioral Sciences (Gravetter and Forzano, 2012)
    Recommended reading for more details about experimental research methods
Administrative

- **Format:** 6 ECTS
- **Lecture:** Tuesday, 10:15–11:45
  - Presentation & discussion of research topics
  - Small group in-class exercises
  - Weekly reading assignments (individual)
- **Lab:** Thursday, 08:15–09:45
  - Practice skills learned from the lecture and discuss reading and written assignments
  - 3 written assignments (in groups)
  - 1 mini HCI research project (in groups)
- **Extra supervision slots during mini project phase by appointment**

**Active attendance in both lecture and lab expected!**
Final Grade

- 30% midterm (June 9)
- 15% 3 written assignments
- 10% mini HCI research project
- 45% final (July 28)
<table>
<thead>
<tr>
<th>Lecture date</th>
<th>Lecture topic</th>
<th>Lecture presenter</th>
<th>Lab date</th>
<th>Lab topic</th>
<th>Lab moderator</th>
<th>Reading assignment</th>
<th>Written assignment</th>
<th>Assignment logistics</th>
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<tbody>
<tr>
<td>07.04</td>
<td>(no lecture: Orientation)</td>
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<td>09.04</td>
<td>(no lab: Orientation)</td>
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<tr>
<td>14.04</td>
<td>R1: Three approaches to HCI research</td>
<td>Jan</td>
<td>16.04</td>
<td>Paper reading and identifying contribution types</td>
<td>Nur</td>
<td>Required; (Widbdoc, 2014) Seven Research Contribution Types in Human-Computer Interaction (Ginswood, n.d.) How to Read an Engineering Research Paper</td>
<td>A01: Categorizing research contributions and writing contribution statements</td>
<td>16.04</td>
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<tr>
<td>21.04</td>
<td>R2: Mechanics of experimental research and how to write a user study protocol (Case study: Text-entry techniques)</td>
<td>Nur</td>
<td>23.04</td>
<td>Literature searching and contributions &amp; benefit statement</td>
<td>Nur</td>
<td>Required; (MacKerze, 2007) Evaluation of Text Entry Techniques</td>
<td>(A01 peer feedback)</td>
<td>23.04</td>
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<tr>
<td>28.04</td>
<td>T1: Research in coding and IDEs</td>
<td>Jan-Peter</td>
<td>30.04</td>
<td>Designing experimental user studies</td>
<td>Nur</td>
<td>Required; TBO Recommended: TBO</td>
<td>A02: Reverse-engineering user study protocol</td>
<td>30.04, 28.04, 30.04</td>
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<tr>
<td>05.05</td>
<td>(no lecture: Student Representative Council Meetings)</td>
<td></td>
<td>07.05</td>
<td>• A01 discussion</td>
<td>Nur</td>
<td>Required; (McGrath, 1985) Methodology matters</td>
<td>(A02 peer feedback)</td>
<td>07.05, 06.05, 07.05</td>
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<tr>
<td>12.05</td>
<td>T2: Touch and Tangibles on Large Interactive Surfaces</td>
<td>Simon</td>
<td>14.05</td>
<td>(no lab: Ascension of Christ)</td>
<td>–</td>
<td>Required; TBO Recommended: TBO</td>
<td>A03: Writing a review: Interactive surfaces and tangibles</td>
<td>14.05, 12.05, 14.05</td>
</tr>
<tr>
<td>19.05</td>
<td>T3: Augmented reality HCI</td>
<td>Nur</td>
<td>21.05</td>
<td>• A02 discussion</td>
<td>Nur</td>
<td>Required; TBO Recommended: TBO</td>
<td>(A03 peer feedback)</td>
<td>21.05, 20.05, 21.05</td>
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<tr>
<td>26.05</td>
<td>(no lecture: Excursion week)</td>
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<td>28.05</td>
<td>(no lab: Excursion week)</td>
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<td>26.05, 28.05</td>
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<tr>
<td>02.06</td>
<td>R3: Understanding statistics in HCI research (Case study: midair input techniques)</td>
<td>Krishna</td>
<td>04.06</td>
<td>None (exam preparation week)</td>
<td>–</td>
<td>None (exam preparation week)</td>
<td>(Midterm exam preparation)</td>
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<tr>
<td>09.06</td>
<td>Midterm: R1–3, T1–2 (30%)</td>
<td>Nur</td>
<td>11.06</td>
<td>Midterm exam discussion (not review)</td>
<td>Nur</td>
<td>Required; (Drogoivic &amp; O'Sullivan, 2014) Running an HCI Experiment in Multiple Parallel Universes (Widbdoc, 2011) Practical statistics for HCI</td>
<td>A04: Mini HCI research project: Midair input techniques</td>
<td>11.06</td>
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<tr>
<td>16.06</td>
<td>T4: Gestural and stroke input: from touch screens to midair</td>
<td>Chat</td>
<td>18.06</td>
<td>A03 discussion</td>
<td>Nur</td>
<td>Required; TBO Recommended: TBO</td>
<td>(A04 continued)</td>
<td>27.06, 17.06, 18.06</td>
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<tr>
<td>23.06</td>
<td>R4: Peer-review process in HCI T5-1: Pattern language</td>
<td>Jan</td>
<td>25.06</td>
<td>Mini project interim presentation and feedback</td>
<td>Nur</td>
<td>Required; (Dearden and Finlay, 2006) Pattern Languages in HCI: A Critical Review</td>
<td>(A04 peer feedback)</td>
<td>30.06 (in the lab)</td>
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<tr>
<td>30.06</td>
<td>T5-2: Pattern language</td>
<td>Jan</td>
<td>02.07</td>
<td>Mini project interim presentation and feedback</td>
<td>Nur</td>
<td>Required; TBO Recommended: TBO</td>
<td>(A04 continued)</td>
<td>30.06</td>
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<tr>
<td>07.07</td>
<td>T6: Interactive e-learning (Course evaluation)</td>
<td>Krishna</td>
<td>09.07</td>
<td>Mini project interim presentation and feedback</td>
<td>Nur</td>
<td>Required; TBO Recommended: TBO</td>
<td>(Final exam preparation)</td>
<td>08.07, 09.07</td>
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<tr>
<td>14.07</td>
<td>T7: Personal fabrication and personal design (Course reflection)</td>
<td>Jan</td>
<td>16.07</td>
<td>Final exam preparation lab</td>
<td>Nur</td>
<td>Required; TBO Recommended: TBO</td>
<td>(Final exam preparation)</td>
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Learning Resources

- Public website with all general info: [http://hci.rwth-aachen.de/cthci](http://hci.rwth-aachen.de/cthci) including links to:
  - L²P course room (slides, literature, assignments)
  - Lecture recordings on iTunes U
  - Research papers in the ACM Digital Library

      Free access from inside RWTH network
CTHCI Team

- Prof. Dr. Jan Borchers
- Nur Al-huda Hamdan, M.Sc.
  - hamdan@cs.rwth-aachen.de
- Topic presenters
Limited Seats

- 30 seats available
- Register in CAMPUS or email Nur for registration before Friday
- You will know if you’re in by next lecture (Tue)
- First assignment in the first lab (this Thu)
Plagiarism

Cite and quote instead of plagiarizing!


“‘The law of similarity captures the idea that elements will be grouped perceptually if they are similar to each other. For instance in the following dialog we tend to devide the given files into two groups:

- Law of Similarity

The law of similarity states that objects will be grouped perceptually if they are similar to each other. In other words the repetition in the forms persuade the human mind to group it together.”

Media Computing Group
Consequences of Plagiarism in this Class

- Plagiarism will result in an immediate 5.0 for this class.
- Repeated plagiarism will also lead to banning from all other classes.
- Sign the declaration of compliance and hand it in after the lab.
Three Approaches to HCI Research

Test
Empirical science

Look
Ethnography

Make
Engineering and design
Empirical Approach

- Research question
- Observation
- Hypothesis
Initial Observation

- Begin with casual or informal observation
- Usually comes from personal experience that catches your attention or raises questions in your mind
- Example: “Cloth has an affordance of pinching. Could this be useful for interaction design?”
Research Question

- Identify variables and hypothesis that are associated with your observation

- **Variables**: characteristics or conditions that change or have different values for different individuals

- **Research question**: a statement that describes or explains a relationship between or among variables
  - A proposal to be tested

- Example: “For pinching cloth, different areas of the body would differ in preference and the way people pinch”
Hypothesis

- **Concrete and testable** statements derived from the research question
- **Operational definition**: a specific set of operations for measuring external, observable behavior
- In-class exercise: try giving an operational definition for the variables highlighted below
  - “There would be a difference in user’s preference among different areas on the body for pinching cloth.”
Research Example: Pinstripe

- Karrer et al., CHI ’11

- Recall the prediction:
  - “There would be a difference in user’s preference among different areas on the body for cloth pinching.”

- Method:
  - Identify 16 different body area
  - Ask the participants to perform the pinching gesture in these areas
  - Collect convenience rating in 5-point Likert scale
Planned Observation

• Collect data to support, refute, or refine the original hypothesis

• Three strategies
  • Descriptive research: X happens
    Focus on the current state of each individual variable
  • Relational research: X and Y happen together
    Measure two or more variables that exist naturally from each participant
  • Experimental research: X causes Y
    Manipulate one or more variables and observe their effects to other variables
Descriptive Research

- Describe a naturally-occurring phenomenon
- Measure and report individual variables without claiming relationships
- Natural phenomena can occur when using a new technology as well
- Methods: observation, survey, case study
Research Example: Natural Troubles of Driving with GPS

• Brown (Sweden) and Laurier (Edinburgh), Best paper CHI ’12

• Goal: To understand users’ interaction with GPS navigation system in non-controlled setting

• 14 drivers, 2 video cameras, field notes
  • 9 hours of video ⇒ 75 clips ⇒ 37 detailed transcriptions
  • Analyzed the data to find common patterns/themes and construct theories that explain them
Figure 1: Following GPS instructions

While the driver 'follows' what the GPS recommends the driver still needs skill to read what the GPS says and even to ignore GPS instructions.
Natural Troubles of Driving with GPS

• Contribution & benefits:
  • “Presents a video analysis study of driving using GPS navigation systems in natural settings. The paper argues for [understanding] driving with [a] GPS as an active process and not as ‘docile driving’.”

• Conclusion
  • Designer should take into account the “intelligent driver”
    E.g., less persistent instructions when the user decided to deviate from them
  • Normal natural trouble: “GPS is used in the way that was not foreseen. The driver must take instructions and the map and fit them with the situation.”
Relational Research

• Measure a set of variables for each participant

• Examine to identify patterns of relationship
  - Changes in one variable are consistently and predictably accompanied by changes in another variable

• Measure the strength of the relationship
Research Example: Social Network Activity and Social Well-Being

- Burke (CMU), Marlow, and Lento (Facebook), Best paper CHI ’10
  - “An empirical analysis of the relationship between direct and passive communication on Facebook and social well-being, including loneliness, bridging, and bonding social capital.”

- Survey in Likert scale (N=1193)

- Analyze the past two months of users’ Facebook activity data, e.g.,
  - Friend count (actual)
  - Directed communication: comments, likes
  - Passive consumption of broadcast items such as status updates
Patterns in the Relationship between Variables

Simulated data for instructional purpose, based on the result from [Burke et al., CHI ’10]
Strength of the Relationship between Variables

Simulated data for instructional purpose
Limitations of Relational Research

- Correlation does not imply causation
  - E.g., loneliness $\Rightarrow$ less direct communication?
  - or less direct communication $\Rightarrow$ loneliness?
  - or third variable $\Rightarrow$ direct communication and loneliness?

- Third variable problem: unidentified variable controls the correlated variables

- Shallow data from large number of people instead of deep data
  - Can be improved by follow-up interviews, follow-up surveys

- Participant sampling method limits the conclusion
  - Method: advertisement on Facebook
  - Participants: only English-speaking users, but compensated by many countries of origin
Experimental Research

- **Purpose**: To infer cause-and-effect relationship
- **Controlling** independent variable
- **Observe the change in the** dependent variables
- **In-class exercise**: recall the following experimental designs
  - Between-group vs. within-group
  - Benefits and drawbacks
- **More details in next lecture**
Research Example: Mid-air Pan-and-Zoom on Wall-sized Displays

- Nancel et al. (Paris), Best paper CHI ’11

- Contributions & Benefits:
  - “Design and evaluation of multiscale navigation techniques for very large displays based on three key factors: number of hands involved, type of movement, type of feedback.”
Figure 2. Matrix of the 12 techniques organized according to key characteristics: uni- vs. bimanual, degree of guidance, linear vs. circular gestures.

1D path involves guiding gestures along a particular path in space; in 2D surface gestures are made on a touch-sensitive surface; while in 3D free gestures are totally free.

Guidance through Passive Haptic Feedback

Two main categories of techniques have been studied for mid-air interaction on wall-sized displays: freehand techniques based on motion tracking; and techniques that require the user to hold an input device. Input devices provide some guidance to the user in terms of what gesture to execute, as all of them provide some sort of passive haptic feedback: A finger operating a knob or a mouse wheel follows a specific path; gestures on touch-enabled devices are made on planar surfaces. Freehand techniques, on the contrary, provide essentially no feedback to the user who can only rely on proprioception to execute the gesture. We call this dimension the degree of guidance.

Gestures can be guided to follow a particular path in space (1D path); they can be guided on a touch-sensitive surface (2D surface); or they can be totally free (3D free). These three values correspond to decreasing amounts of passive haptic feedback for the performance of input gestures.

DESIGN CHOICES

Panning. For all techniques, controlling the cursor's position is achieved naturally by ray-casting from the dominant hand to the wall display (dashed arrows in Figure 2). As mentioned earlier, first order of control was discarded for both pan and zoom operations. Panning is achieved by dragging, as in applications such as Adobe Illustrator or Google Maps with their typical hand-shaped cursor.

Zooming. As in desktop applications such as Google Maps or NASA's WorldWind, linear techniques zoom in by moving forward towards the display and zoom out by moving backwards; circular techniques zoom in by turning clockwise and zoom out by turning counterclockwise (solid arrows in Figure 2). Pointing plays an important role when zooming, as it specifies the focus of expansion (zoom in)/contraction (zoom out). Letting users specify this focus point is very important on displays of that physical size, as they will typically not be standing right in the center. A focus of expansion implicitly located at the center of the screen would make zooming operations tedious and hard to control as every zoom operation would require multiple panning actions to compensate drifts induced by the offset focus.

Bi-manual interaction. All bimanual techniques (Figure 2, bottom row) are grounded in Guiard's study of asymmetric division of labor in bimanual actions that led to the Kinematic chain model. Following the observation that motion of the dominant hand typically finds its spatial reference in the results of motion of the non-dominant hand, we assign...
Mid-air pan-and-zoom on wall-sized displays
Three Approaches to HCI Research

Test
Empirical science

Look
Ethnography

Make
Engineering and design
Ethnography

Experimental research

Hypothesis → Study → Data → Theory

Ethnographic research

Study → Data → Theory
Ethnography

- Collect the data
- Code the data and find patterns that occur in the data
- Create theories that explain the data
- Try to attack the theories by gathering more data
  - Leads to stronger theories
Data Collection

• Methods: Observation, interview, participation, logging
  • Format: Field notes, video, audio, log files

• Triangulation: use multiple data sources to support an interpretation to increase the confidence of the conclusion
  • From different participants
  • From different types of data, e.g., observation, interview, logs
Research Example: Vlogging in Dentist Training

• Becvar and Hollan (UCSD), GROUP ’07

• Field site: dental hygiene training program in San Diego, CA, USA

• Goals
  • To gain understand the teaching and learning practices, media and representations
  • To implement and evaluate a design prototype based on the finding of the first goal

• Method
  • Ethnographic study of the current practice
  • Implement and deploy the prototype, then do another ethnographic study
Vlogging in Dentist Training: Understanding Current Practice

• Method (2004, one year in the field)
  • Observation
  • Video recording
  • Contextual interview

• 18 students, 4 instructors participated

• Sample finding: strategies used by clinical instructors
  • Molding: laying their hands over students’ hands as they work with instruments
  • Directing: verbally talking a student through a new procedure: “Do this”
  • Demonstration: using hand gestures to show correct/incorrect ways to handle instruments
Three Approaches to HCI Research

- **Test**: Empirical science
- **Look**: Ethnography
- **Make**: Engineering and design
Engineering & Design

- Objective: solve a problem with a solution that works

- Key attributes*:
  - Compelling target
    - Solve a concrete, compelling problem with demonstrated need
    - Solve a set of problems using a unifying set of principles
    - Explore how people will interact with computers in the future
  - Technical challenge
    - Requires novel, non-trivial algorithms, or configuration of components
  - Deployed when possible
    - System is deployed and intended benefits and unexpected outcomes documented

* from James Landay Slides: James & Friends’ Systems How To
Research Example: Skinput

• Harrison et al., Best paper CHI ’10

• Contributions & Benefits
  • “Skinput is a technology that appropriates the human body for acoustic transmission, allowing the skin to be used as a finger input surface.”
Skinput: Appropriating the Body as an Input Surface

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Human-Computer Interaction Institute
Carnegie Mellon University
Three Approaches to HCI Research

- **Test**
  - Empirical science

- **Look**
  - Ethnography

- **Make**
  - Engineering and design
The Messy Truth

Observation → Prototype 1 → Prototype 2 → Real-world study → Prototype n → Commercial product

Related scientific theory → Descriptive model

Long-term effect study → Predictive model
“This was my ideal model of how the supporting science could work. It required good designers to actually do design, but what we could do was help structure the design space so that the movement through that design space was much more rapid. The science didn’t design the mouse, but it provided the constraints to do it.”

— Stu Card, Designing Interactions (2007)
Next Week: Experimental Research

• How can we be sure that X causes Y? — Experimental methods
• How to measure that? — Measures and metrics
• How good is a piece of knowledge? — Validity and generalizability
• How to design a user study? — User study protocol
• Illustrated by a contemporary topic: Text entry UIs
What You Need To Do Now

• Sign up for this class in CAMPUS by Friday!

• Read this paper today (definitely before the lab!):
  • Seven Research Contribution Types in Human–Computer Interaction
    — Jacob Wobbrock, 2014

• Come to the lab this Thu, April 16th!
  • Literature searching and reading techniques
  • Help with CAMPUS/L2P problems

• Read this paper before the next lecture:
  • How to Read an Engineering Research Paper — William G. Griswold

Links to articles: hci.rwth-aachen.de/cthci


