SimTech Cluster of Excellence

Universität Stuttgart

http://www.vis.uni-stuttgart.de

Intuitive and Multimodal Interaction with Infotainment Systems in the Car

Prof. Dr. Albrecht Schmidt
University of Stuttgart
http://albrecht-schmidt.blogspot.com/

automotive interiors EXPO 2011

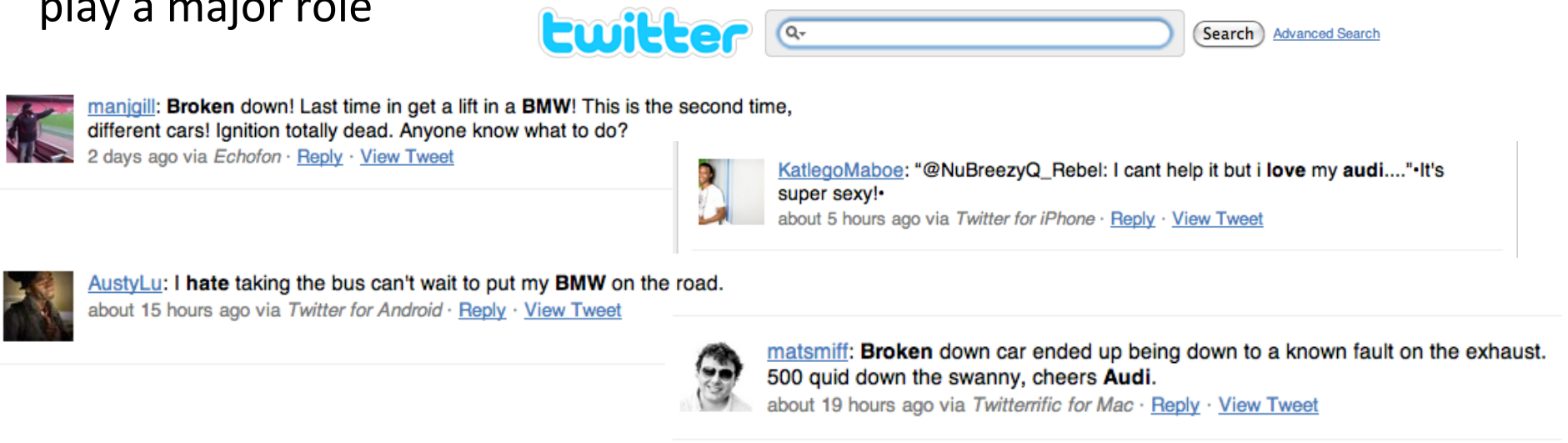
17, 18, 19 MAY 2011 MESSE STUTTGART, GERMANY

Overview

- **Trends that change the perception of technologies**
- User expectations
- Driving user interface research – selected projects
  - Text input while driving / re-inventing the wheel
  - Communication in the car
  - Attention switching between UI and street
  - Networked cars – cars and communities
- Trends and challenges

Pervasive Computing is changing the understanding of technology

- Consumer behavior and consumers values change
- Implemented functionality is less discriminative
- Not available functionality but **usable functionality** will be the measure
- **Quality** – as experienced and expressed by one's social network – will play a major role



Overview

- Trends that change the perception of technologies
- **User expectations**
- Driving user interface research – selected projects
  - Text input while driving / re-inventing the wheel
  - Communication in the car
  - Attention switching between UI and street
  - Networked cars – cars and communities
- Trends and challenges

What has become of cars?

Image from: BMW

Image from: http://apfelblog.

"VW up! … like an iPod touch that you can drive, too."

The Car…

… a means for transport.

- … an space for media consumption?
- … is a personal communication center?
- … alters our perception of the environment?
- … creates user generated content?
- … used as a inter-connected workplace?
- … mobile (phone) terminal

Essentially a interactive computing platform and a node in a distributed (computer/social) network?

Some reasons why…

- Increase mobility
- Assistive functionalities ease the driving task
- People live connected lives
  - information access always and everywhere
  - availability of communication as normal
- Media consumption is digital and ubiquitous
- Context acquisition becomes possible
  - Sensing technologies have improved
  - Processing / sense making of sensor information
- Cars become networked
  - Car to internet, car to infrastructure, car to car

What has not changes?

- Primary function as transport vehicle is central and a prerequisite
- Primary task (basically driving) has priority
- “fun of use” and “ease of use” are essential
- Human users wants to be in control
- Driving is often a social situation
- Need for safety (gets even more emphasized)

What needs to be changed?

"Just 100 years ago, it was normal that, in [such] a mine, on average one person per day got seriously injured and one person per week died while working. It seemed inevitable, and people accepted it because energy was necessary. Today, we don't consider such working conditions acceptable. However, with current cars and personal transport, it's somehow acceptable that more than 4,000 people per year are killed in road accidents in Germany alone"

Driving Automotive Research
IEEE Pervasive Magazine

Selected areas to be addressed

- Safe communication while driving
  - Contextualizing as an essential step
- Text input and output
  - Essential for many application
- Making it easy that interactions can be interrupted
  - Minimizing the cognitive cost for the user for interrupting
- Interacting with all sense
  - Creating truly multimodal user interfaces

Overview

- Trends that change the perception of technologies
- User expectations
- **Driving user interface research – selected projects**
  - Text input while driving / re-inventing the wheel
  - Communication in the car
  - Attention switching between UI and street
  - Networked cars – cars and communities
- Trends and challenges

Pushing the Boundaries of Human Computer Interaction

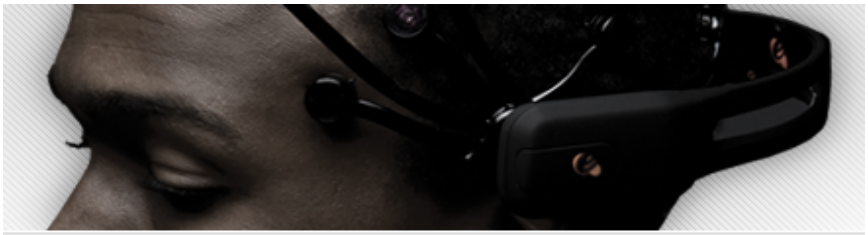
What is the ultimate user interface in the car?

Pushing the Boundaries of Human Computer Interaction

What is the ultimate user interface in the car?








Overview

- Trends that change the perception of technologies
- User expectations
- Driving user interface research – selected projects
  - **Text input while driving / re-inventing the wheel**
  - Communication in the car
  - Attention switching between UI and street
  - Networked cars – cars and communities
- Trends and challenges

Handwritten Text Input While Driving

Handwritten Text Input While Driving Study

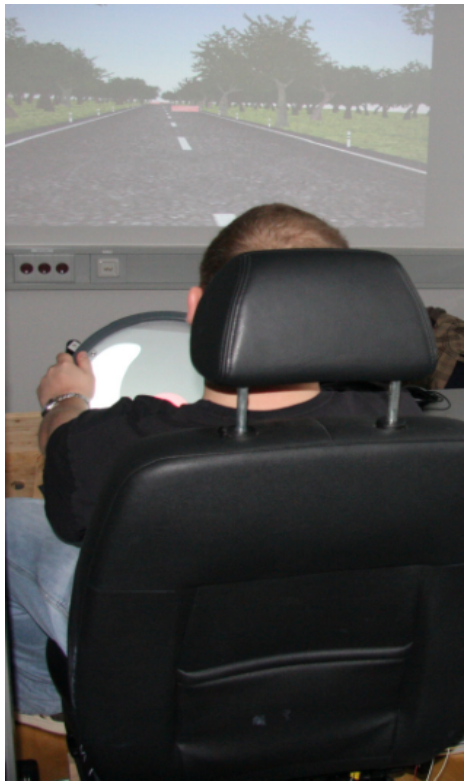
- Driving simulator CARS
- 16 participants (5 female)
- inputting address and names
- 5 minutes drivers under each condition
  - steering wheel/steering wheel (sw/sw
  - steering wheel/dashboard (sw/db)
  - central console / central console (cc/cc)
  - central console/dashboard (cc/db)
  - one reference drive

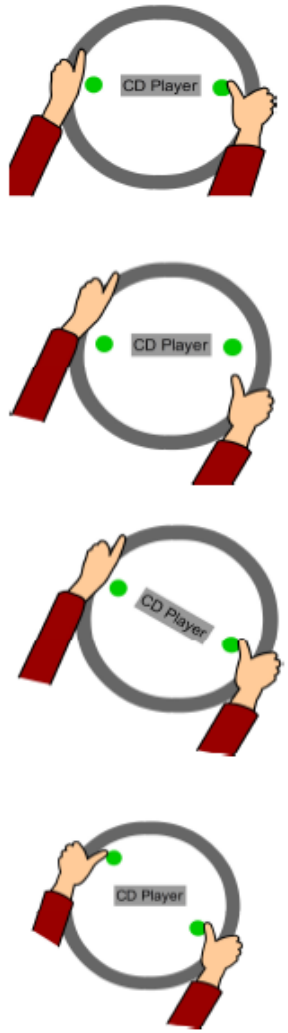
input	output	speed	lane keeping
cc	cc	29.5	121.0
	db	29.6	103.5
sw	sw	30.7	104.6
	db	31.4	113.0
wt		33.5	87.9

- Text input while driving will inevitably impact driving performance
- steering wheel is well accepted by users and lead to 25% fewer corrections and remaining errors

Multitouch steering wheel

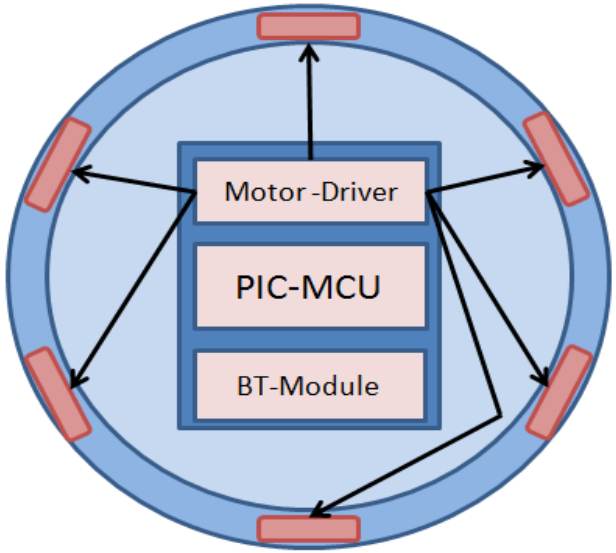
- The whole steering wheel is a interactive multitouch display
- We conducted experiments to find intuitive gestures for common tasks, e.g.
  - Change volume
  - Navigate on a map
- Reduces the time that people look away from the street





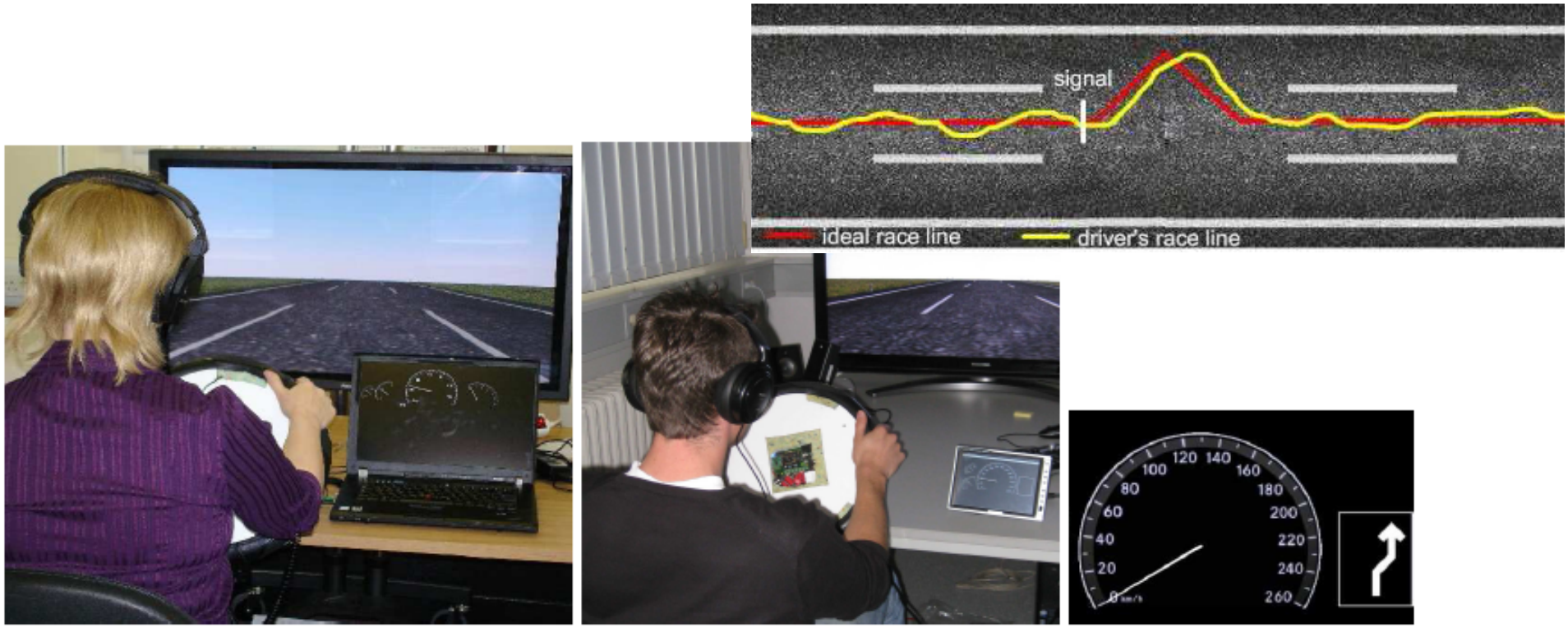
Haptic feedback

Tactile Output Embedded into the Steering Wheel



- Directional tactile output as an additional modality
- Motivation: turn off audio when in conversation and then missing the exit

Tactile Output Embedded into the Steering Wheel



Results show that adding tactile information to existing audio, or particularly visual representations, can improve both driving performance and user experience.

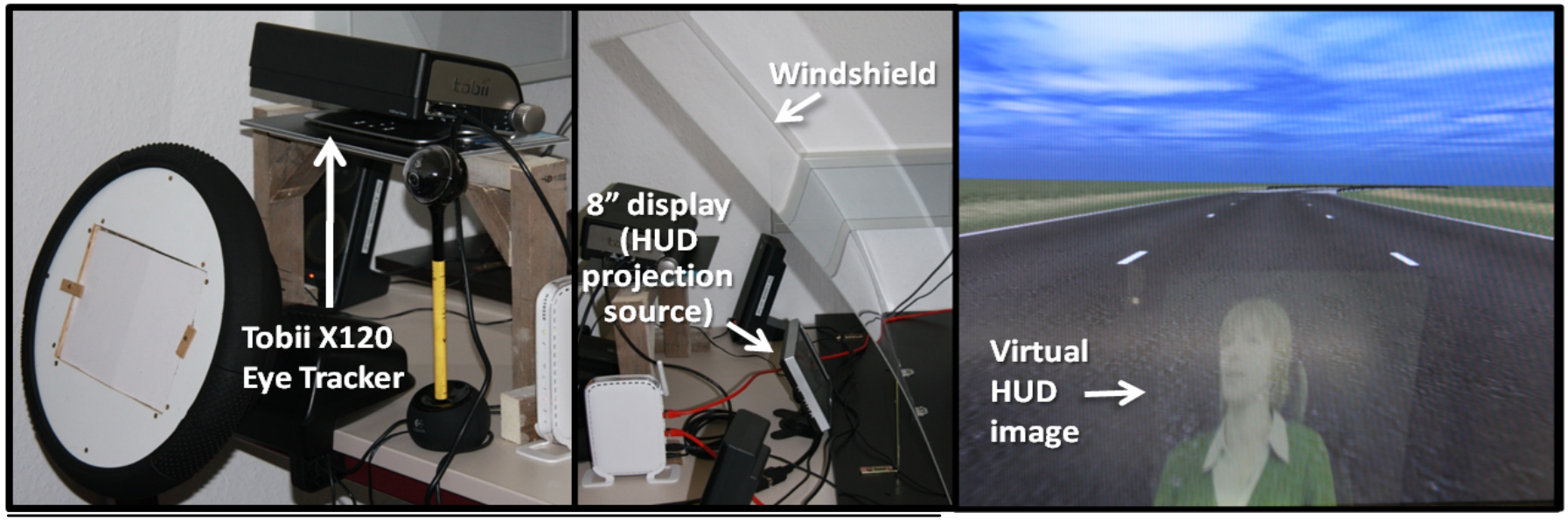
Overview

- Trends that change the perception of technologies
- User expectations
- Driving user interface research – selected projects
  - Text input while driving / re-inventing the wheel
  - **Communication in the car**
  - Attention switching between UI and street
  - Networked cars – cars and communities
- Trends and challenges

Bridging the Communication Gap
Video link improves communication

		Reference (No driving)	No Video System	Monitor Video System
		Mean	Mean	Mean
At Rear-seat Passenger	# glances/min	2.6	0.4	0.0
	# looks/min	2.3	0.0	0.0
At Monitor Display	# glances/min	0.0	0.0	3.3
	# looks/min	0.0	0.0	0.0

Bridging the Communication Gap in the Car



		ReactionTime (seconds)	
		Mean	Standard Error of Mean
VideoSystem	Reference	**1.40**	**0.06**
	No Video System	**1.51**	**0.06**
	Monitor Video System	**1.53**	**0.06**
	HUD Video System	**1.50**	**0.05**
ConversationTask	Article	**1.50**	**0.05**
	Game	**1.53**	**0.04**

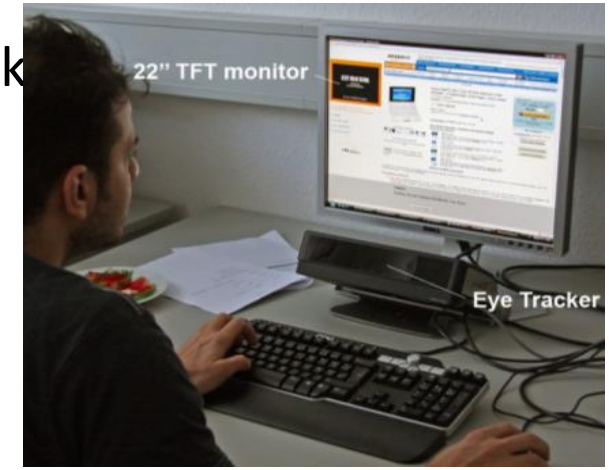
Without compromising driving performance

Overview

- Trends that change the perception of technologies
- User expectations
- Driving user interface research – selected projects
  - Text input while driving / re-inventing the wheel
  - Communication in the car
  - **Attention switching between UI and street**
  - Networked cars – cars and communities
- Trends and challenges

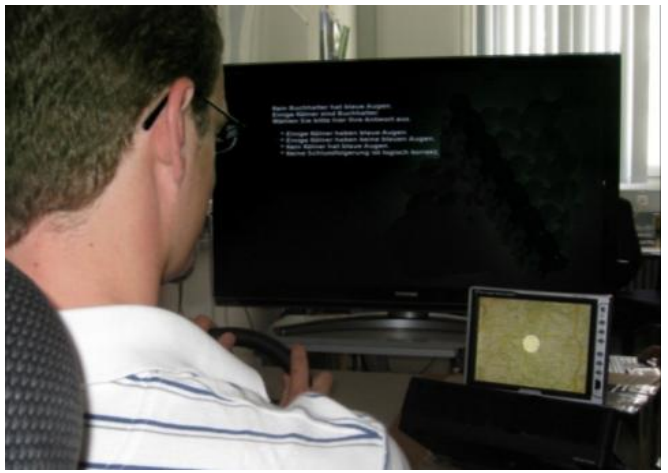
How to implement Gazemarks?

- **Acquire** the gaze position data **(x,y)** of the eye track in
  real time
- **Detect** when the user switches **attention** between displays
- **Save last gaze position** when the user "leaves" the screen
- On "returning" to a display
  visualize the last gaze position



Experiment & Result

- Tasks
  - Map search task on small screen
  - IQ questions on large screen
- Procedure
  - Find given letter
  - attention switch, solve IQ task
  - find given letter again
- 16 Participants (23 to 52 years old)



- Result: participants were considerably (about 3 times)
  faster in searching with *Gazemarks*
  - with *Gazemarks:* **625.75 ms** (median)
  - without *Gazemarks* :1999.50 ms (median)

Overview

- Trends that change the perception of technologies
- User expectations
- Driving user interface research – selected projects
  - Text input while driving / re-inventing the wheel
  - Communication in the car
  - Attention switching between UI and street
  - **Networked cars – cars and communities**
- Trends and challenges

A Networked Car Application Platform

…an ongoing Research Project

- Cars share in real-time data about
  - Their environment and the car (e.g. location, temperature, weather, street surface condition, vibration, camera…)
  - Surrounding traffic (e.g. density, speed, …)
  - User interaction (e.g. steering, interaction with pedals, …)
  - Physiological Information (e.g. gaze direction, surprise, anger, …)
- The information is collected, processed, abstracted, and accumulated
- Using an application programming interface (API) developers can create applications

A Networked Car Application Platform

…an ongoing Research Project

- Imagine all the information that goes over the bus systems in the car is shared and centrally collected
- Imagine 1%, 5%, 10%, 50% of the people share it?

- What new information could we create?
- What could the user do with it?
- What could a community do with it?
- What could a manufacturer do with it?

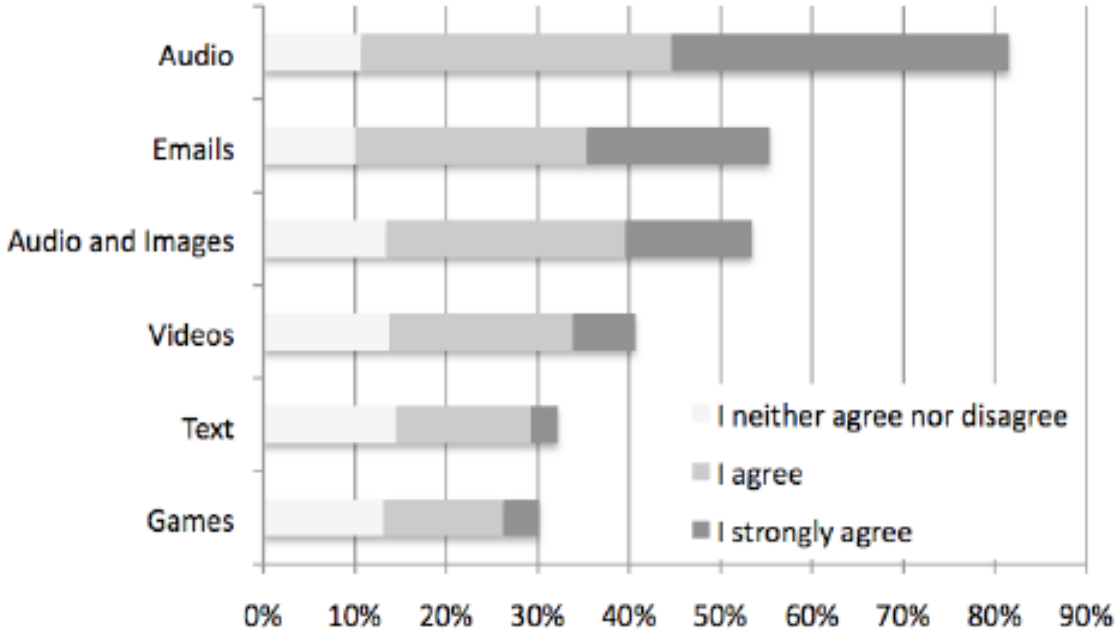
A Networked Car Application Platform

…an ongoing Research Project

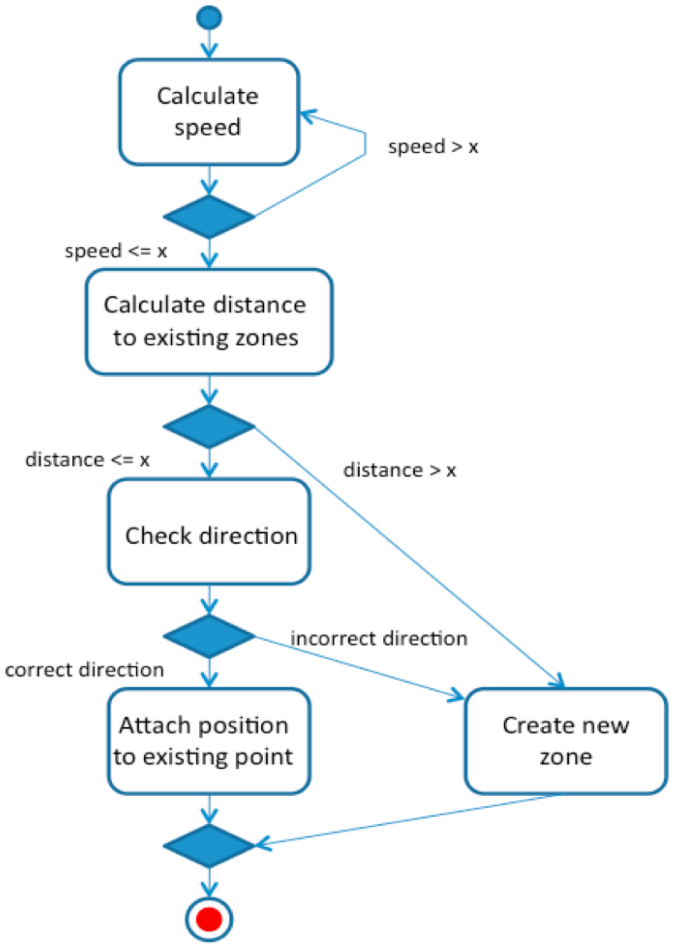
- Many applications that become possible, e.g.
  - Creating a map with street conditions information about damage (e.g. holes in the road surface) and temporary issues (e.g. ice on the road)
  - Virtual black box for insurance that allows specific tariffs (e.g. car is parked during the night indoors)
  - Linking the car to social software (e.g. facebook) and communication (e.g. twitter) and proving information
  - Detailed usage profile when selling the car
  - …
- Great potential, but many open questions
- We are seeking collaboration with companies …

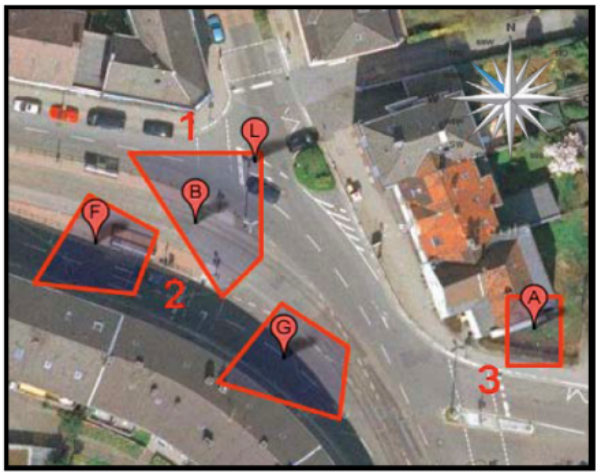
Micro entertainment

- car usage:
  ~86 min/day
- (safe) usage
  of displays
  while stopping
- lack of standard
  to detect traffic light phas
  - detect waiting zones
  - estimate waiting times



Micro entertainment



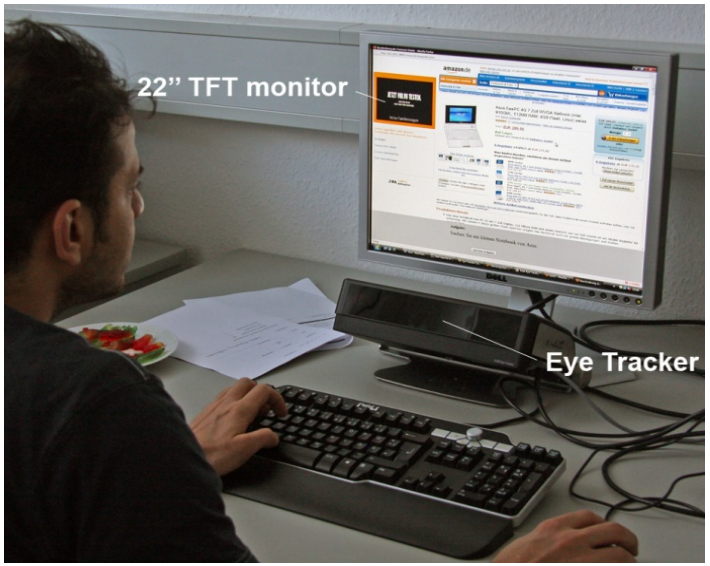


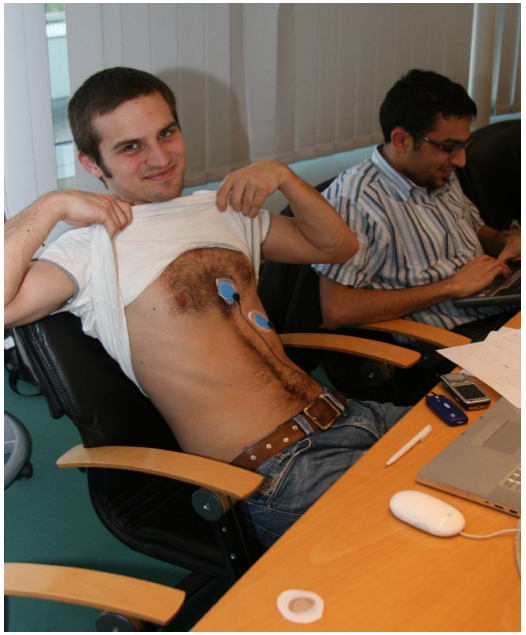
Overview

- Trends that change the perception of technologies
- User expectations
- Driving user interface research – selected projects
  - Text input while driving / re-inventing the wheel
  - Communication in the car
  - Attention switching between UI and street
  - Networked cars – cars and communities
- Trends and challenges

Interaction with all senses

- Physiological sensors
- Brain interface
- Eye gaze
- haptics
- …





Challenge 1: boredom vs. stress

- Fighting both!

Challenge 2: safety vs. convenience/fun

- supporting both!

Resulting challenges for the UI

- More information available
  - car data, e.g. sensors, night vision, …
  - from the environment, e.g. signs, parking distance, …
  - other cars, e.g. weather warnings, collision warnings, …
  - from the backend, e.g. internet, online source, …
  - From human to human communication channels, e.g. phone, instant messaging, …
- New interaction demands from assistive systems (joint tasks – human and car)
- Increased complexity of interaction while driving due to secondary tasks

Questions?
Comments?

We are interested in joined research!

- Visit my websites at:
  http://www.pervasive.wiwi.uni-due.de/
  http://albrecht-schmidt.blogspot.com/

Bio: Albrecht Schmidt

Albrecht Schmidt is a professor for Human Computer Interaction at the University of Stuttgart. Previously he was a Professor User interface Engineeing and Pervasive Computing at University of Duisburg-Essen. In 2006/2007 he had a joined position between the University of Bonn and the Fraunhofer Institute for Intelligent Analysis and Information Systems (IAIS) working in the area of Media Informatics. He studied computer science in Ulm, Germany and Manchester, UK and receive in 2003 a PhD from the Lancaster University in the UK. His research interest is in human computer interaction beyond the desktop, including user interfaces for mobile devices and cars. Albrecht published well over 100 refereed archival publications, he is co-founder of the ACM conference on Tangible and Embedded Interaction (TEI), he initiate a conference on Automotive User Interfaces (auto-ui.org) and he is on the editorial board of the IEEE Computer Magazine.

References

- Schmidt, A., Spiessl, W., and Kern, D. 2010. Driving Automotive User Interface Research. *IEEE Pervasive Computing* 9, 1 (Jan. 2010), 85-88. DOI= http://dx.doi.org/10.1109/MPRV.2010.3
- Kern, D., Marshall, P., and Schmidt, A. 2010. Gazemarks: gaze-based visual placeholders to ease attention switching. In *Proceedings of the 28th international Conference on Human Factors in Computing Systems* (Atlanta, Georgia, USA, April 10 - 15, 2010). CHI '10. ACM, New York, NY, 2093-2102. DOI= http://doi.acm.org/10.1145/1753326.1753646
- Pfeiffer, M., Kern, D., Schöning, J., Döring, T., Krüger, A., and Schmidt, A. 2010. A multi-touch enabled steering wheel: exploring the design space. In *Proceedings of the 28th of the international Conference Extended Abstracts on Human Factors in Computing Systems* (Atlanta, Georgia, USA, April 10 - 15, 2010). CHI EA '10. ACM, New York, NY, 3355-3360. DOI= http://doi.acm.org/10.1145/1753846.1753984
- Kern, D. and Schmidt, A. 2009. *Design space for driver-based automotive user interfaces. In Proceedings of the 1st international Conference on Automotive User interfaces and interactive Vehicular Applications* (Essen, Germany, September 21 - 22, 2009). AutomotiveUI '09. ACM, New York, NY, 3-10. DOI= http://doi.acm.org/10.1145/1620509.1620511
- *Kern,D., Hornecker,E., Marshall,P., Schmidt,A., Rogers, Y. 2009.* Enhancing Navigation Information with Tactile Output Embedded into the Steering Wheel. In *Proceedings of the 7th Int. Conference on Pervasive Computing 2009 (Pervasive 2009)*. Nara, Japan. Springer LNCS 5538, pp 42-58.

References

- Graf, S., Spiessl, W., Schmidt, A., Winter, A., and Rigoll, G. 2008. In-car interaction using search-based user interfaces. In *Proceeding of the Twenty-Sixth Annual SIGCHI Conference on Human Factors in Computing Systems* (Florence, Italy, April 05 - 10, 2008). CHI '08. ACM, New York, NY, 1685-1688. DOI= http://doi.acm.org/10.1145/1357054.1357317
- Dagmar Kern, Albrecht Schmidt, Michael Pitz, Klaus Bengler. Verbesserung der Telekommunikation im Auto unter Ausnutzung von Status- und Kontextinformationen. Mensch und Computer 2007.
- Holleis, P., Kern, D., and Schmidt, A. 2007. Integrating user performance time models in the design of tangible UIs. In *CHI '07 Extended Abstracts on Human Factors in Computing Systems* (San Jose, CA, USA, April 28 - May 03, 2007). CHI '07. ACM, New York, NY, 2423-2428. DOI= http://doi.acm.org/10.1145/1240866.1241018
- Schmidt, A., Kern, D., Streng, S. Holleis, P, Magic Beyond the Screen, *Multimedia, IEEE* , vol.15, no.4, pp.8-13, Oct.-Dec. 2008
- Schmidt, A. 2010. Ubiquitous Computing: Are We There Yet? *IEEE Computer* 43, 2 (Feb. 2010), 95-97. DOI= http://dx.doi.org/10.1109/MC.2010.54
- Albrecht Schmidt. Anind Dey. Thomas Seder. Oskar Juhlin. Proceedings of the 1st International Conference on Automotive User Interfaces and Interactive Vehicular Applications. ACM 2009. ISBN:978-1-60558-571-0. Essen, Germany. September, 21-22, 2009. http://portal.acm.org/toc.cfm?id=1620509