Implicit Interaction –
smart living in a smart world

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Definition
User Interface Engineering

User Interface Engineering is a structured approach for designing and implementing useful and usable interactive systems.

By following the user interface engineering process the interactive qualities of a system are ensured.

User Interface Engineering

- create user interfaces in a structured way
- ensure system properties by design
  - utility
  - efficiency
  - usability
  - pleasurably
  - durability
  - openness
- research challenges
  - develop **models** to allow prediction and validation
  - systematic **exploration** of modalities and interaction techniques
  - **toolkits** and development support
  - designing specific interfaces that allow user creativity

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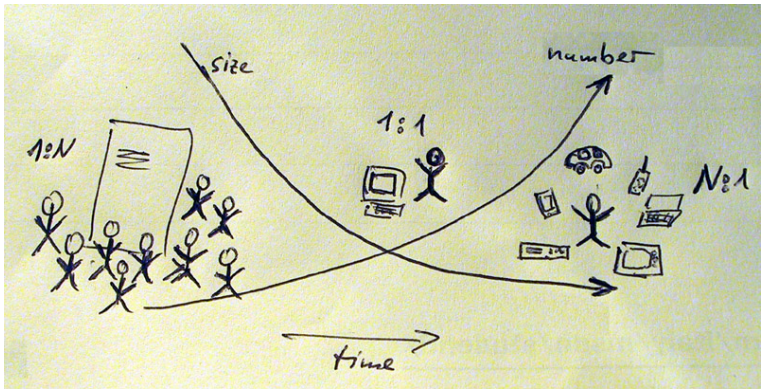
Pervasive Computing

Enabling Intelligent Environments

- Processing
  cheap, fast, small, energy efficient
- Storage
  big and fast
- Networking
  global, local, ad-hoc, low-power
- Displays
  projection, flexible materials, power consumption
- **Sensors**
  types, speed, accuracy, price
- **Actuators**
  many, computer controlled

"The most profound technologies are those that disappear. They weave themselves into the fabric of everyday life until they are indistinguishable from it." (Mark Weiser)



User Needs & Technology Drive

- Looks at user needs on a more general level
  (e.g. Maslow's hierarchy of needs)
- Successful designs have addressed
  - Survival
  - Safety
  - Food
  - Love
  - Communication
  - Recognition / admiration
  - …
- Allow technology to drive actual applications

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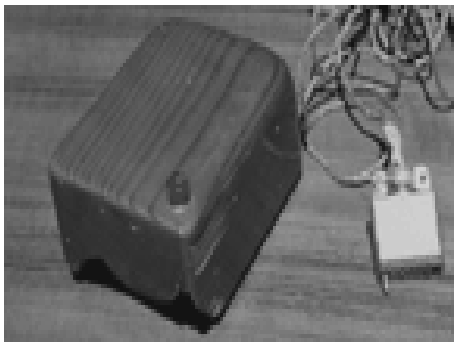
technology creates opportunities and user needs…

Sketch Pad 1963

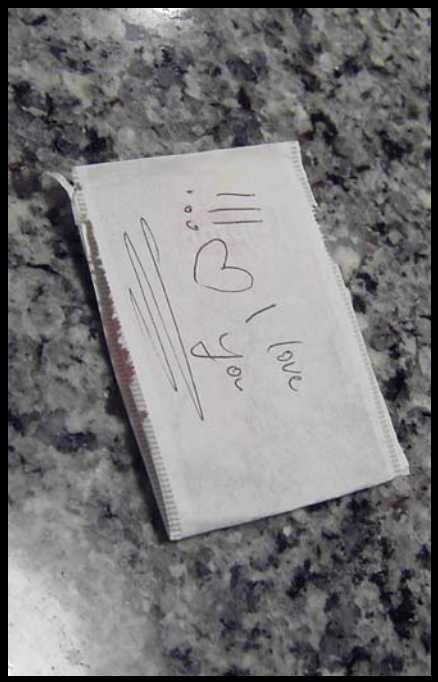


Mouse 1964

…but if we do not understand the user products are likely to fail!

Unpredictable* Users?
Smart Users?
Creative Users?

*if you have a nail, everything at hand looks like a hammer…



Communication appliance with hand written text input?

What is interaction with Ubiquitous Computing?

How many computer* did you use today?

*what is a computer anyway…

How many computer* did you use today?

How many of these systems are adaptive?

How many of these systems are context-aware?

How many of these systems are networked?

How many of these systems are embedded?

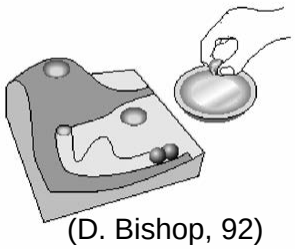
*what is a computer anyway…



How do we interact with computers beyond the desktop?

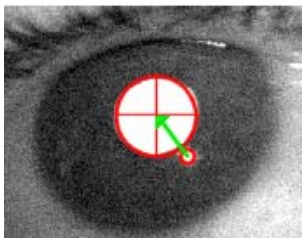
Future User Interfaces

novel user interface paradigms



(D. Bishop, 92)

- Tangible and physical user interface
- Context-aware user interfaces and Implicit interaction
- Speech and gesture
- Physiological and emotional interaction
- Eye gaze interaction
- Interfaces ecologies



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Design Space for Interactive Systems

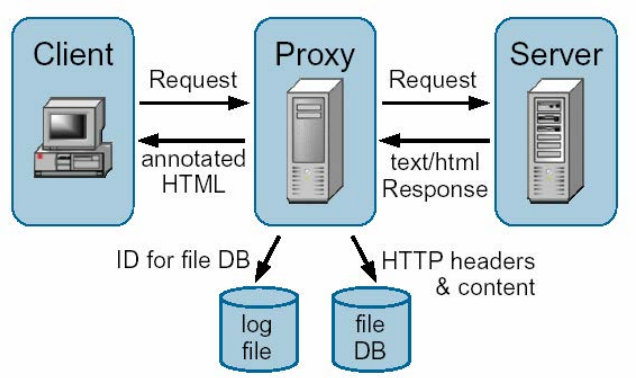
Implicit and explicit multimodal interaction

		mode of interaction	
		explicit	implicit
modality	command line		
	GUI & direct manipulation		
	gestures and speech		
	tangible and physical UIs		
	physiological and emotional		
	eye gaze		

Implicit Interaction

Tracking of User Activities on a Webpage

- Approach
  - Proxy server
  - Adding java script to web pages
  - Reporting interaction back while user is on a web page



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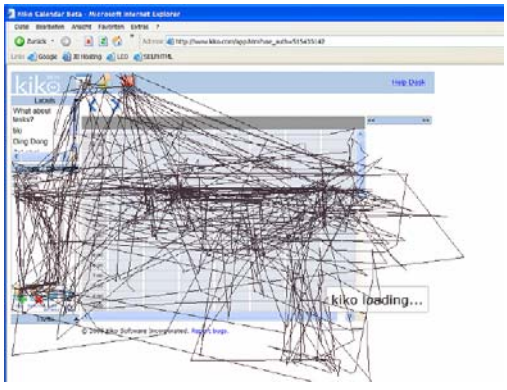
Data collected

```
141.84.8.77 2005-10-25,11:5:57 http://www.kiko.com/ serverdata 12
141.84.8.77 2005-10-25,11:5:58 http://www.kiko.com/ load width=1280;height=867
141.84.8.77 2005-10-25,11:6:2 http://www.kiko.com/ mousemove x=672;y=7
141.84.8.77 2005-10-25,11:6:2 http://www.kiko.com/ mouseover x=731;y=457 target=link:http://www.kiko.com/contact.htm+linktext:(
141.84.8.77 2005-10-25,11:6:6 http://www.kiko.com/ click x=815;y=231 target=id:SPAN16
141.84.8.77 2005-10-25,11:6:37 http://www.kiko.com/app.htm?use_auth=678397351 mousemove x=849;y=352
141.84.8.77 2005-10-25,11:6:37 http://www.kiko.com/app.htm?use_auth=678397351 mouseover x=472;y=296 target=id:DIV144
141.84.8.77 2005-10-25,11:6:37 http://www.kiko.com/app.htm?use_auth=678397351 mouseover x=161;y=229 target=id:left_bar
141.84.8.77 2005-10-25,11:6:38 http://www.kiko.com/app.htm?use_auth=678397351 click x=147;y=183 target=unknown:scrollbar
141.84.8.77 2005-10-25,11:6:40 http://www.kiko.com/app.htm?use_auth=678397351 mousemove x=148;y=138
141.84.8.77 2005-10-25,11:6:50 http://www.kiko.com/app.htm?use_auth=678397351 click x=26;y=507 target=id:IMG14
141.84.8.77 2005-10-25,11:6:50 http://www.kiko.com/app.htm?use_auth=678397351 focus
141.84.8.77 2005-10-25,11:6:56 http://www.kiko.com/app.htm?use_auth=678397351 keypress key=T
141.84.8.77 2005-10-25,11:6:56 http://www.kiko.com/app.htm?use_auth=678397351 keypress key=e
141.84.8.77 2005-10-25,11:6:56 http://www.kiko.com/app.htm?use_auth=678397351 keypress key=s
```

- Detailed data
- Time stamped
- Visualization on top of the application



Eye Gaze Interaction

An new modality for explicit

and implicit interaction

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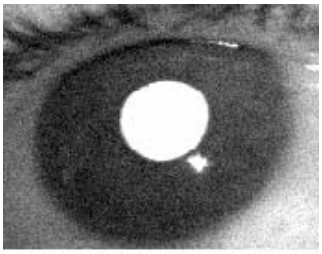
Implicit and explicit input

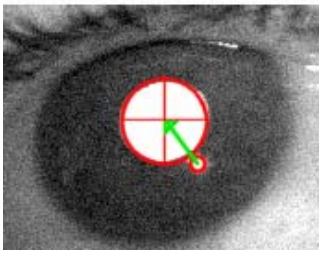
Eye gaze as additional input

- Using an eye tracker as additional input channel
  - For explicit and implicit interaction
- Currently mainly used
  - Psychology, e.g.
    - Where do people look? Gaze path, How long do they look at an item?
  - Usability testing, e.g.
    - Where do user look first?
  - Users with severe disabilities, e.g.
    - Eye movement as only input
- Systems are still expensive
- Hardware and processing required is already today very affordable
- Expectation for future devices (if it is shown they are useful)
  - Hardware included in the screen similar to speakers today
  - Integration of eye tracking into everyday devices

Video Based Eye Gaze Tracking

- The picture shows the camera with an infrared LED mounted below the tablet PC.
- The white pupil in the camera image comes from reflection of infrared light (red eyes from flash light).
- The infrared light also causes a reflection glint, which does not move as the eye is perfectly round





The position of the gaze on the screen can be calculated by the distance from the glint to the pupil center.

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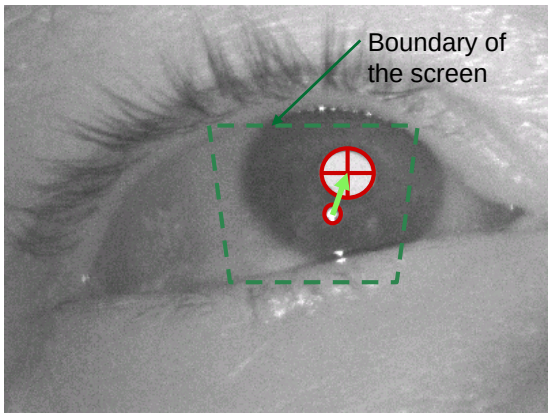
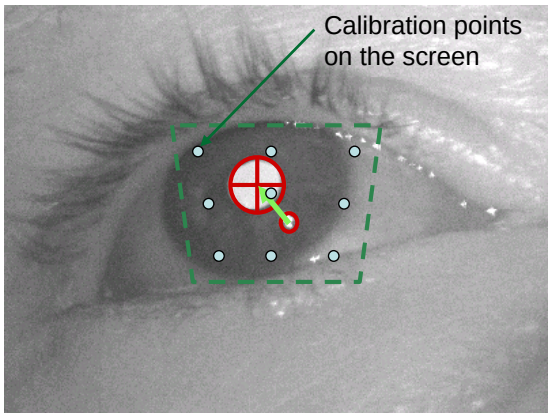
Calibration with calibration points





Implicit use of eye-gaze

You look where you click!

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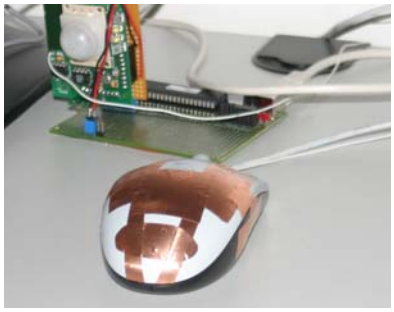
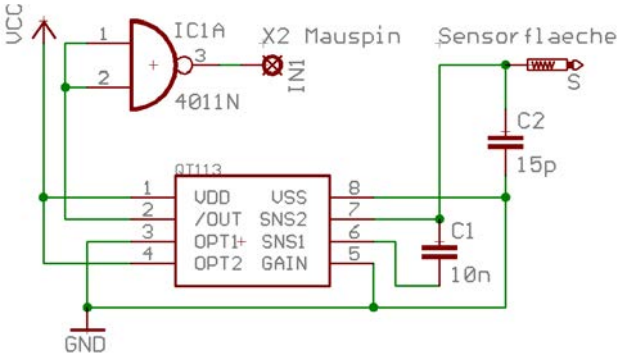
Touch Sensitive Mouse
Implicit Gaze Interaction





- Capacitive sensor to detect hand/finger on the mouse
- Additional input parameter
- Center mouse on the position where the user looks

Explicit use of eye-gaze

You decide where you look!

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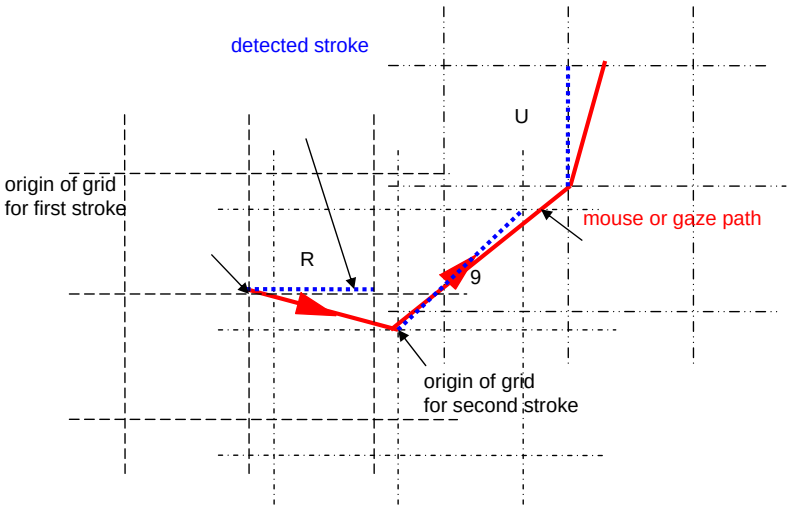
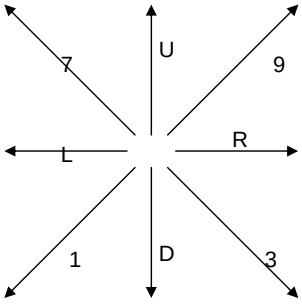
Implementing a Gaze Gestures Algorithm

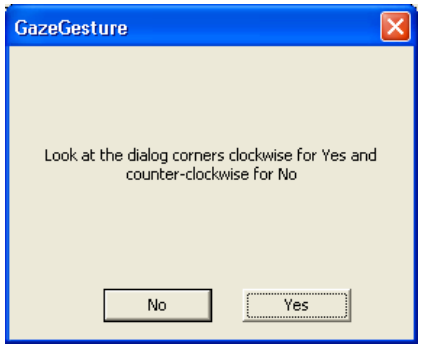
- Translation of a path into a string
- Similar to mouse gesture, exended with timeout and timeout character

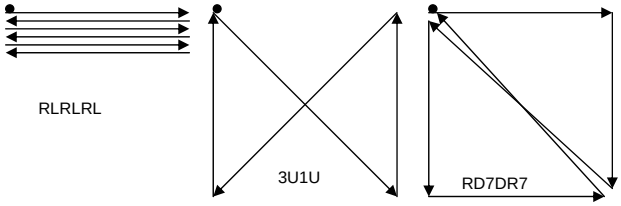




Design of the User Study

- 2 tasks to see how well users can perform gestures
- Different screen backgrunds
- Further task to find out how often gestures occur during normal work





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Some Results of the User Study

Gesture	Helping Lines	Text Background	Blank Background
RLRLRL	3113 (±627)	3089 (±728)	3288 (±810)
3U1U	2222 (±356)	2311 (±443)	2429 (±307)
RD7DR7	3163 (±490)	3563 (±651)	3569 (±520)

Time in milliseconds of the gestures

- The time of a gestures is largely independent from the background
- The time depends on the number of strokes in the gesture

Some Results of the User Study

Gesture		Gesture		Gesture	
RDLU	0	DRUL	2	RLRLRL	69
DLUR	2	RULD	3	3U1U	0
LURD	1	ULDR	0	RD7DR7	0
URDL	1	LDRU	1		

- Most gestures do not or very seldom occur during normal work
- Specific gestures (RLRLRL) do occur frequently as they are a typical reading gesture

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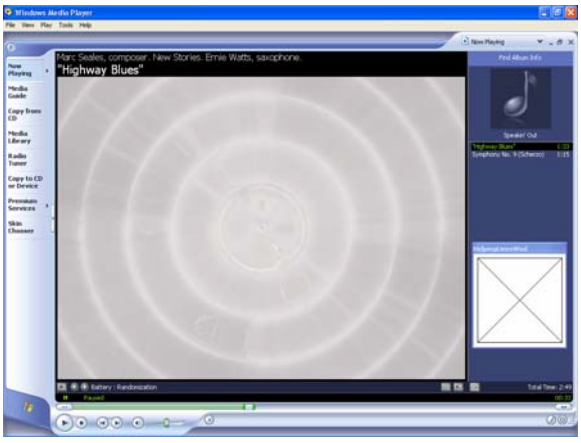
Experiments with Standard Applications and Media Devices

- Eye gesture remote control
- Gaze gestures with 4 strokes need about 2 seconds
- Slower than dwell time or pressing a key
- However
  - no need for calibration
  - no Midas touch problem



Further application of eye-gaze

- Imagine a TV that tracks eye-gaze
  - "…people who watch like you also watched …"
  - No ad-skipping anymore :-(
  - …

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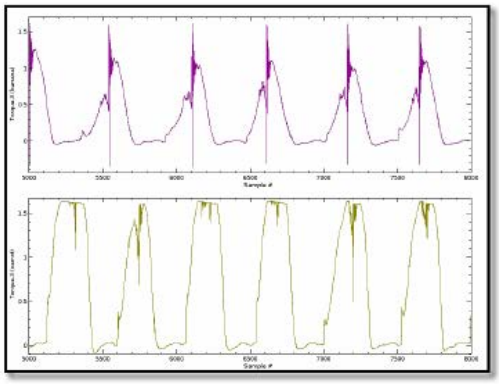
Interaction in smart environments

Augmented Tools
Exploration of a design space

- Implicit interaction and activity recognition
- Force sensing built-in to a knife
- Load cells in the cutting board



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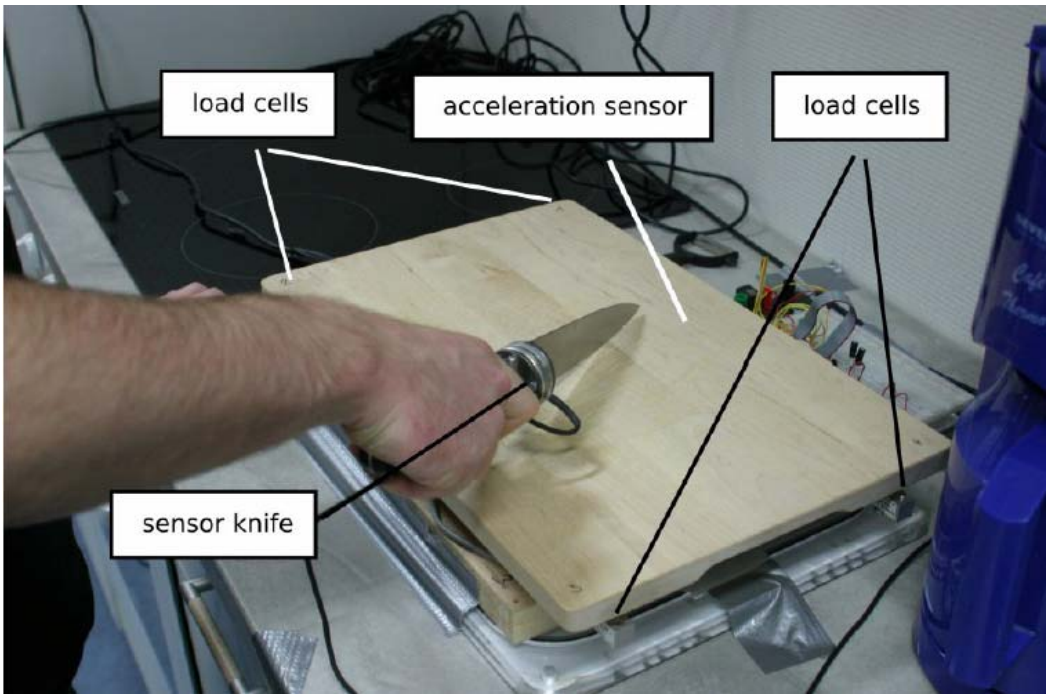
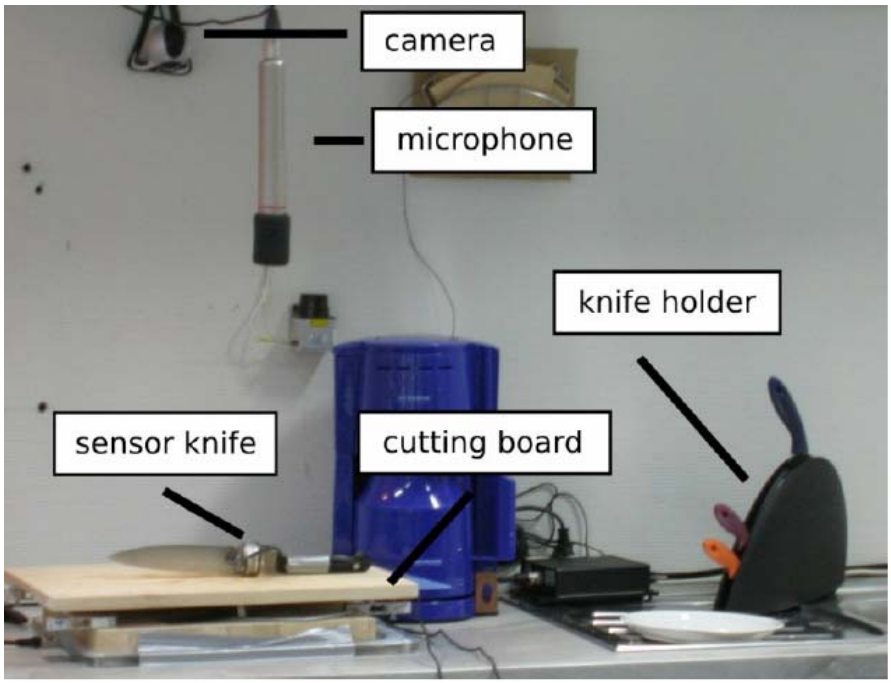
Study Setup (1)



Study Setup (2)



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Results (2)

classified as ->	apple	carrot	kohlrabi	banana	leek	pepper
apple	27	0	0	5	0	2
carrot	0	102	3	4	5	9
kohlrabi	3	0	183	0	1	9
banana	0	0	0	167	0	0
leek	0	2	0	2	179	4
pepper	2	17	29	1	9	89

TABLE II

CONFUSION MATRIX OF THE BEST CLASSIFICATION RESULT USING THE KNIFE DATA.

Implicit Data Generation Beyond the Desktop

- Think about
  - Your car navigation system
  - Your mobile phone
  - Your radio and TV
  - Your gas/electricity/water supply meter
  - …
  - Your cloths and shoes
  - Your waste bin
  - Your sewage leaving the house
  - …
- A great wealth of information?
  - Understanding human behavior
  - Anticipating needs
  - Providing just in time services
  - New services and products
- Or just pure horror?

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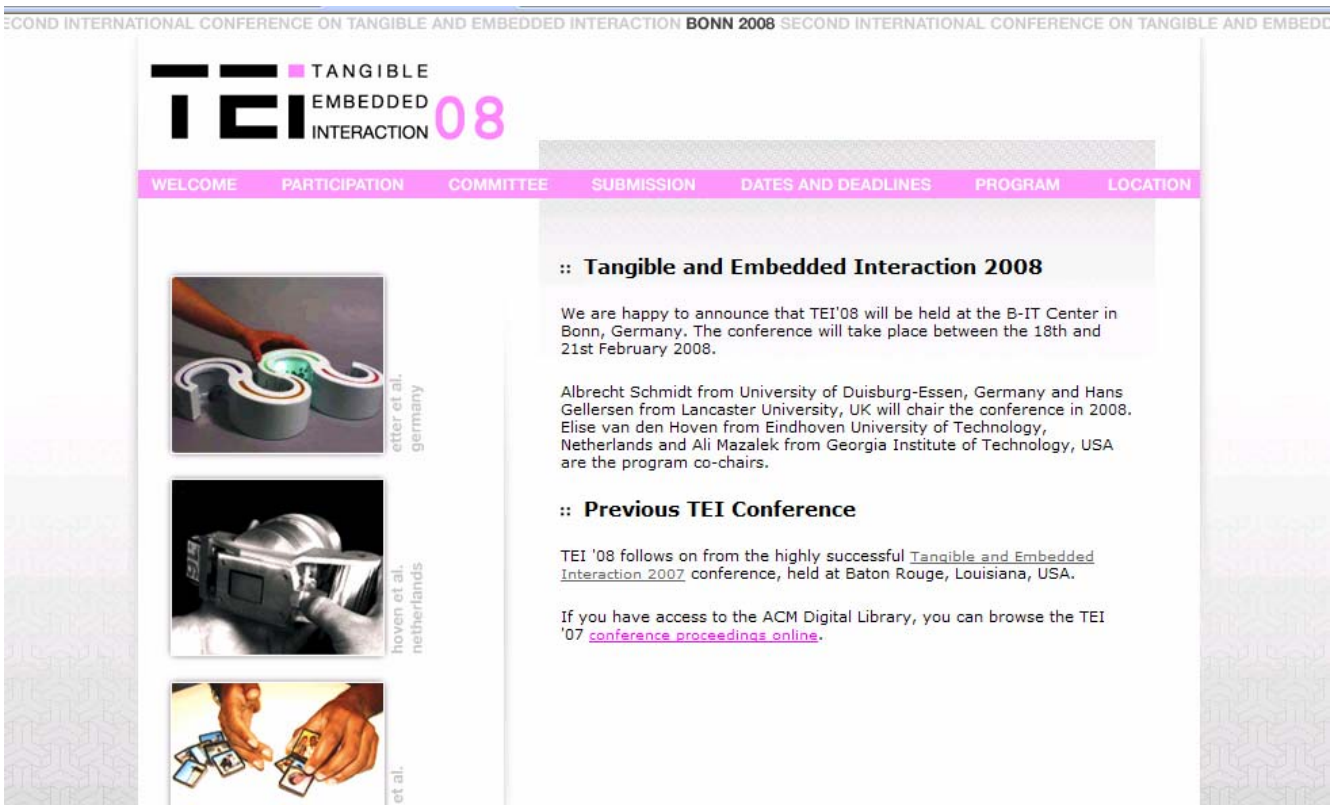
Conclusion and Discussion

- New technologies create new user interface options
- Several research challenges
  - Exploring the design space
  - Creating models
  - Building toolkits and development tools
- Beyond the desktop calls for new approaches
  - Undo does not work well in the real world
  - Multi-tasking with real-world tasks



www.tei-conf.org – Feb 2008 in Bonn

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Further Reading

- Drewes, H.; Schmidt, A.: Interacting with the Computer using Gaze Gestures. In: Proceedings of Human-Computer Interaction - INTERACT 2007, 11th IFIP TC 13 Int. Conference, Part II, Springer LNCS 4663, September 2007, pp. 475-488.. 2007
- Kranz, M.; Maldonado, A.; Hörnler, B.; Rusu, R.; Beetz, M.; Rigoll, G.; Schmidt, A.: A Knife and a Cutting Board as Implicit User Interface - Towards Context-Aware Kitchen Utilities. In: Proceedings of the 1st international Conference on Tangible and Embedded interaction (Baton Rouge, Louisiana, February 15 - 17, 2007). TEI '07. ACM Press, New York, NY, 213-214. . 2007.

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