

Visualizing Sensor Data

Hauptseminar "Information Visualization - Wintersemester 2008/2009"

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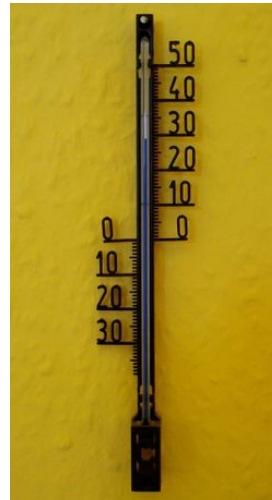
16.02.2008

Challenges and Problems

- ≡ Unique properties of sensor data
 - ≡ Large amount of data
 - ≡ Multidimensionality of data
 - ≡ Real time data
- ≡ Reliability of sensors
- ≡ Lifetime of the sensor network
- ≡ Different IDs for the same object from different sensors
- ≡ Answering of “on-the-fly” queries not reliable
- ≡ Fitting visualization according to user’s ideas

Sensors – Taxonomy(I)

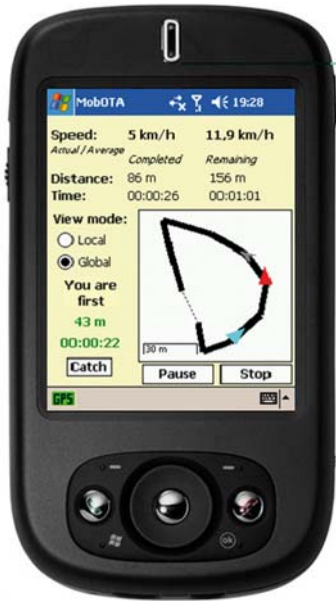
≡ Measurands



[1][2][3][11][14][18][19][20]

Sensors – Taxonomy(II)

≡ Field of application

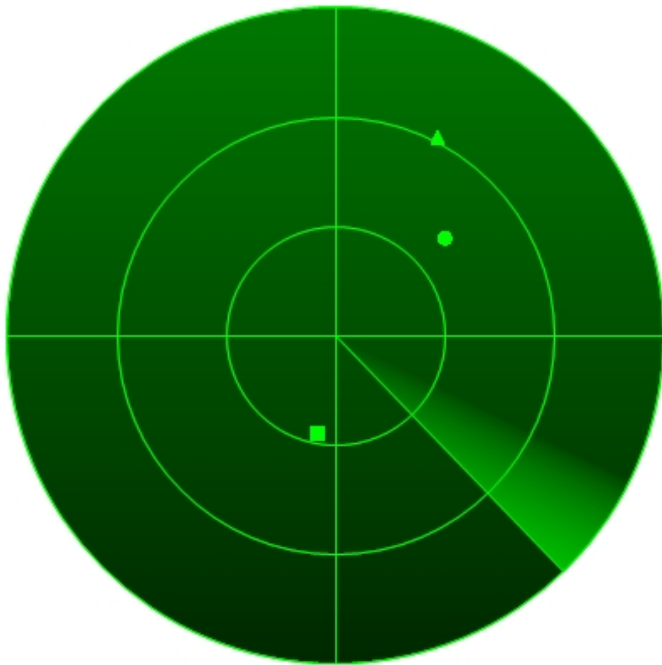


[8][11][18][19][20]

Sensors – Taxonomy(III)

≡ Additional taxonomies:

- ≡ Active & passive sensors (electrical / no electrical impulse)
- ≡ Absolute & relative sensors (fixed / relative scale)



Sensors - Data Fusion

≡ Problem: Large data sets & multidimensionality

≡ Solution: Data Fusion

≡ Feature Extraction

≡ Data Cleaning

≡ Data Reduction

≡ Dimension Reduction

Sensors - Space & Time

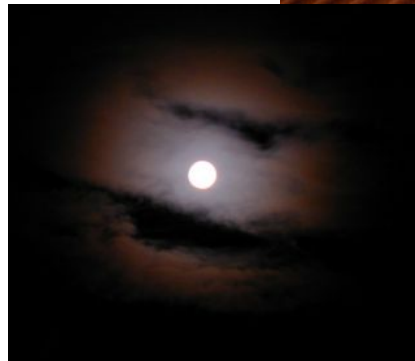
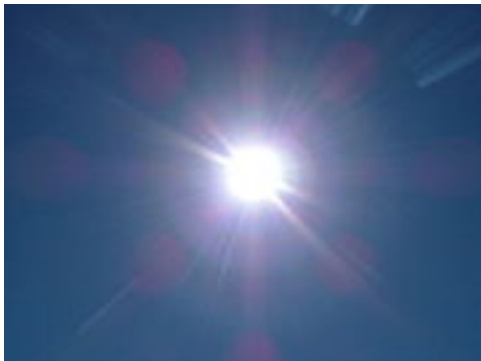
Additional important information of sensor data: **space and time**

Space

- Relative (e.g. door sensor)
- Absolute (e.g. position sensor)

Time

- Momentary (e.g. sonar)
- Continuous (e.g. heart rate)

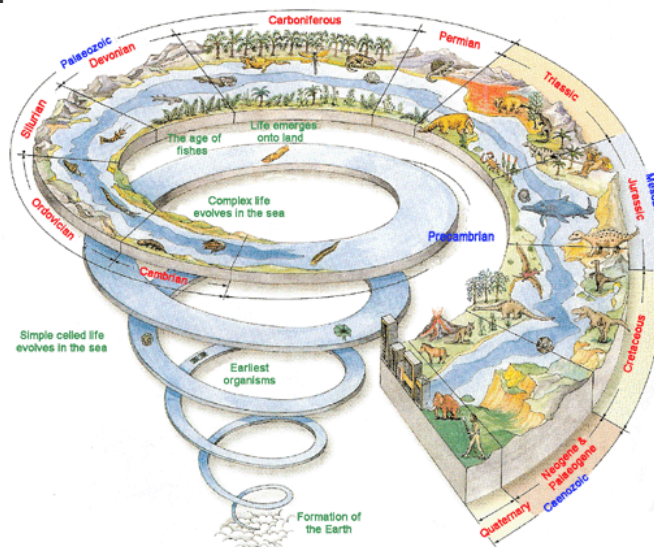


[11][23][24]

Visualizations – Taxonomy (I)

≡≡≡ Classification by Data Type (Shneiderman):

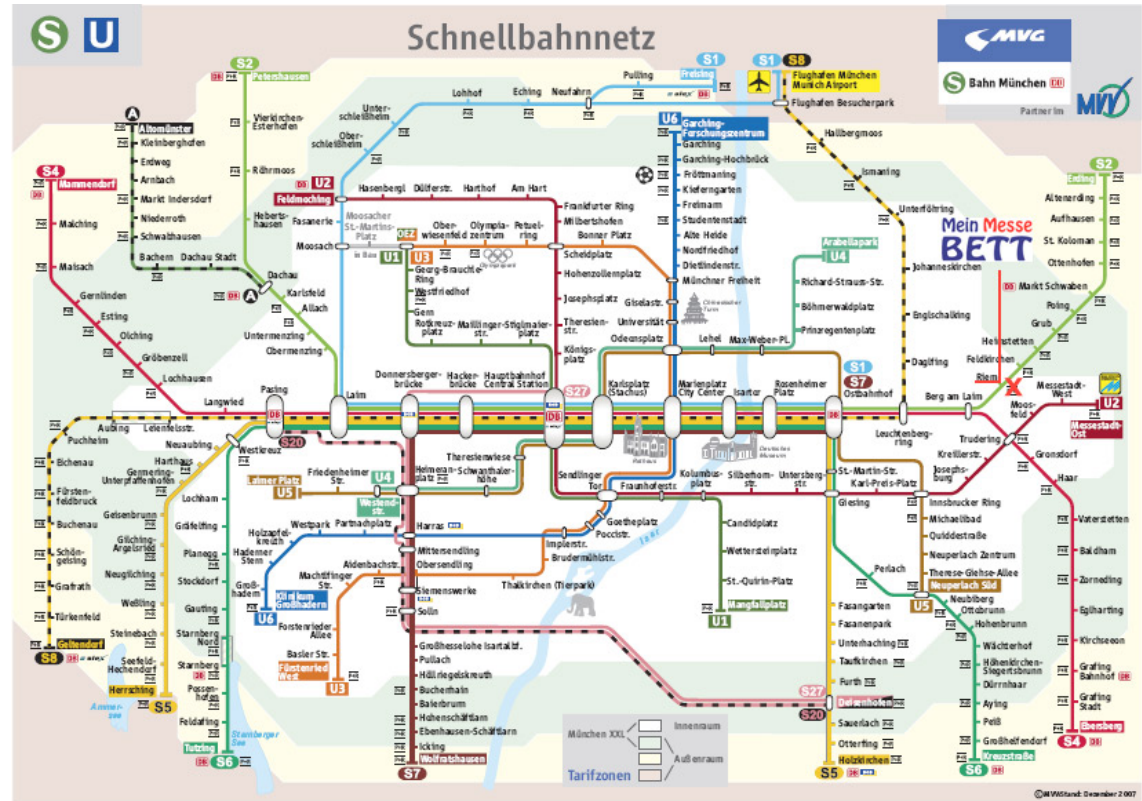
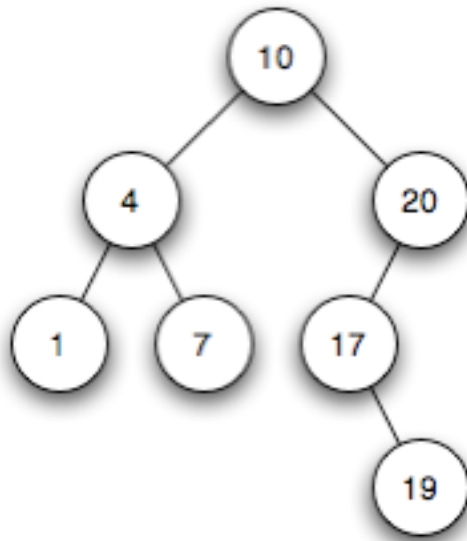
- ≡ 1-dimensional
- ≡ 2-dimensional
- ≡ 3-dimensional
- ≡ Temporal



Visualizations – Taxonomy (II)

Classification by Data Type (Shneiderman):

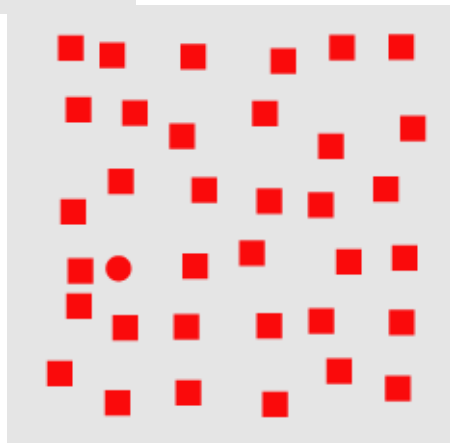
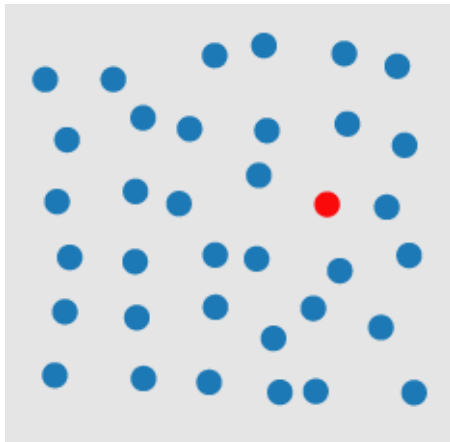
- ≡ Multi-dimensional
- ≡ Tree
- ≡ Network



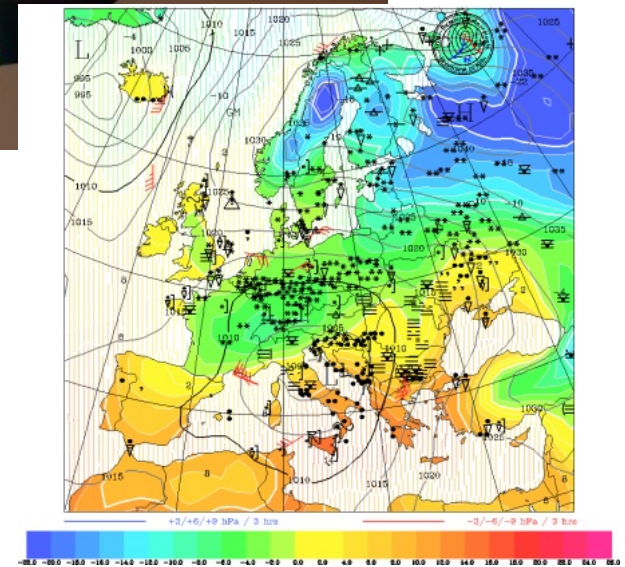
[11][12][25][26]

Visualizations – Guidelines (I)

≡ Perception



≡ Common Sense



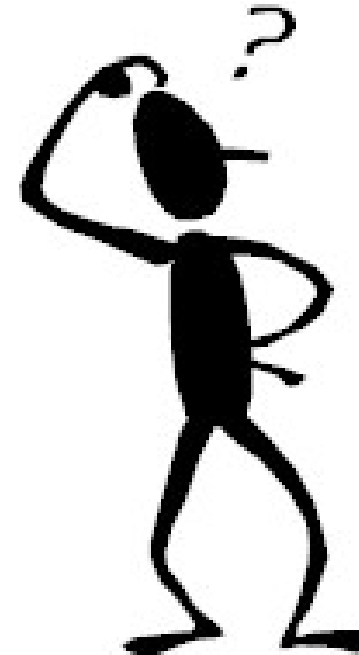
[4][7][27][28]

Visualizations – Guidelines (II)

☰ Interface



☰ User



Starting Points

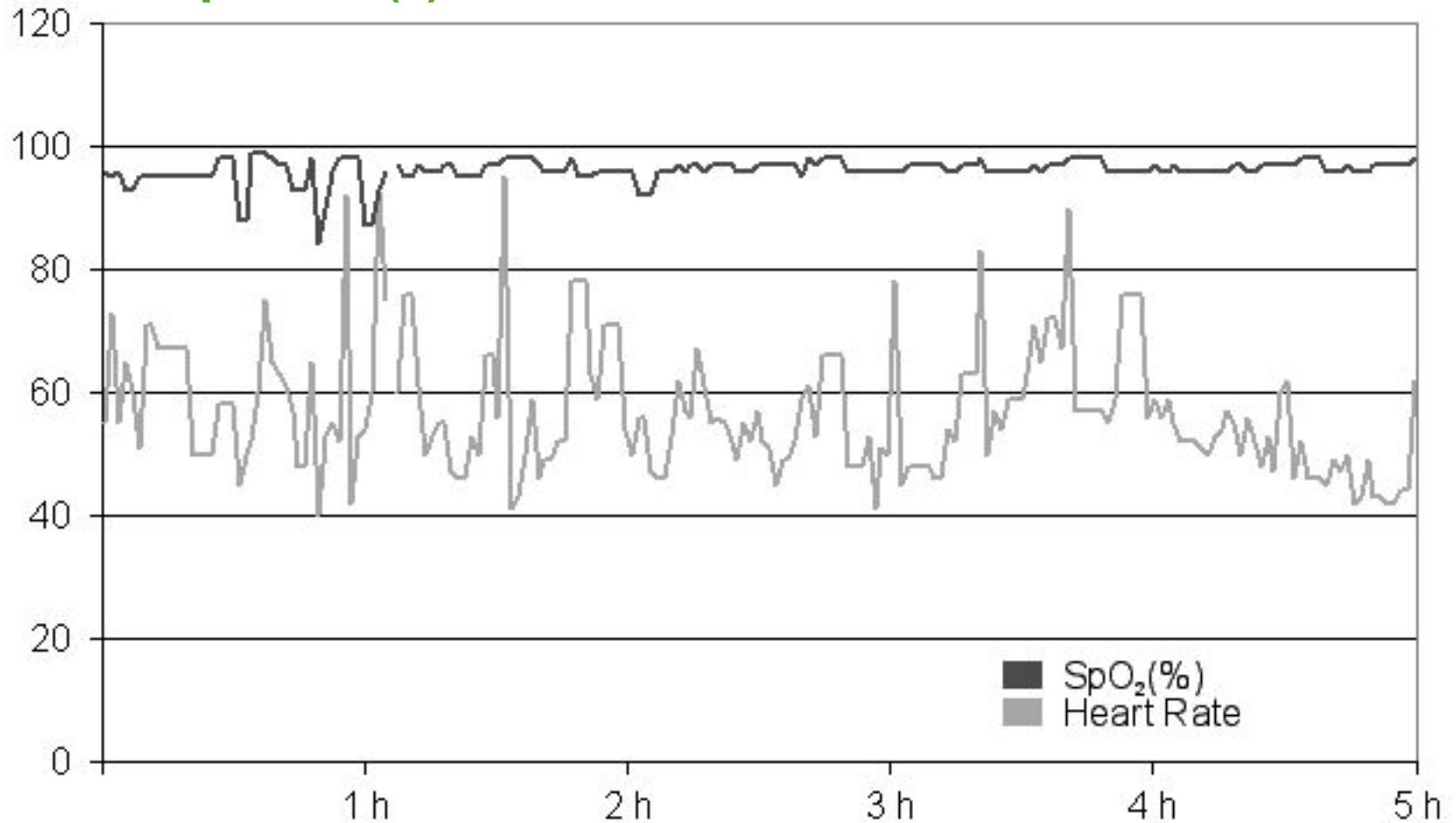
- ☰ Task itself as a starting point
- ☰ Number of sensors and dimension of the data
- ☰ Shneiderman's „Visual Information Seeking Mantra“
 - ☰ Overview first
 - ☰ Zoom and filter
 - ☰ Details on demand

Mapping

	1-dimensional	2-dimensional	3-dimensional	multi-dimensional
relative-momentary	1-dimensional	2-dimensional	3-dimensional	n-dimensional
relative-continuous	2-dimensional	3-dimensional	n-dimensional	n-dimensional
absolute-momentary	3-dimensional	n-dimensional	n-dimensional	n-dimensional
absolute-continuous	n-dimensional	n-dimensional	n-dimensional	n-dimensional

[25][26]

Examples (I)

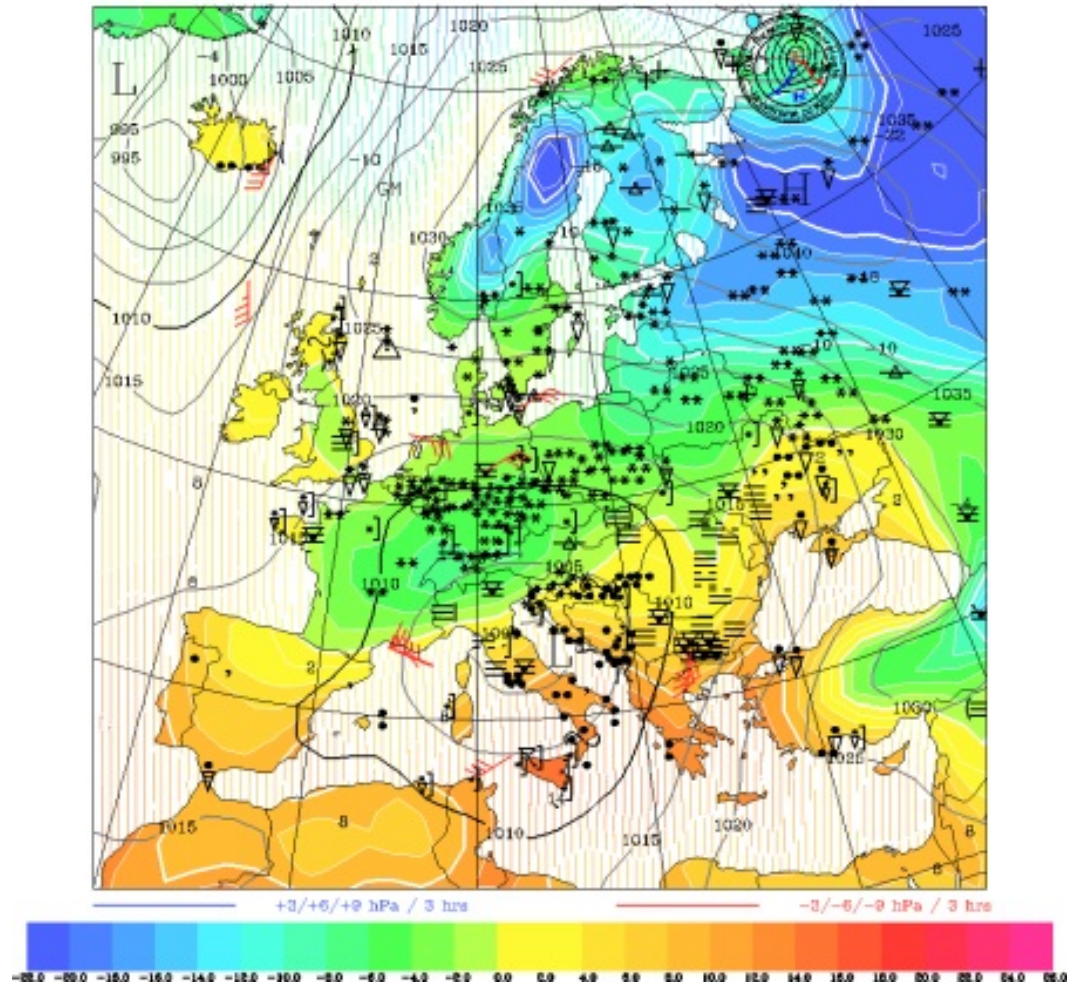


Oximeter measurements: Records SpO₂ concentration and heart rate

Data is 1-dimensional and relative-continuous

[29]

Examples (II)



Weather map showing Europe

Data is 1-dimensional and absolute-momentary

[4]

Examples (III)



Showing map of a navigation system

Data is 2-dimensional and relative-momentary

[10]

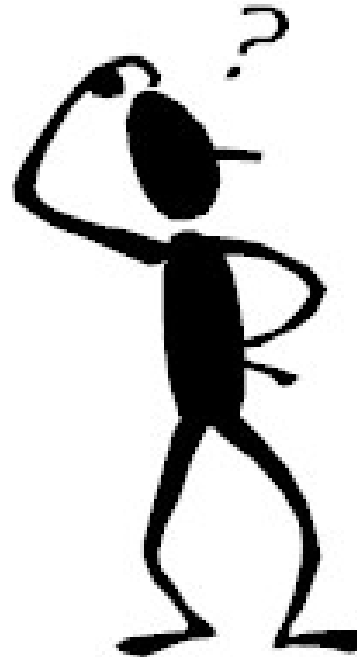
Summary & Conclusion

- ≡ A lot of possibilities to classify sensors
- ≡ Necessity of data fusion
- ≡ Importance of space and time
- ≡ Taxonomy of visualizations according to Shneiderman
- ≡ Guidelines (perception, common sense, interface, user)

- ≡ Check of the mapping with examples
- ≡ Mapping hard because of the development in hard- and software
- ≡ Visualizations look and feel according to every day life visualizations

Questions?

Questions?



References (I)

- [1] <http://www.elderly.com/> (Micro)
- [2] <http://de.wiktionary.org/wiki/Thermometer> (Thermometer)
- [3] <http://www.solarenergy-shop.ch/> (Bewegungsmelder)
- [4] <http://www.mir-co.net/wetter/wetterkarten.htm> (Wetterkarte)
- [5] <http://www.buechertransportdienst.de/> (Karte)
- [6] <http://www.dinosaurisle.com/> (Timeline)
- [7] <http://www.jux.de> (Ampel)
- [8] <http://www.fit.fraunhofer.de/> (PDA)
- [9] <http://www.wiedervermarktung.de/notebooks.html> (Notebook)
- [10] <http://www.connect.de/> (Navi)
- [11] <http://de.wikibooks.org/wiki/Hauptseite> (Baum, EKG, Geigerzähler, Wüste, Nordpol, Tag, Nacht)
- [12] <http://mein-messebett.de/bilder.htm> (Netzwerk)
- [13] <http://www.codeproject.com> (Radar)
- [14] <http://www.palintest.com.au/> (ph-Meter)

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- [26] B. Shneiderman, S. Card, J. Mackinlay, and B. Shneiderman. Readings in Information Visualization: Using Vision to Think. Morgan Kaufmann, 1999.
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- [29] F. Michahelles, P. Matter, A. Schmidt, and B. Schiele. Applying wearable sensors to avalanche rescue. Computers & Graphics, 27(6):839–847, 2003.