

Visualizing Sensor Data

Hauptseminar "Information Visualization - Wintersemester 2008/2009"

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Datum

Agenda

1. Aspects of sensors
2. Relevance of position and time
3. Aspects of visualization
4. A data type taxonomy
5. Visualizing for a user
6. Visualizing given data
7. Example of a sensor network / visualization

Aspects of sensors

- ≡ Sensor nodes combine:
 - ≡ Sensing components
 - ≡ A micro computer
 - ≡ A wireless communication device

- ≡ Different kinds of sensors:
 - ≡ Acoustic
 - ≡ Biological
 - ≡ Mechanical
 - ≡ Thermal
 - ≡ ...

- ≡ Application Areas:
 - ≡ Medicine
 - ≡ Military
 - ≡ Scientific Measurement
 - ≡ ...



Figure 1: The Mica2 (left) and ESB 430/2 (right) wireless sensor nodes



Sources: 1, 8

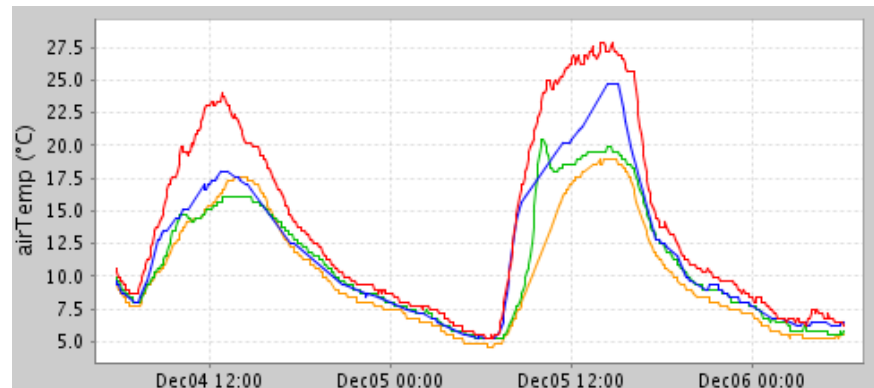
Relevance of position and time

- ≡ Sensor networks mostly used to observe a certain phenomenon
 - User wants to know, where and when a measured event occurred
- ≡ Reasons:
 - ≡ Reaction to an event
 - ≡ Interest in development over time
 - ≡ Possibility to define regions of interest (e.g. „only during the night“)
 - ≡ Space and time important components of data fusion
 - ≡ ...
- ≡ Node positioning and time synchronization fundamental
 - ≡ Fixed installation vs. arbitrary deployment
 - ≡ Absolute scales vs. relative scales

Aspects of visualization

☰ Many different kinds of visualization:

- ☰ Graphs
- ☰ Charts
- ☰ Maps
- ☰ Diagrams
- ☰ ...



☰ Choice of suitable visualization depends on:

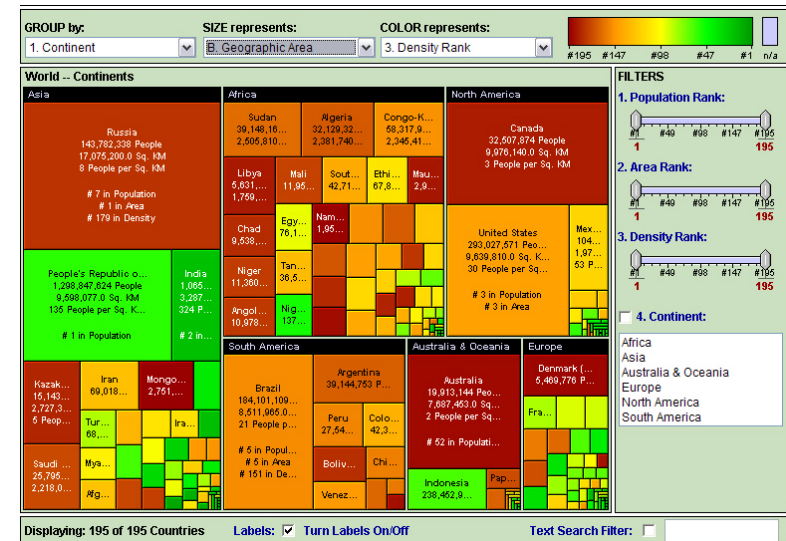
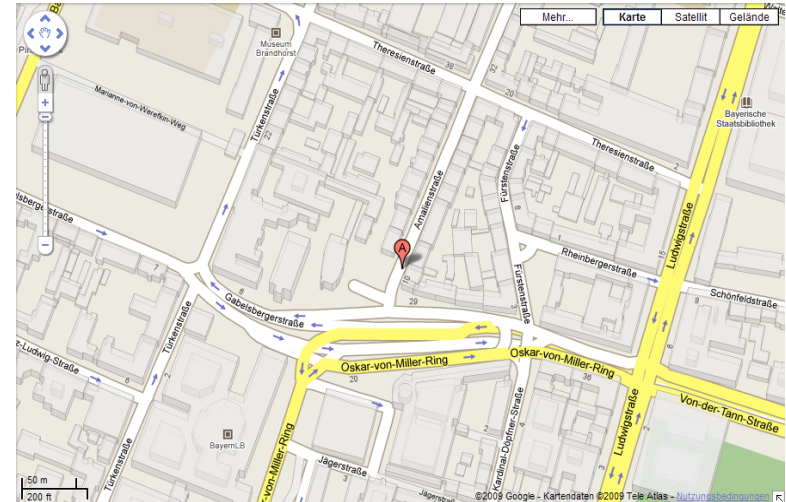
- ☰ Given data
- ☰ Application area
- ☰ Needs of the user
- ☰ ...



Sources: 2, 5

A data type taxonomy

- ≡ Shneiderman: Taxonomy of visualizations by data type[9]
- ≡ Seven data types:
 - ≡ 1-dimensional data: linear data types
 - ≡ 2-dimensional data: planar or map data
 - ≡ 3-dimensional data: real-world objects
 - ≡ Temporal data: have a start and finish time
 - ≡ Multidimensional data: points in a n-dimensional space
 - ≡ Tree data: hierarchy of items, which have a link to one parent item
 - ≡ Network data: items linked to an arbitrary number of items



Sources: 3, 7

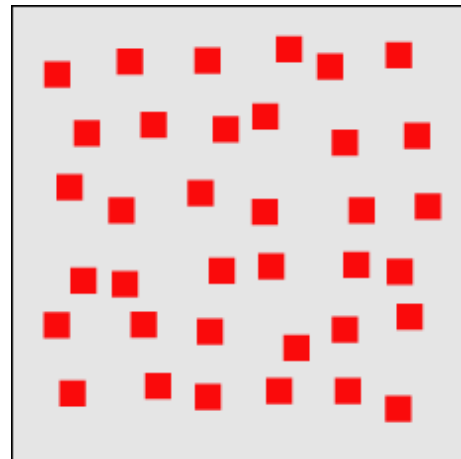
Visualizing for a user

☰ Tasks a user generally wants to perform (Shneiderman):

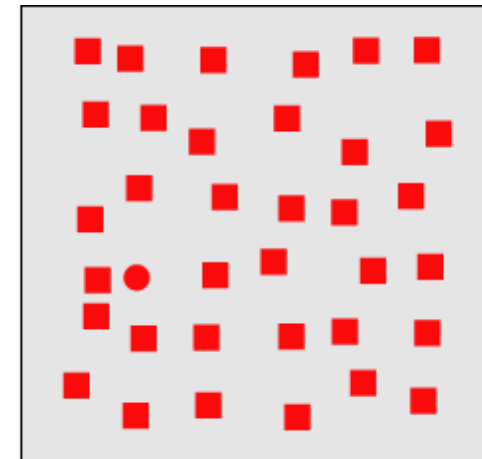
- ☰ Overview: Gain an overview of collection
- ☰ Zoom: Zoom in on special items
- ☰ Filter: Filter out uninteresting items
- ☰ Details-on-demand: Of items or groups
- ☰ Relate: View relationships
- ☰ History: Of actions
- ☰ Extract: Sub-collections

☰ Human perception:

- ☰ Preattentive processing
- ☰ Color encodings



(a)



(b)

Source: 6

Visualizing given data

- ☰ Too many possible application areas and needs of the user
 - Limitation of possible visualizations regarding the dimension of the data

- ☰ Aspects of dimension:

- ☰ Position of sensor
- ☰ Time of measurement
- ☰ Number of measurands

→ Possible classification of sensor data by dimensions:

	Spatio-temporal			
	relative		absolute	
	momentary	continuous	momentary	continuous
1-dimensional	1-dimensional	2-dimensional	3-dimensional	multidimensional
2-dimensional	2-dimensional	3-dimensional	multidimensional	multidimensional
3-dimensional	3-dimensional	multidimensional	multidimensional	multidimensional
multidimensional	multidimensional	multidimensional	multidimensional	multidimensional

- ☰ Example: Temperature-sensor monitoring temperature of machine x in a factory
 - 1-dimensional sensor (temperature), continuously measuring at relative position (machine x)
 - 2-dimensional data, e.g. to be shown in a line graph

Example of an existing network

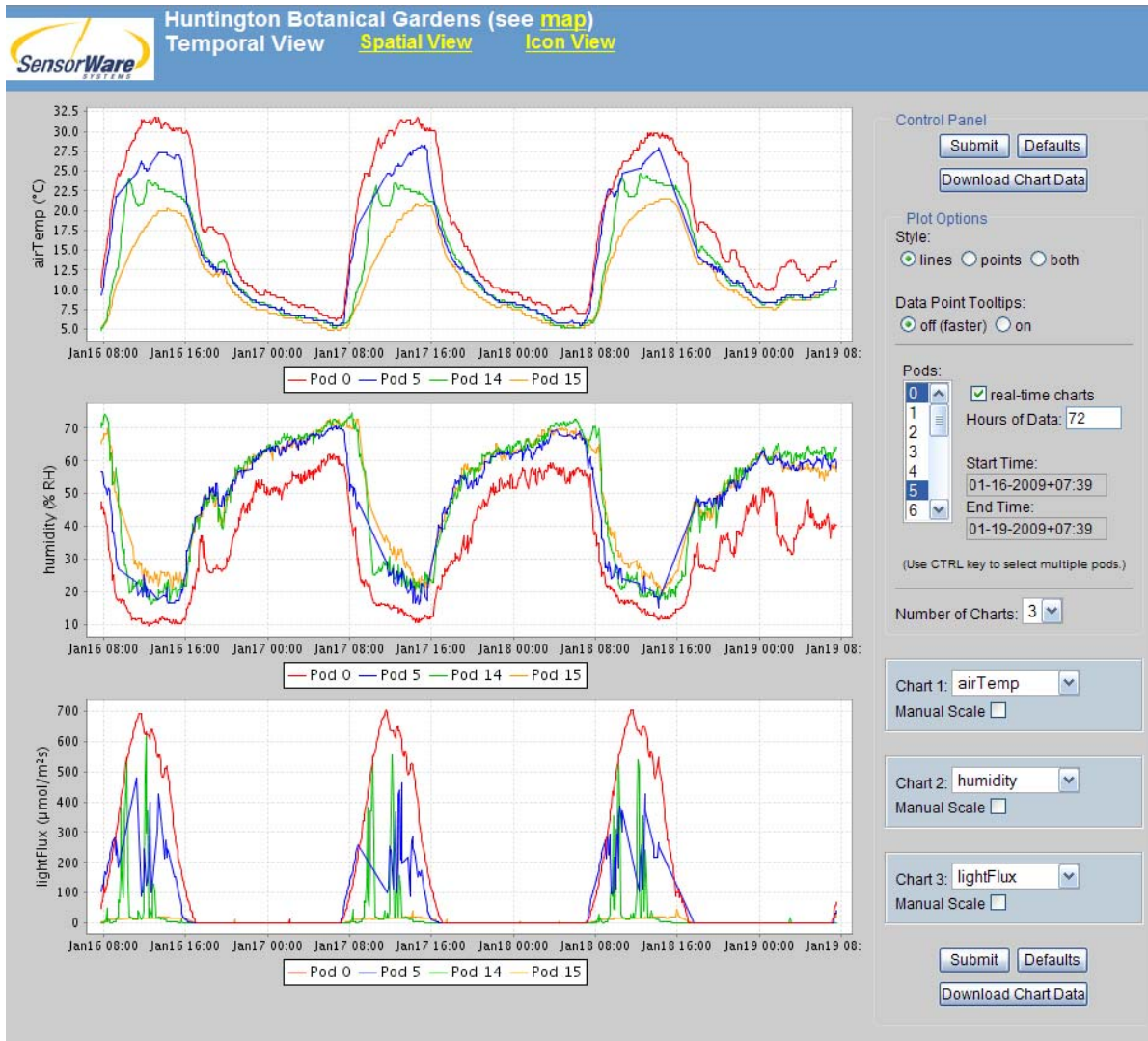
SensorWare Systems Sensor Web pods in Huntington Botanical Garden, San Marino, CA:

- ≡ Since June 2000
- ≡ By now 20 pods, building a permanent wireless sensor network
- ≡ Pods consisting of: radio, microcontroller, battery pack, special packaging and a sensor suite
- ≡ Sensor suite able to sense: air temperature, air humidity, light levels, soil temperature, soil moisture, battery status, own temperature
- ≡ Visualization open to everybody over:
<http://caupanga.huntington.org/swim/>



Source: 4

Example of a visualization I



Temporal View:

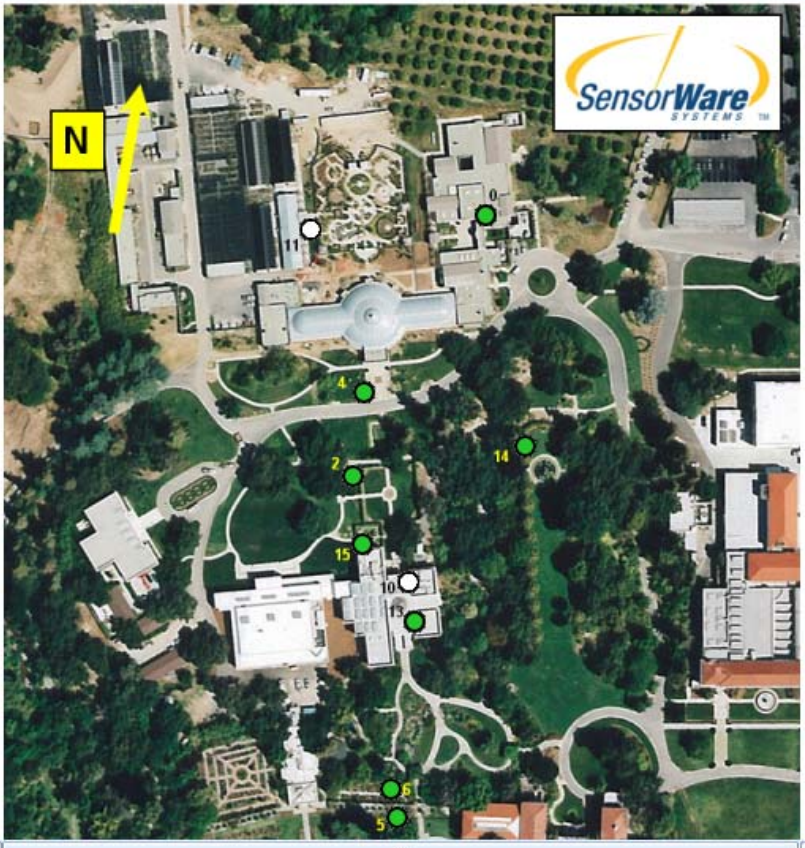
- ≡ Line graphs
- ≡ Interaction panel
 - ≡ Style
 - ≡ Pods
 - ≡ Time of measurement
 - ≡ Measurands

Source: 2

Example of a visualization II

SensorWare SYSTEMS | **Huntington Botanical Gardens (see [map](#))**
 Spatial View | [Temporal View](#) | [Icon View](#)

humidity



caupanga-> web-> 14-> humidity	
Pod ID:	14
humidity:	63 (% RH)
@:	Jan 19, 2009 07:54 (PST)
Condition Limits	
+ Warning:90	+ Alert:95
- Warning:30	- Alert:10

Modify display:

Real-time:

Time: 01/19/2009 07:55
(MM/DD/YYYY HH:mm)

Submit

Select Measurement: humidity

Jump (min): -30 -5 +5 +30
 Jump (day): -1 +1

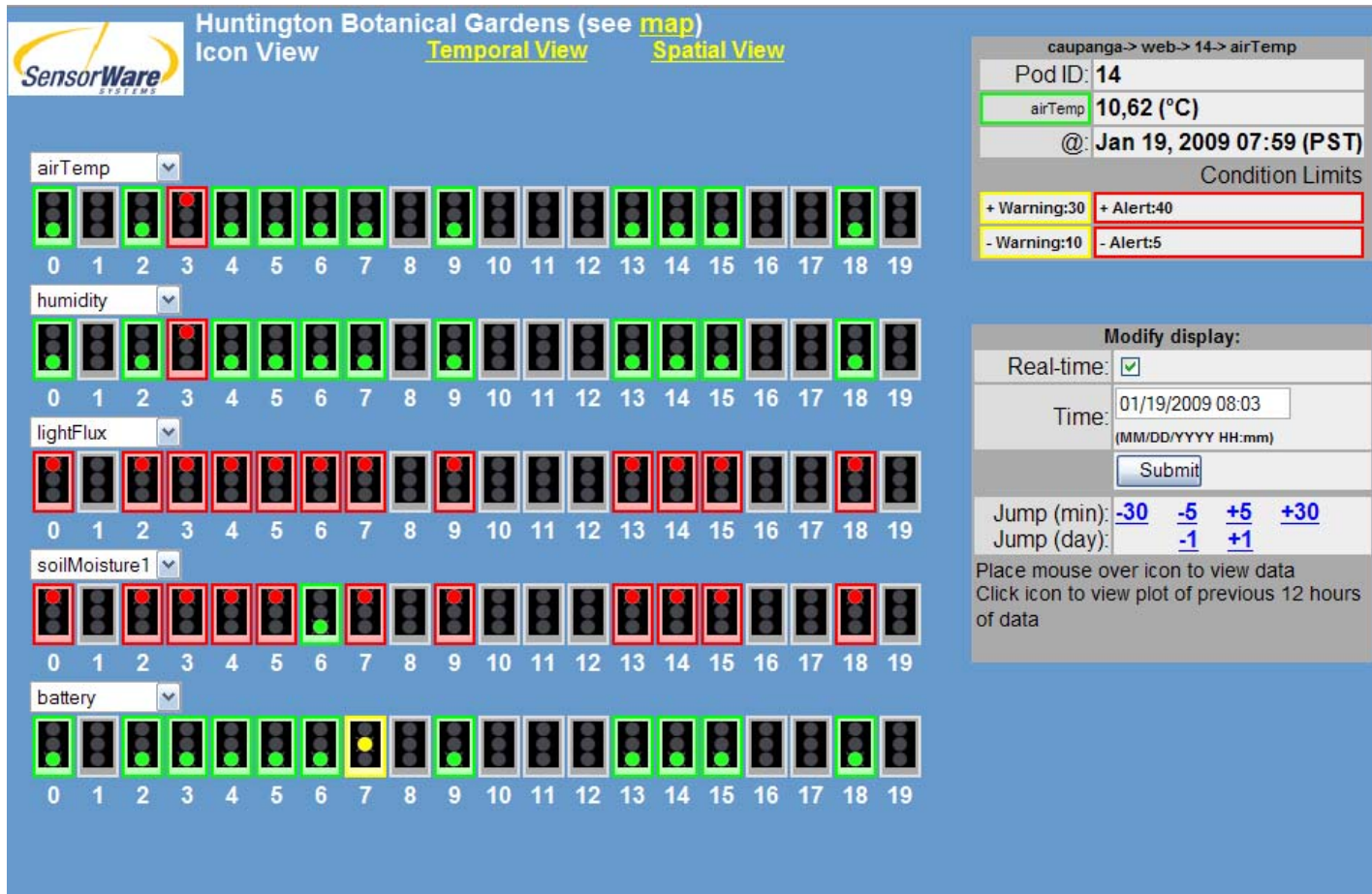
Place mouse over dot to view data
 Click dot to view plot of previous 12 hours of data

Spatial View:

- ≡ Image
- ≡ Pod-Details
- ≡ Interaction panel
 - ≡ Time of measurement
 - ≡ Measurands

Source: 2

Example of a visualization III



Icon View:

- ≡ Lines of traffic lights
- ≡ Pod-Details
- ≡ Interaction panel
 - ≡ Time of measurement
 - ≡ Measurands

Source: 2

Any questions?

Thank you!

References

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3. <http://maps.google.de/>
4. <http://sensorwaresystems.com/historical/resources/pictures/hunt-107.shtml>
5. <http://service.tagesschau.de/wetter/deutschland/vorhersage.html>
6. <http://www.csc.ncsu.edu/faculty/healey/PP/index.html>
7. http://www.georgehernandez.com/h/aaBlog/2006/media/04-18-World_TreeMap.jpg
8. T. R. Nelson and T. T. Elvins. Visualization of 3D ultrasound data. Computer Graphics and Applications, IEEE, 13(6):50-57, 1993.
9. B. Shneiderman. The eyes have it: a task by data type taxonomy for information visualizations. In Visual Languages, 1996. Proceedings., IEEE Symposium on, pages 336-343, 1996.