



Wireless Sensor Networks and Applications
Dagstuhl, Germany, 2004-03-18

Sensor Networks - A Resource for Novel Interactive Applications?

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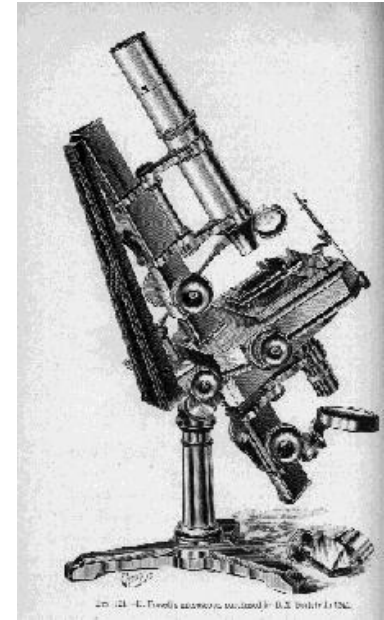
Applications of Sensor Networks

- Is there a general applications theme?
- Wireless sensor networks as a scientific tool
 - Acquire new information
 - Allow interaction with information
- Sensors to acquire (implicit and explicit) user interaction
 - Facilitate new usage
 - Sensor information as basis for interaction
 - New tools for interaction

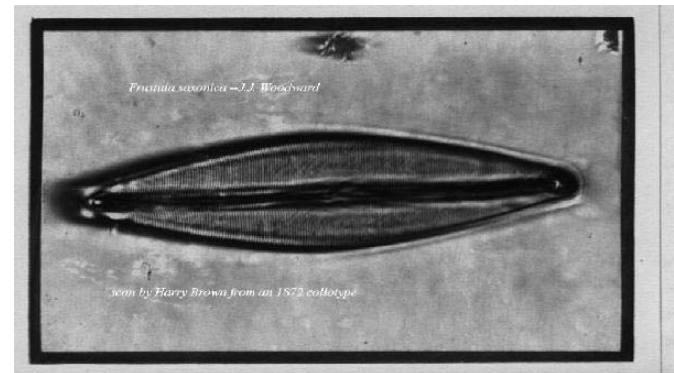
Wireless sensor networks as a scientific tool

What is Science About? Understanding the World?

*"Of all the inventions none there is Surpasses
the noble Florentine's Dioptrick Glasses
For what a better, fitter guift Could bee
in this World's Aged Luciosity.
To help our Blindnesses so as to devize
a paire of new & Artificial eyes
By whose augmenting power wee now see
more than all world Has ever down Before."*



'In commendation of ye microscope'
Henry Powers 1664 (in the old English)



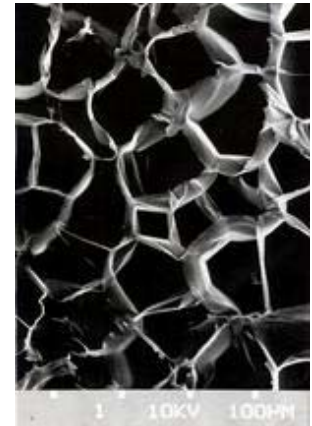
<http://members.aol.com/Hbronstein/index/alb2.htm>

<http://www.udayton.edu/~hume/Microscope/microscope.htm>

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More About the Microscope...

- Scientists describe and explain the world based on what they can observe
- But there are lot of things you can not see without augmentation of your senses!
- The invention of the microscope changed science
 - People are able to see things that are very small
 - People can understand processes because of the observations
 - Education in science has changed, people can learn things differently
- What do we really see when looking through a microscope?
- What can you see with an electron microscope?



Are Sensor Networks the next generation of “Microscopes”?

- Sensor networks may
 - allow us to see things we were not aware of before
 - help to monitor actions we have not understood before
 - be tools to teach things differently because we can directly observe them
- ... But I am doubtful that the one developing the **microscope** is also discovering the **bacteria**...
- It is not so much about the question "what does the data tell me?"
- It may lead to a point where we help to find a new understanding

So what are sensor networks...

... don't really want to go in this discussion?

- The number of nodes deployed
 - One sensor connected wirelessly to a base station
 - ...
 - Millions, billions, ... of sensors forming networks
- Scale of deployment
 - Microscopic: Many very small sensors distributed over a petri dish (e.g. monitoring a chemical reaction)
 - ...
 - Large scale: Sensors distributed over a continent or in space (e.g. monitoring the movement of land-masses)
- Extrinsic and intrinsic sensing
 - Sensing by observation (e.g. satellite, vision, remote-*)
 - ...
 - Sensing from within

Research Approach?

- Lot of horizontal research
- Need prototypes (vertical research) additional to horizontal!
- Even if the technology is far from being usable we should engage with the anticipated users
- Building specific solutions and verifying/questioning assumptions we make
- ... hope that we can generalize the results
- we should try to build the "**microscope**"
... but we should not assume that we are the ones discovering "**bacteria**"

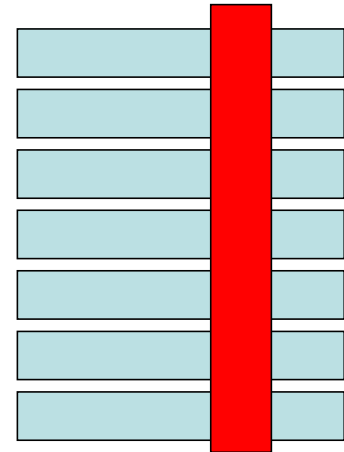
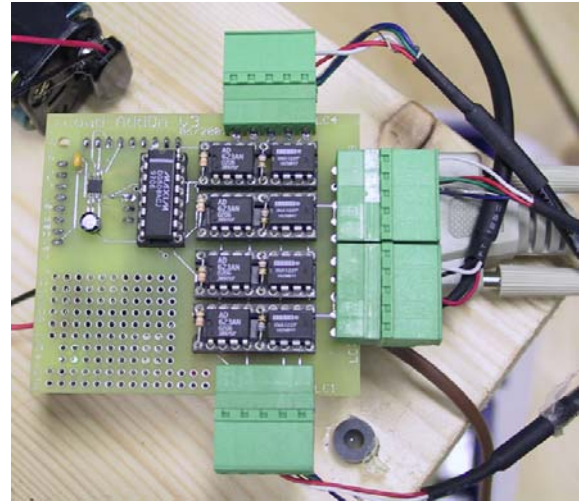
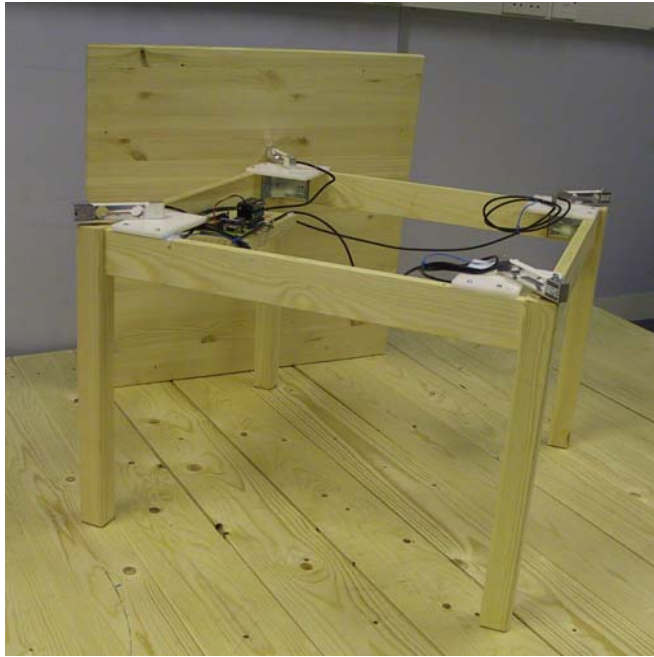
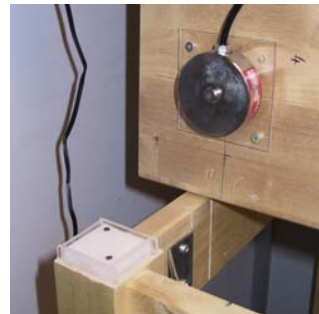
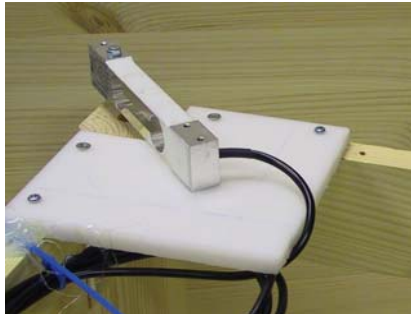


Table & Floor as Wireless Sensors



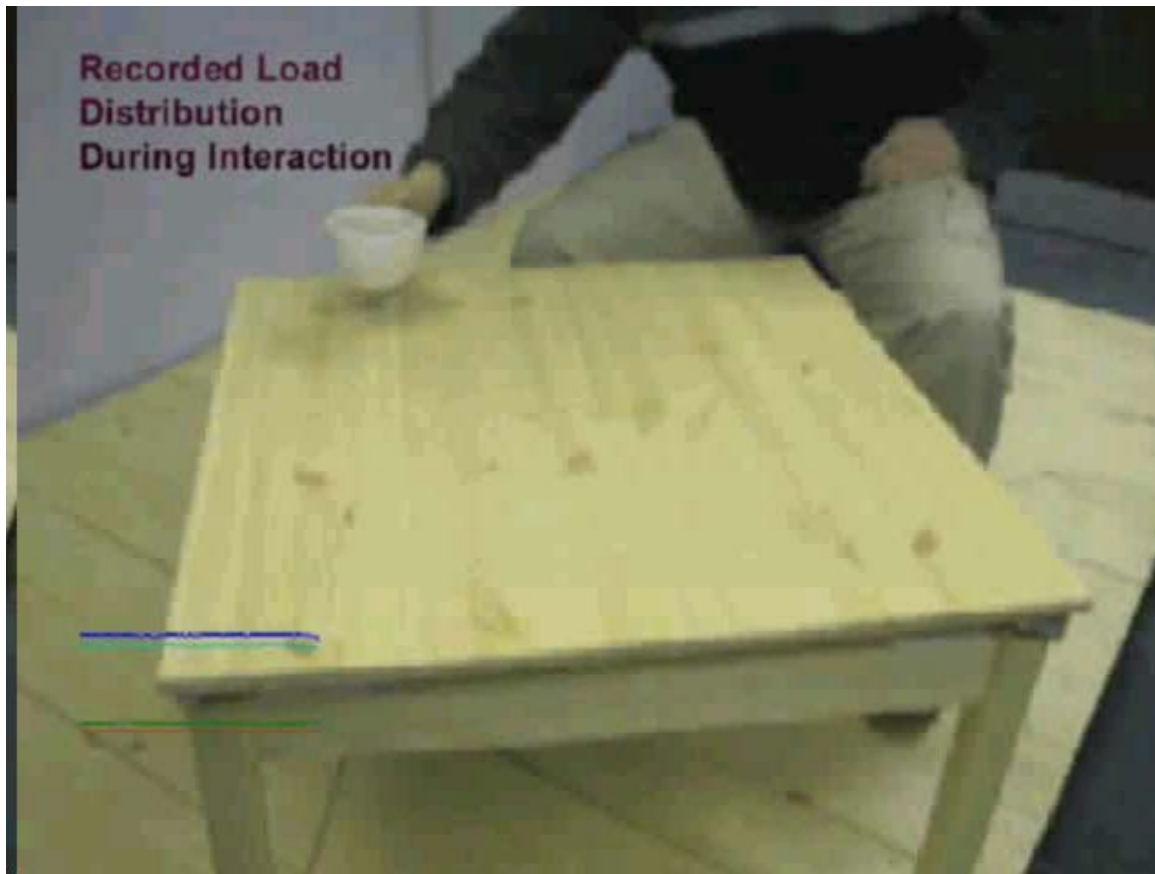
- Smart-Its sensor AddOn board
- 16 Bit DA
- Instrumentation Amps



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Load-Sensing Surface

Surfaces as Interaction Device



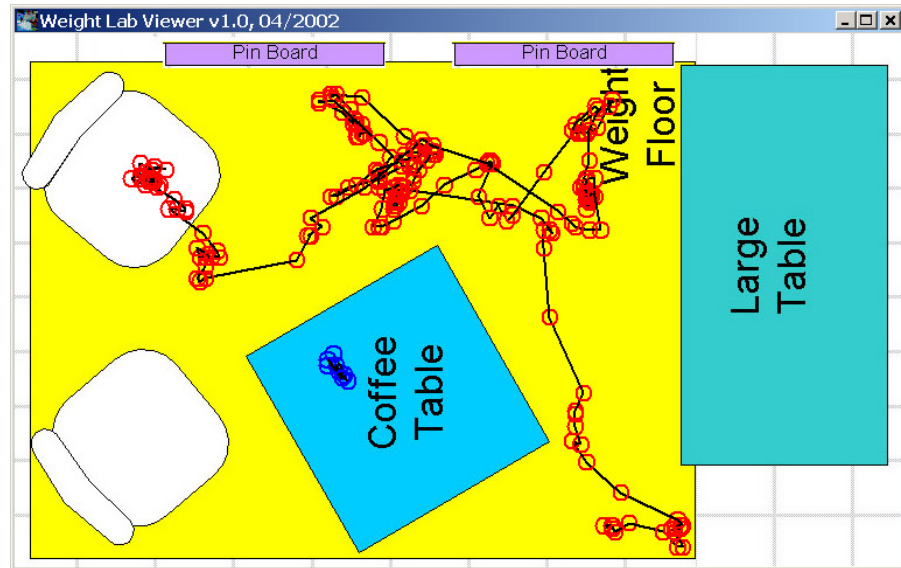
Load-Sensing Surfaces

Weight Lab

- Lab environment with load-sensing floor, tables, and shelves
- Common furniture, unobtrusively augmented (wireless)

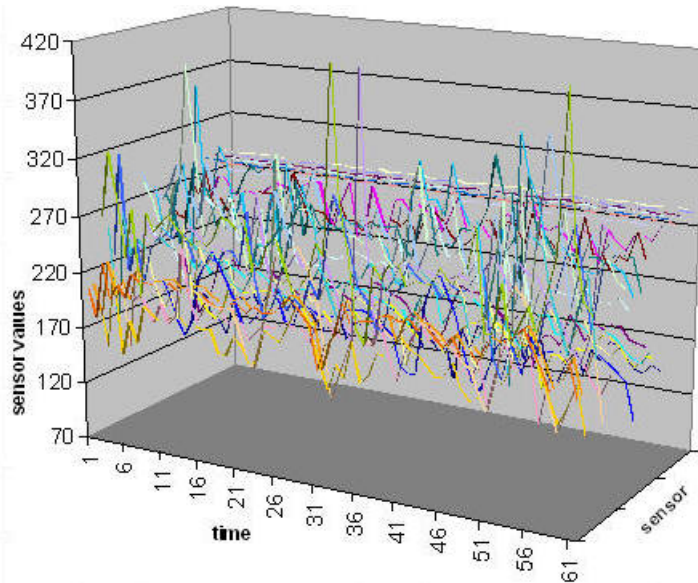
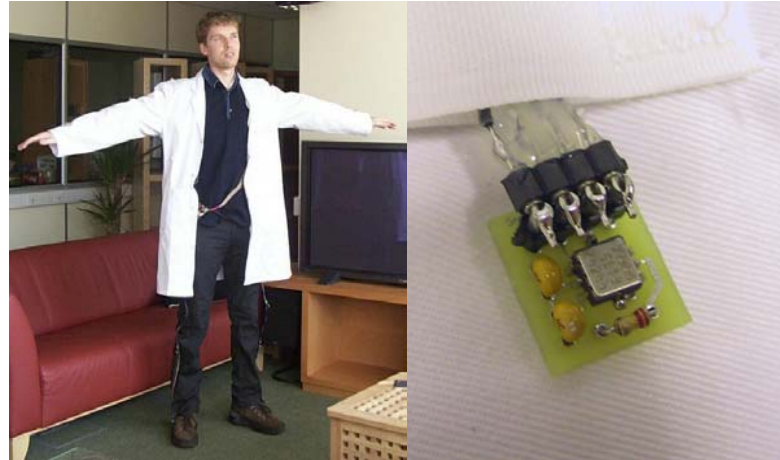
Context Acquisition

- Tracking of people, objects, activities
- In presence of noise (cluttered surfaces)



Body Sensor Network

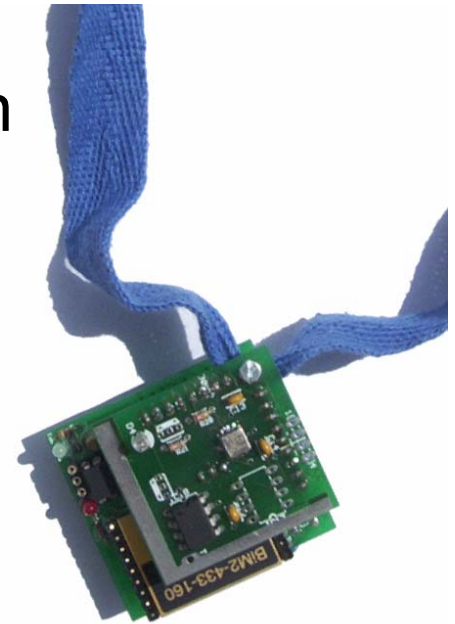
- 30 acceleration sensors
- Distributed over the body (trousers and lab jacket)
- Wired connection



Assessing human behaviour with networked wearable sensors?

A personalized, wireless, wearable device (Realized using Smart-Its)

- processor, memory, sensors, communication, battery
- customizing the local environment
- support for explicit and implicit interaction



What can you observe?

- Encounters and activity
- Social network of a person
- would the data of 1000 people over 1 year give us new insight in human behaviour?



Novel user interfaces using wireless sensor networks

Why bother with sensor based physical user interfaces – looking at history ...

From text-based UIs to GUIs and direct manipulation

- Empowering non-expert users
- Teaching by demonstration
- Immediate feedback
- Actions are comprehensible and reversible
- New level of “explorability”

Facilitated the move towards widespread Personal Computing

- Considering the user as integral part of the system

Resulted in novel applications and new interfaces

So what is different from traditional HCI and User interface design

- Input modalities
 - more than pressing buttons and moving an object in two dimensions
- Output modalities
 - not just an audio visual channel
 - all senses!
- Distribution – physical and conceptual

Magic beyond the screen

- ... it is a vivid physical relationship

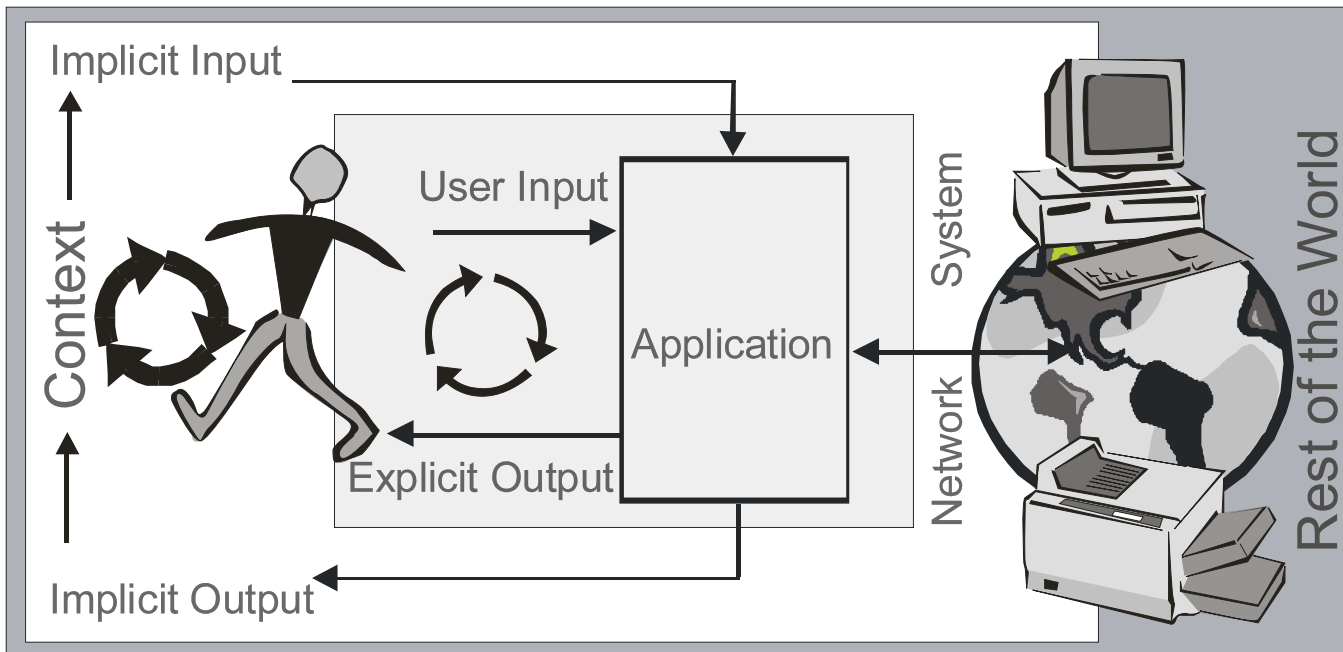
Physical interfaces are not new

- Long tradition in mankind
 - Significant body of knowledge available
- Musical instrument
 - You never reach a point where you can't improve your performance
 - Enormous learning effort for a single application



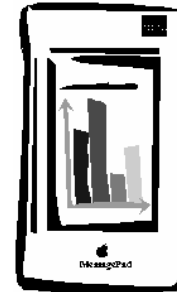
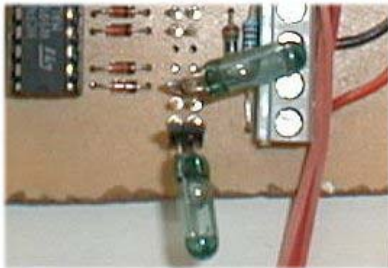
Implicit Interaction

**Invisibility & transparent use vs.
traditional explicit human computer interaction**

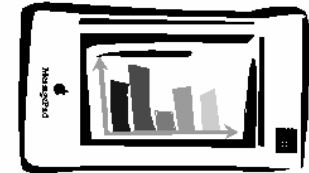
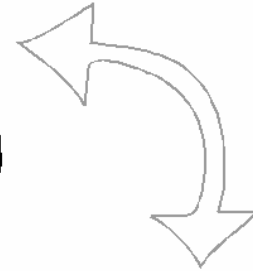


Getting Physical

Initial experience (1998)



Portrait



Landscape

Context-Aware Computing

- location is just one dimension...

Extremely simple, but still it creates a new experience

- 2-Bit Input
- Not an input device
- Very specific function

Project TEA

(European project, completed in 2000)

Technology for Enabling Awareness

Project goal

- building an add on component that supplies awareness to a mobile device

Technology

- Sensors to provide location independent contexts (acceleration, light, sound, temperature)



Project TEA cont.

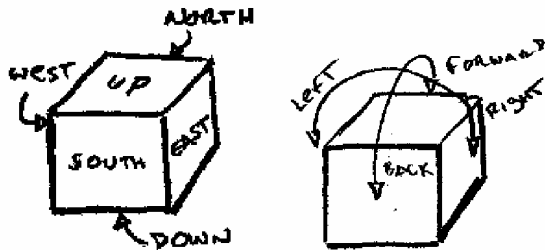
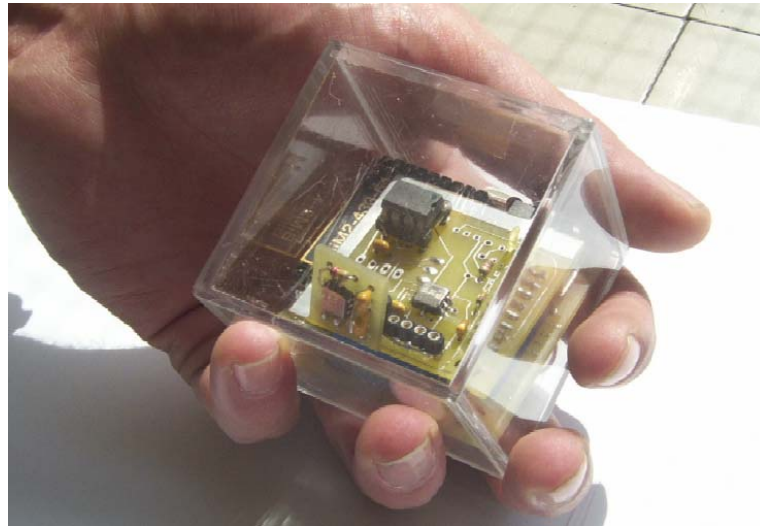
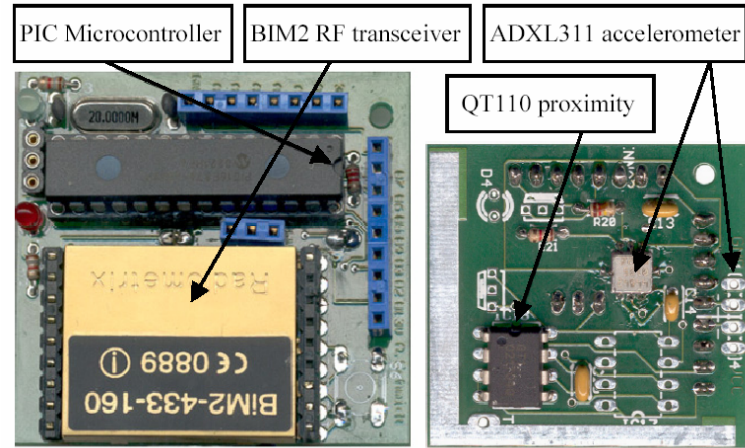
Applications

- user interface adapts to situations/context
- Implemented example applications
 - automated profile change
 - context sharing
- Recognized contexts
 - hand
 - table
 - Suitcase
 - wardrobe
 - outside

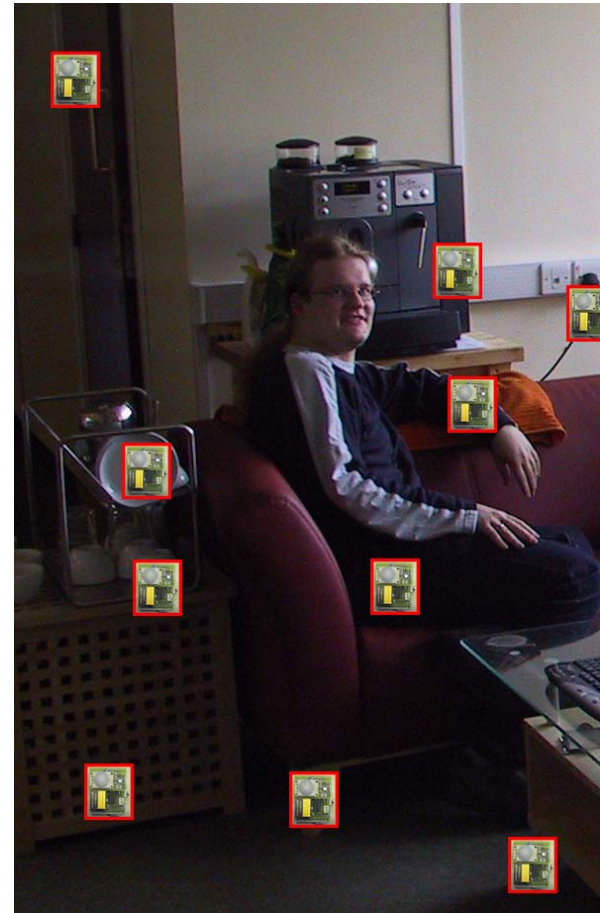
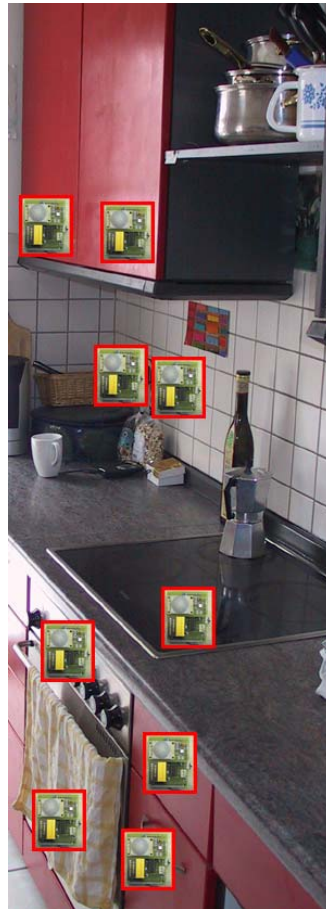


Wireless Sensors in Cubes

- Exploring the question if there is a tangible UIs



Vision of future environments



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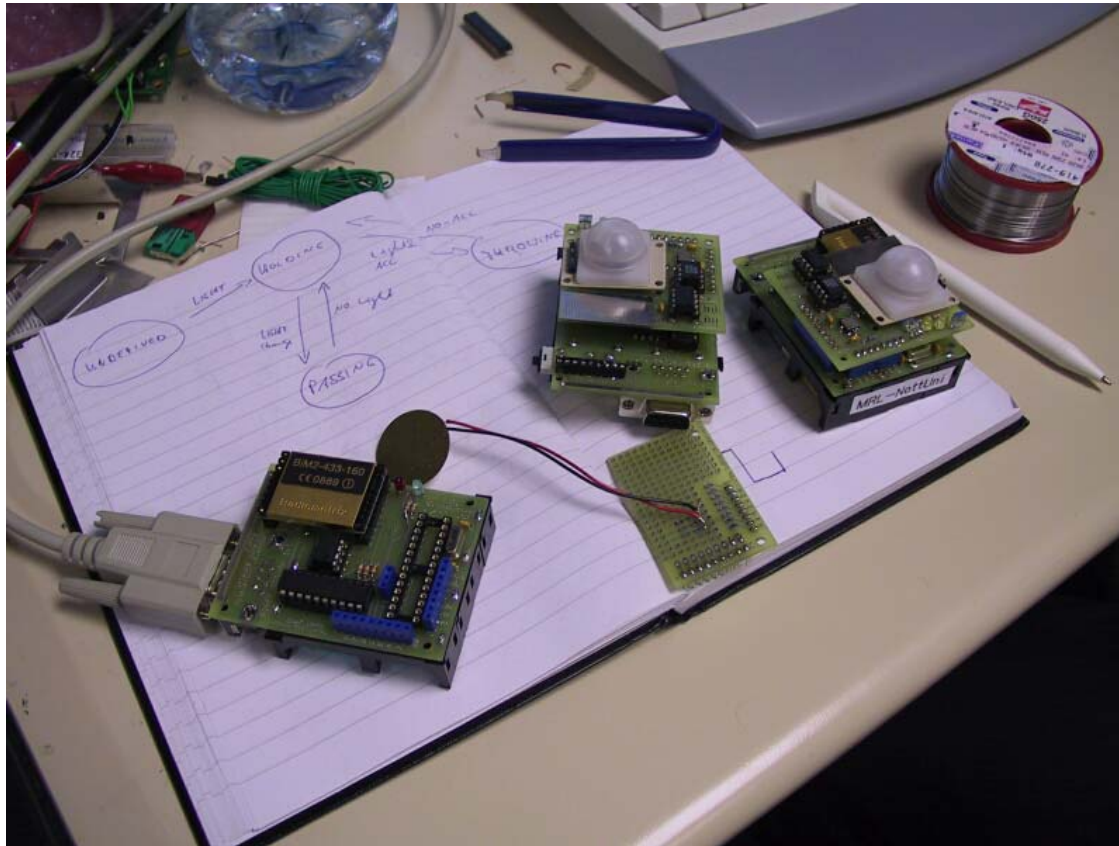
Vision of future environments



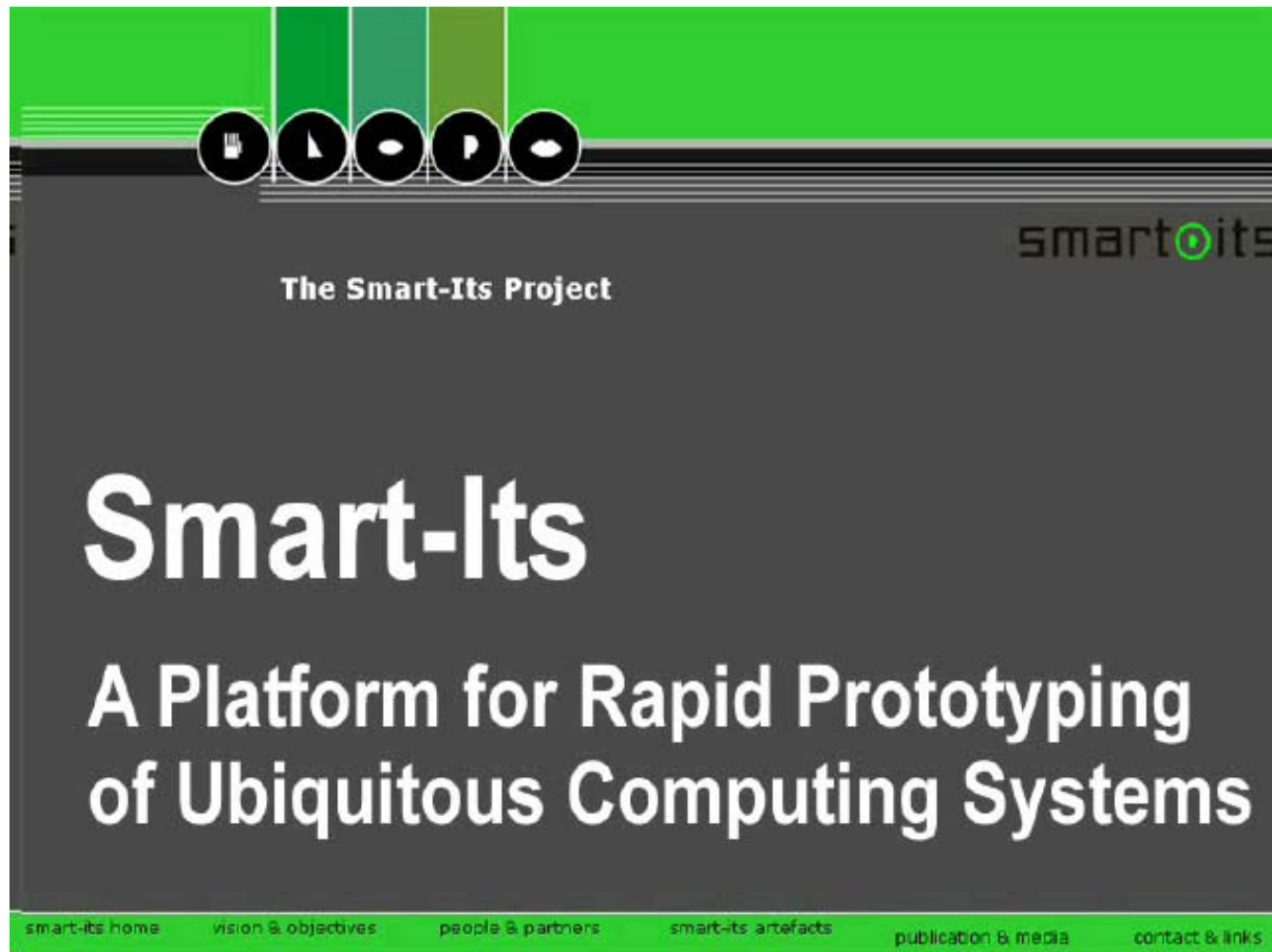
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Physical Prototyping

rapid cycles between idea and tangible evaluation



Prototyping Exercise - Impressions



The screenshot shows a website for 'The Smart-Its Project'. At the top, there is a green header with a navigation bar containing five circular icons: a hand, a play button, a stop button, a right arrow, and a left arrow. Below the header, the text 'The Smart-Its Project' is displayed in white on a dark grey background. The main content area features the title 'Smart-Its' in a large, bold, white font, followed by the subtitle 'A Platform for Rapid Prototyping of Ubiquitous Computing Systems' in a slightly smaller, bold, white font. In the top right corner, the 'smart@its' logo is visible. At the bottom, a green footer contains a navigation menu with the following links: 'smart-its home', 'vision & objectives', 'people & partners', 'smart-its artefacts', 'publication & media', and 'contact & links'.

The Smart-Its Project

Smart-Its

A Platform for Rapid Prototyping
of Ubiquitous Computing Systems

smart@its

smart-its home vision & objectives people & partners smart-its artefacts publication & media contact & links

Smart-Its – A Ubiquitous Computing Platform

Means for exploring applications and new forms of physical interaction

- Building scenarios
 - Rapid-prototyping of interactive applications
 - explore interaction with the Ubiquitous Computer
- Purposefully simple in composition
- Hardware
 - Encouraging design of customized I/O boards
 - e.g. multi-sensor board
 - e.g. actuator control board
- Software
 - Abstractions for sensing and communication



Sensor and actuator nodes in the lab



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Conclusions

- Application areas for wireless sensor networks
 - Scientific tool research and education
 - Enabling technology for novel user interfaces
- Platform and deployment is critical
 - Horizontal research is a prerequisite
 - But without vertical research we will not find applications
 - Make the technology work ...
 - ...and “get the user into the loop”
- Some demos of the DYI-Smart-It in the demo session or at:
<http://ubicomp.lancs.ac.uk/twiki/bin/viewauth/Smartits/WebHome>