Finding Small Changes Using Sensor Networks

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Outline

- Background and Motivation
- Our Experiment
  - Prototype sensor nodes
  - Finding "small changes" using a sensor network
- Conclusion / Discussion

Background

- Ubiquitous Computing
  - *"Next comes ubiquitous computing, or the age of calm technology, when technology recedes into the background of our lives."*
    - M.Weiser

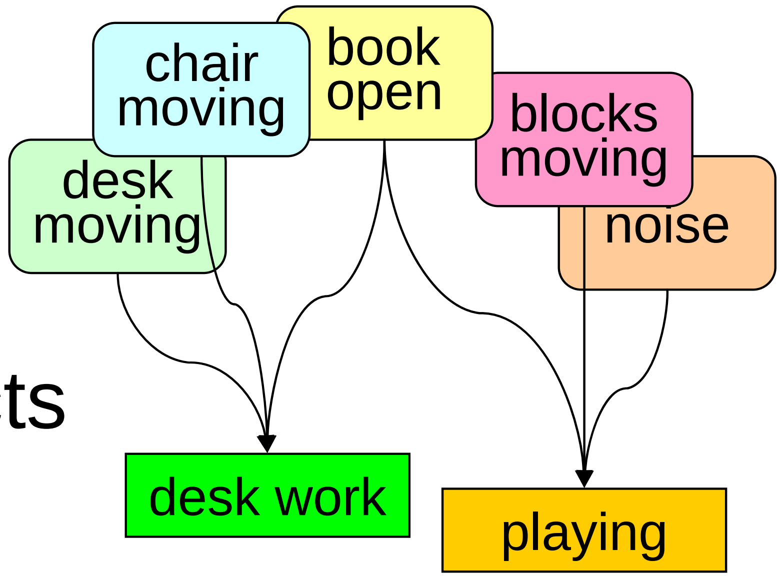
- Smart Environment Assists Daily Life
  - actualized by small sensors and networks
  - Not only factories and hospitals
    but also home and office.

Target:
context-aware applications
in home and office

Motivation

- Context-aware applications need “contexts”
  - In home and office,
    hard to abstract “contexts”
    because a system might observe
    various behaviors that
    relate to many objects.

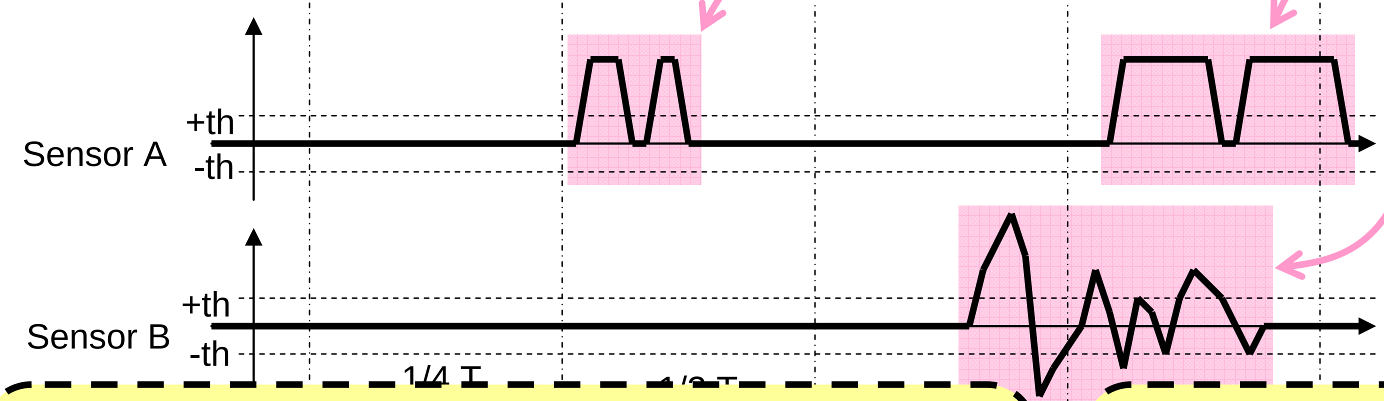
- We describe contexts
  based on small changes
  of sensor data captured by
  sensor nodes attached to objects



“Small changes” in Sensor Data

Change within a time window exceeds threshold

Small change



Advantages:

- Easy calculation using low CPU power
- Possible to pack data into small packets (better for network load)

Disadvantages:

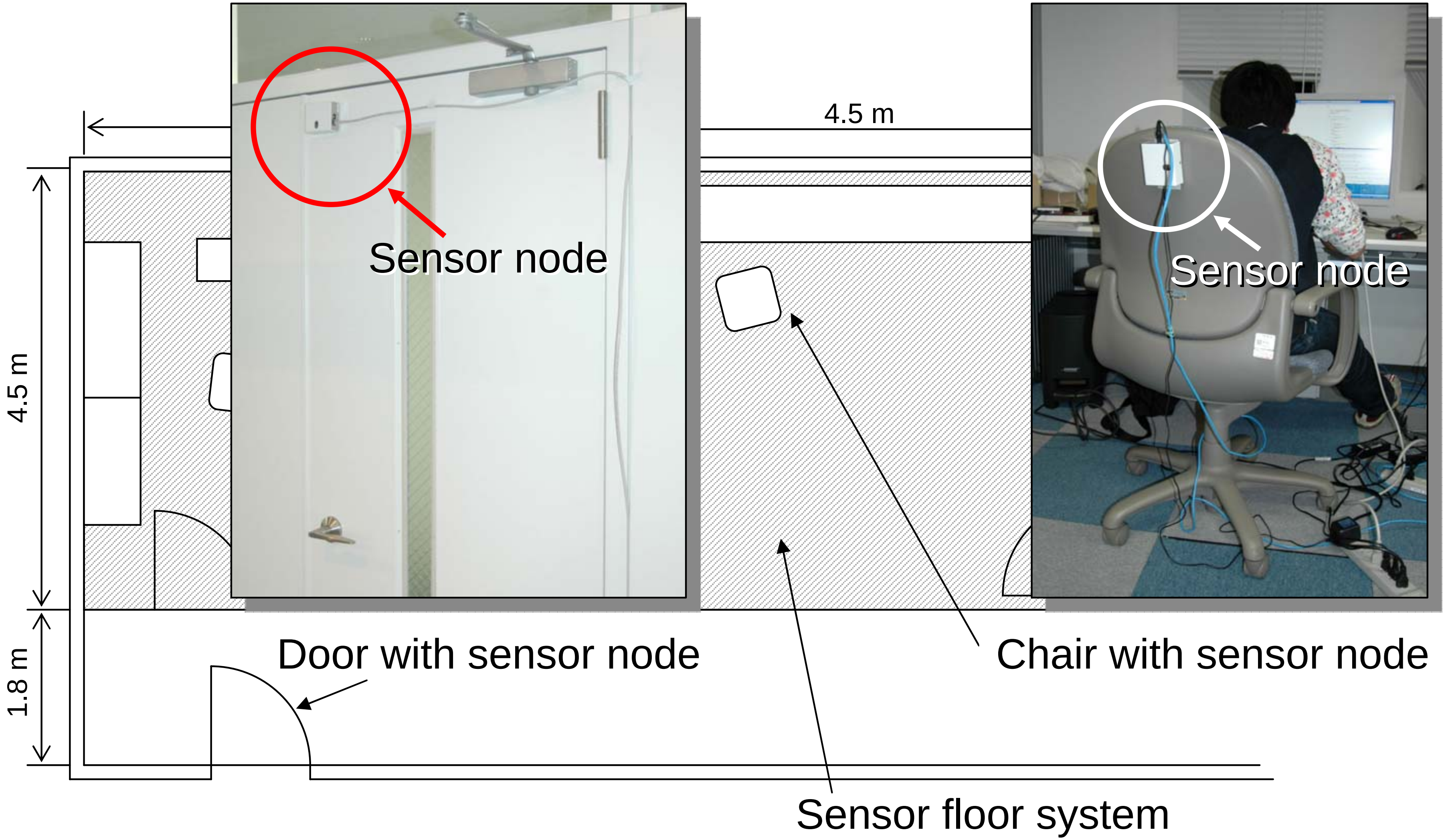
- Discarding wave characteristics
- Need to add knowledge to data (small changes and sets)

			○		
1/2 T	B	×	○	0.5	0.5
1/1 T	A	○		1.0	1.0
	B	○		1.0	

Apply several of time windows and check small changes

Calculate change probabilities and co-change probabilities

Experimental Setting

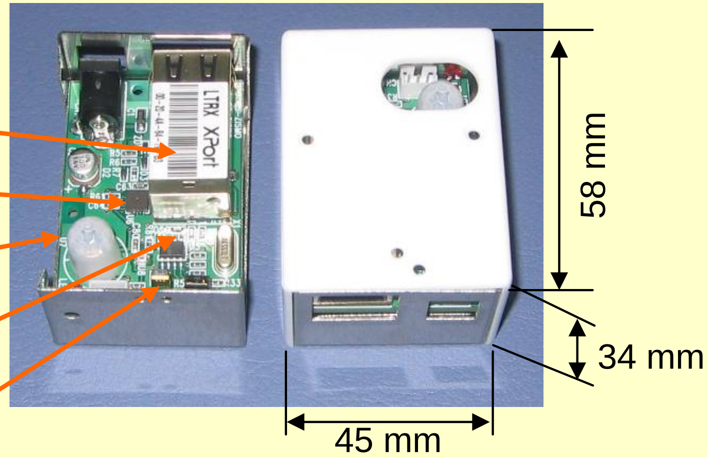


Prototype Sensor Node

1) Prototype sensor nodes attached to objects in office

Prototype Sensor Node

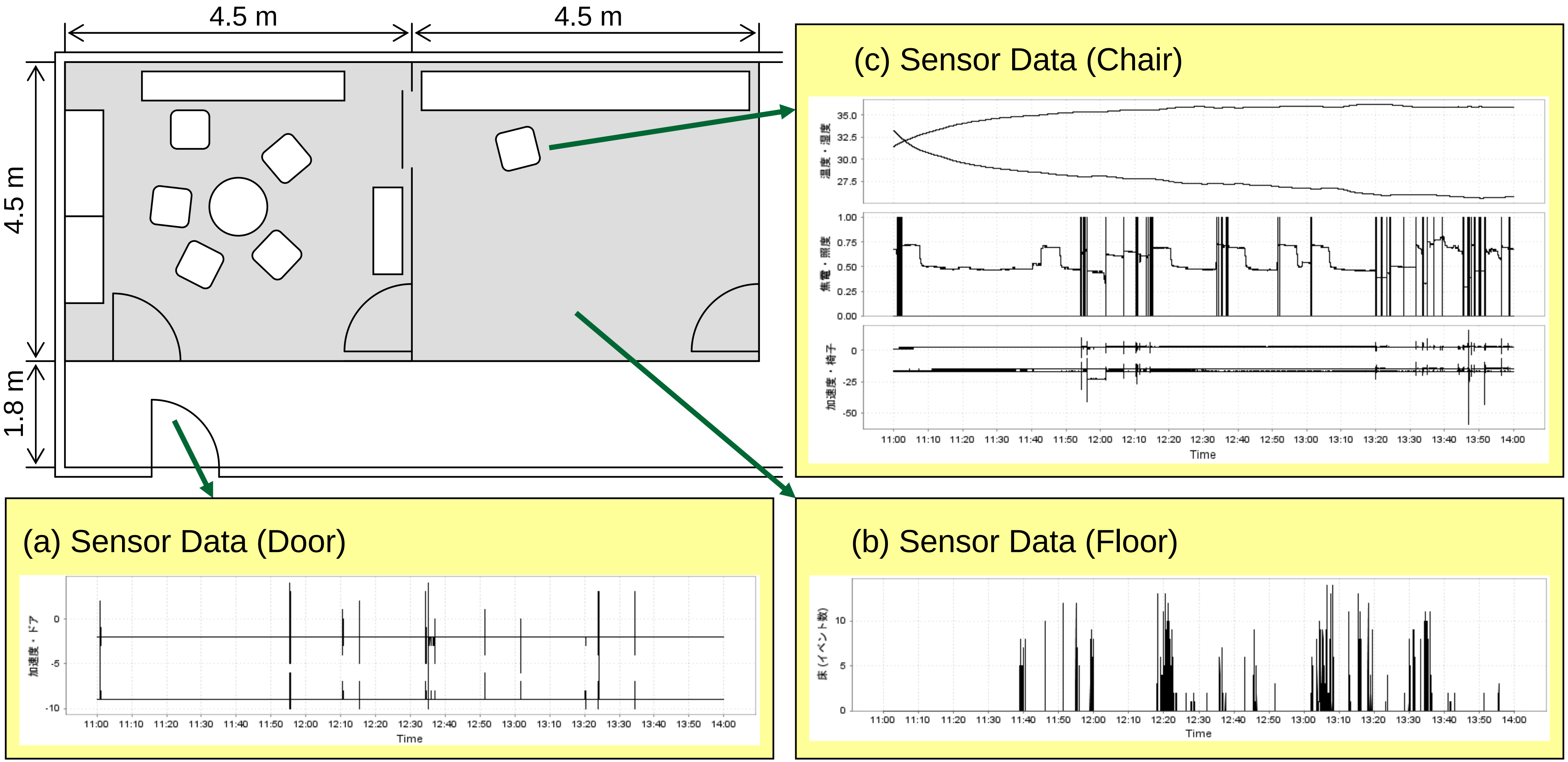
XPort Ethernet Controller
Accelerometer
Infrared Sensor
Illuminometer
Thermometer, Hygrometer



with embedded CPU H8/36049HG (ROM 96 K, RAM 4K, 10MHz)

Sensor Data

2) Store sensor data on server disk (sampling rate is about 10Hz)



3) Capture small changes in sensor data

Change Probabilities of One Sensor

Change and co-change probabilities of chair sensor data

A chair is moving.
→ An individual is sitting

Changed sensor	Ti[illegible]				
	1	5	10	15	[illegible]0
Accelerometer	.346	.533	.591	.618	.669
Infrared sensor	.023	.050	.070	.092	.139
Illuminometer	.002	.014	.030	.044	.086
Acc.･Infrared	.013	.041	.062	.085	.128
Illumi.･Acc.	.002	.012	.025	[illegible]	.072
Infrared･Illumi.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Acc.･Infrared･Illumi.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Finding events by analyzing sequences:
Infrared, then Acc. → An individual sat.
Acc., then Infrared → An individual left.

Co-change Probabilities among Sensors

Change and co-change probabilities of sensor data of chair, door, and floor

Changed Sensor	[illegible]				
	1	[illegible]	[illegible]	[illegible]	[illegible]
Chair	.346	[illegible]	[illegible]	[illegible]	[illegible]
Door	.008	[illegible]	[illegible]	[illegible]	[illegible]
Floor	.063	.107	[illegible]	.165	.217
Chair・Door	.002	.013	.020	.024	.044
Door・Floor	.001	.004	.006	.010	.025
Floor・Chair	.026	[illegible]	.098	.122	.169
Chair・Door・Floor	.001	[illegible]	.005	.007	.022

Hints for contexts:
- Door moved, then chair moved
  → Individual started working
- Chair moved, then door moved
  → Individual left office

Inferring distance between objects:
distance(chair,door) > distance(chair,floor)

Conclusion / Discussion

- Preliminary results:
  - Small changes translated into contexts by adding object and situational knowledge

- Discussion
  - Index of change probabilites
  - Is “small change” sufficient?
  - How large of knowledge is necessary?
  - How many sensor nodes in an office?