

Technical Monitoring Systems for the Support of Home Care

Andreas Hein

University of Oldenburg / OFFIS – Institute for Information Technology



Agenda

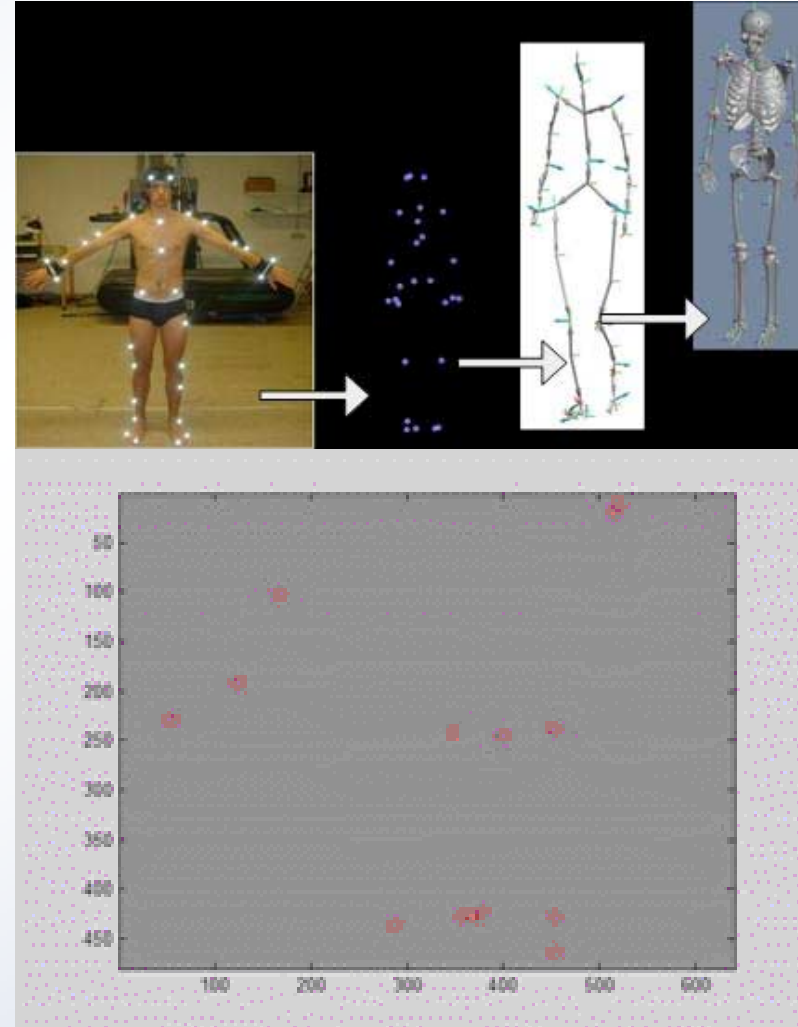
- Introduction and Motivation
- State of the Art
- Technical Approach
 - Vision Sensor
 - Accelerometers
 - Energy Consumption
 - Home Automation
- Design of Experiments
- Results
- Conclusions

Introduction and Motivation

- Identification / Definition of Nursing Care Levels (I to III, in Germany) by:
 - Activities of Daily Living (ADL) and Instrumental ADL
 - At discrete times / upon request
 - Gradual changes and phaseal / erratic progression difficult to detect
 - Subjective assessment
 - Level of capacity vs. level of performance
- Development of an ambient system for comprehensive, automatic and continuous determination of activities at home
 - Identification of long-term changes in behaviour
 - Support for the elderly themselves, their relatives and caregivers

State of the Art (I)

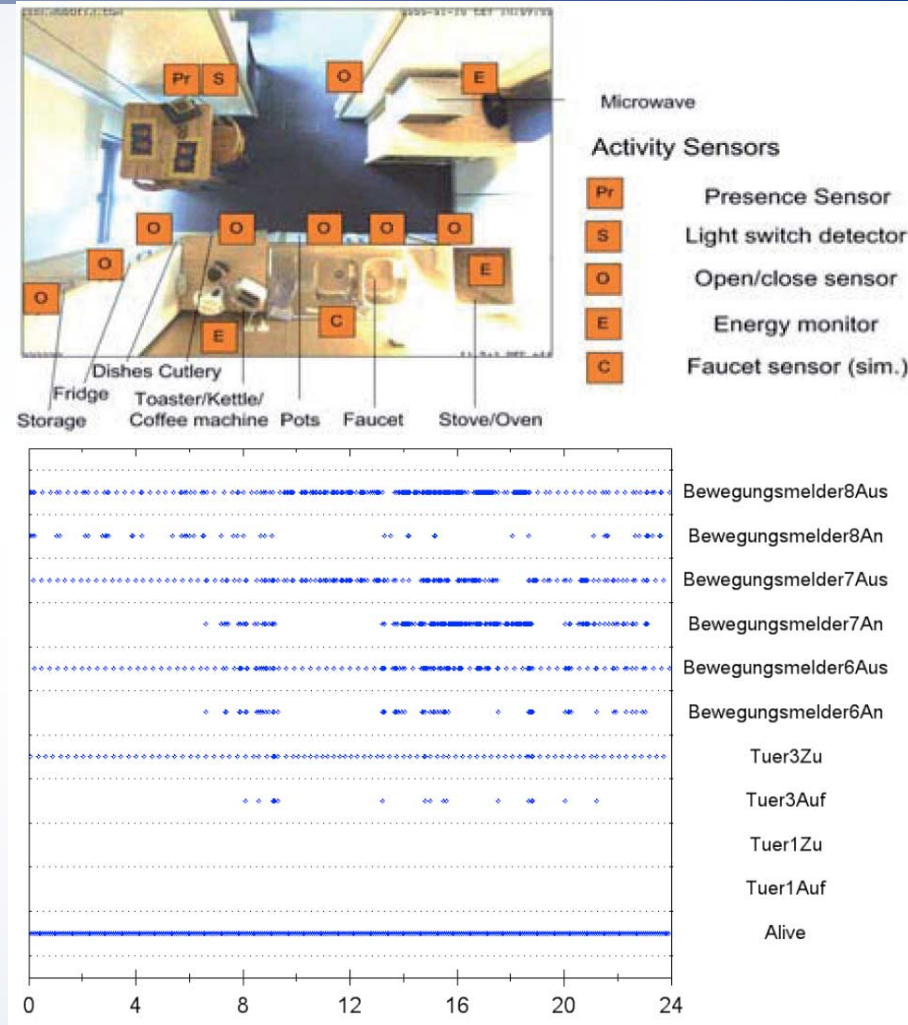
- Continuous data approach
 - Motion analysis using vision systems
 - with artificial markers
 - markerless
 - Motion analysis using accelerometers at the body
 - Context information by microphones, temperature sensors and electromyography



Source: Group on Human Motion Analysis at KIT

State of the Art (II)

- State-based sensors approach
 - Motion/presence detectors
 - Door/window contacts
 - RFID-tags
 - Energy Monitors
- Classification of activities using
 - Modelled decision trees
 - Unsupervised learning (density estimation, clustering)
 - Supervised learning (Decision tree learning, Nearest Neighbour Algorithm)



Source: Kleinberger, 2010 & Floeck, 2010

Technical Approach (I)

- Vision Sensor
 - Localisation of persons and extraction of their trajectories in the living room or kitchen
 - Detection of motion primitives based on the segmentation of the optical flow
 - Activity detection based on histograms of motion primitives

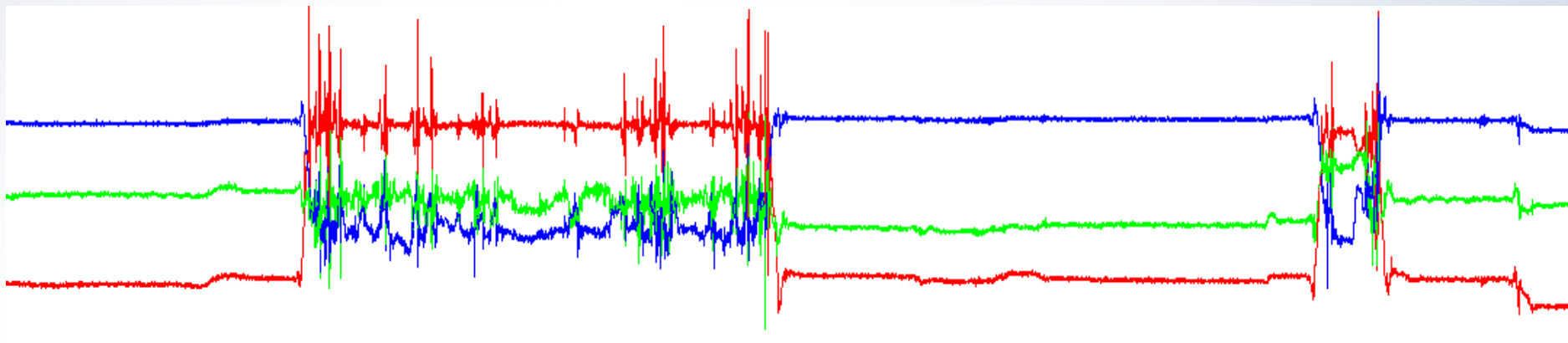


Technical Approach (II)

- Accelerometer
 - Upright posture trained from walking (periodic data + activity)
 - Angle regarding an upright posture
 - Activity level
 - Degree of autocorrelation

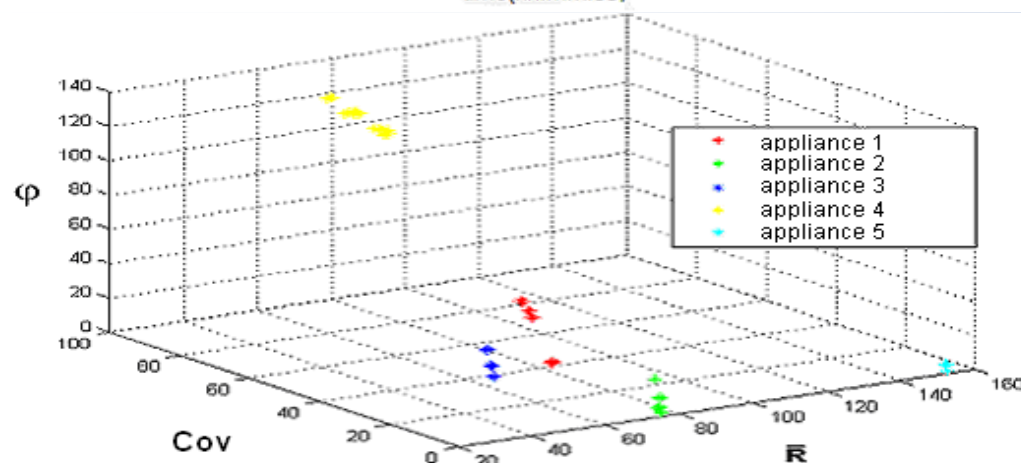
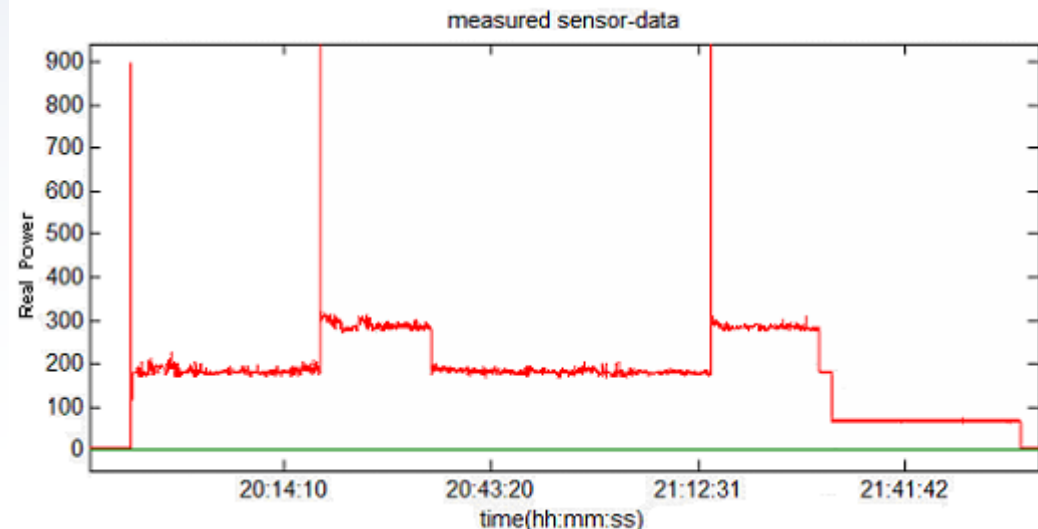


Source: <http://shimmer-research.com>



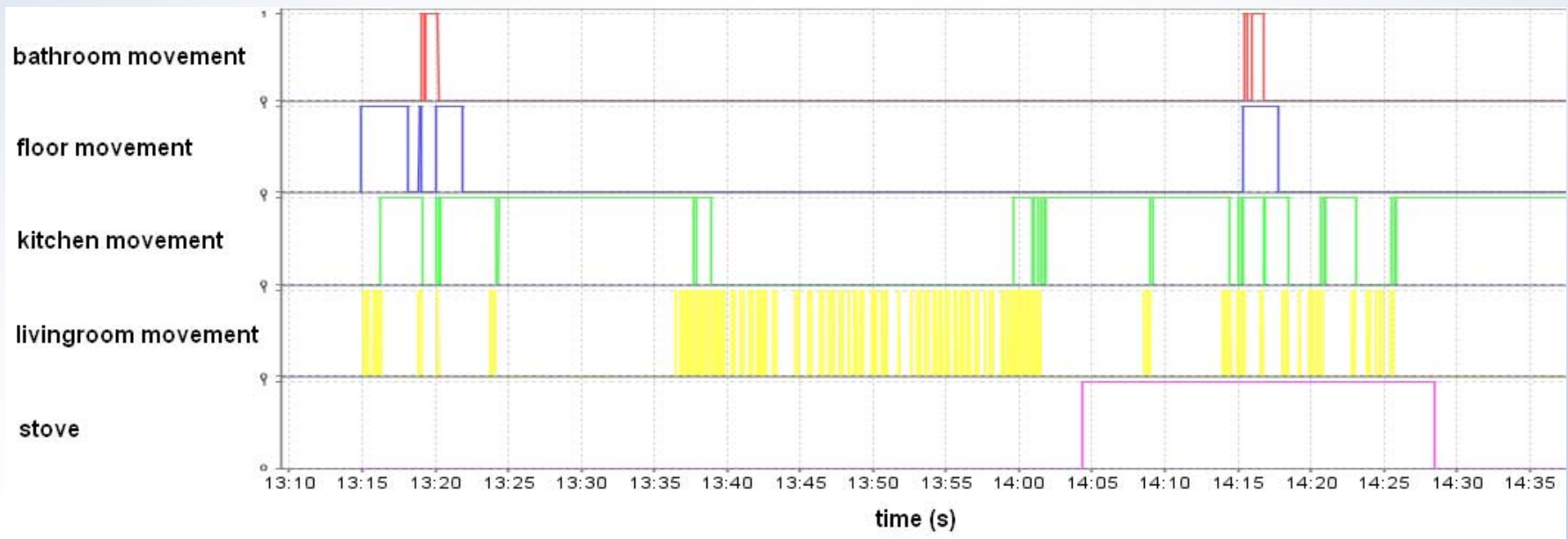
Technical Approach (III)

- Power sensor:
 - Only one sensor installed in the fuse box
- Algorithm:
 - Detection of appliances on the basis of its switch-on signal and switch-off signal:
 - Features: average resistance, phase and covariance
 - Classification: Nearest Neighbour method



Technical Approach (IV)

- Home Automation connected
 - on KNX are presence detector, switcher, light, outlet
 - on FS20 are motion detector, light barrier, door contact
 - via Powerline are stove, oven, fridge



Design of Experiments (I)

- Aim:
 - Determine the quality of recognition of the activity “preparation of food and beverage”
 - Relevant aspect of independence linked to cognitive abilities (creativity, memory, planning), mobility and safety
- Approach
 1. Identification of activities with healthy, young subjects (N=6)
 2. Comparison with older subjects (N=6, ≥ 70 years)
 3. Longitudinal analysis of recordings with only vision sensor (N=1, 13 months) and only power consumption sensor (N=1, 6 months)

Design of Experiments (II)

- Identification of activities in the IdeAAL room
- Performed activities
 - Preparation of meals or beverages
 - Consumption of meals or beverages
 - Washing dishes
 - Reading book or newspaper
 - Watching TV
- Computing parameters from sensor data
- Annotating data using video streams from kitchen and living room
- Generating a classification model using C4.5-tree induction algorithm

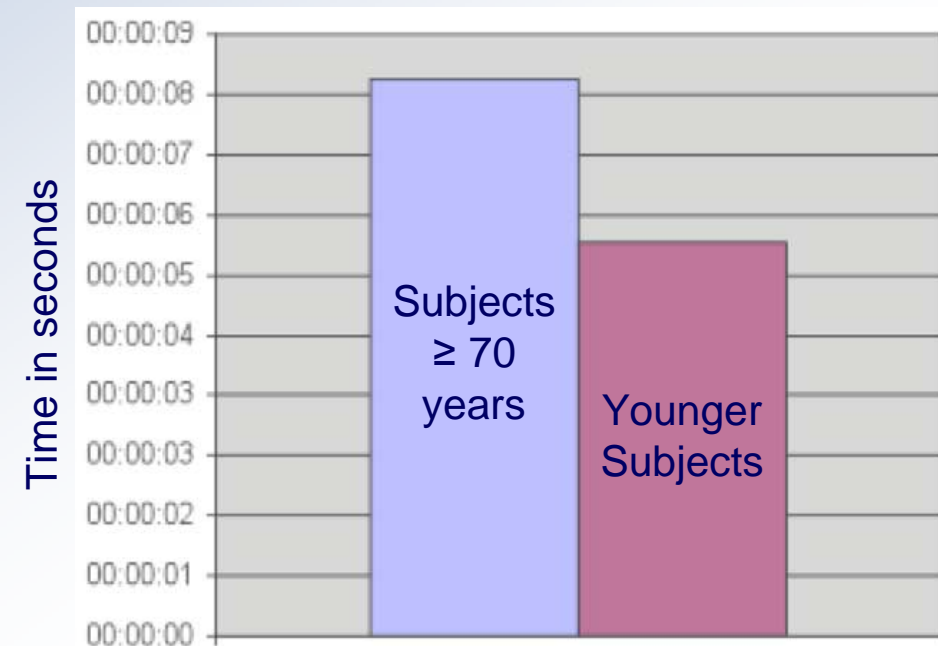


Results

1. Identification of activities with healthy, young subjects (N=6)
 - Data of 3 subjects are used as training data
 - Results for remaining 3 subjects
 - Recognition of preparing meals
 - Sensitivity 64,3%
 - Specificity 90,4%
 - Recognition of preparing beverages
 - Sensitivity 100%
 - Specificity 98,8%
 - Consumption of meals and beverages could be recognized with a specificity of about 90% and a sensitivity of 26,5%

Results

2. Comparison with older subjects (N=6, ≥ 70 years)
 - Reduction of gait velocity with age

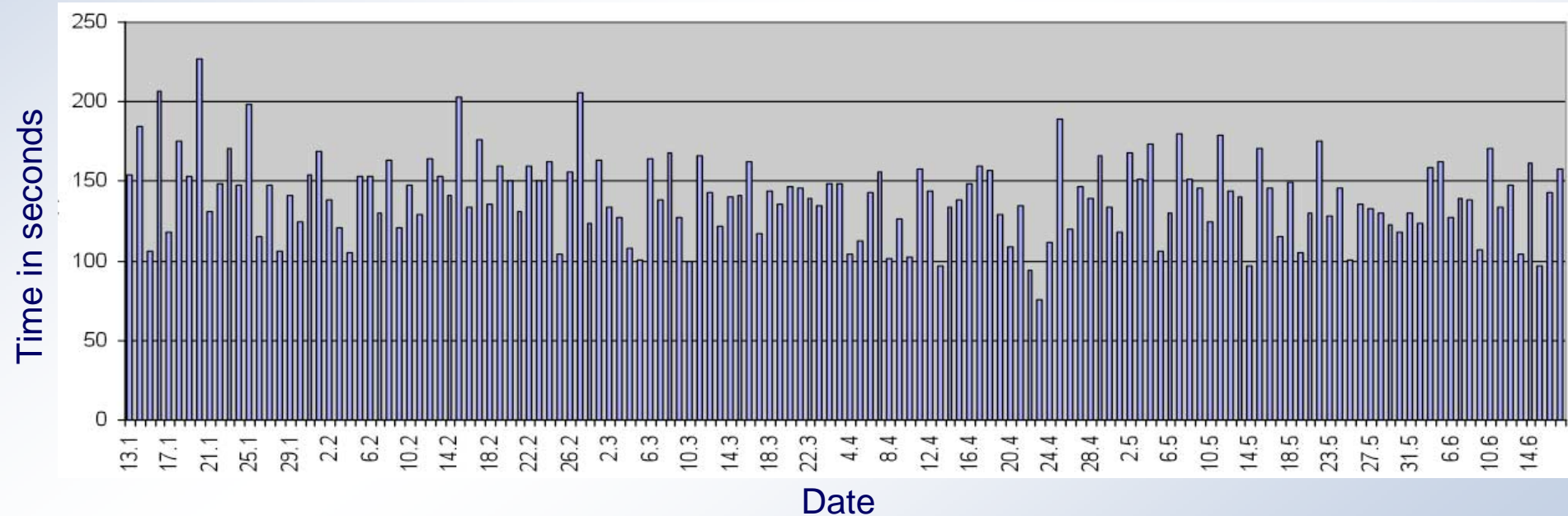


Age group (years)	Men Median (IQR)	Women Median (IQR)
20–39	1.5 (1.2–1.6)	1.4 (1.3–1.6)
75–79	1.1 (0.9–1.3)	1.1 (0.9–1.2)
80–84	1.1 (0.9–1.2)	1.0 (0.9–1.4)
85–89	1.1 (0.8–1.2)	0.8 (0.7–1.0)
90+	0.9 (0.6–0.9)	0.8 (0.6–0.9)
Total (75+)	1.1 (0.9–1.2)	1.0 (0.9–1.1)

Source: Butler et al., 2009

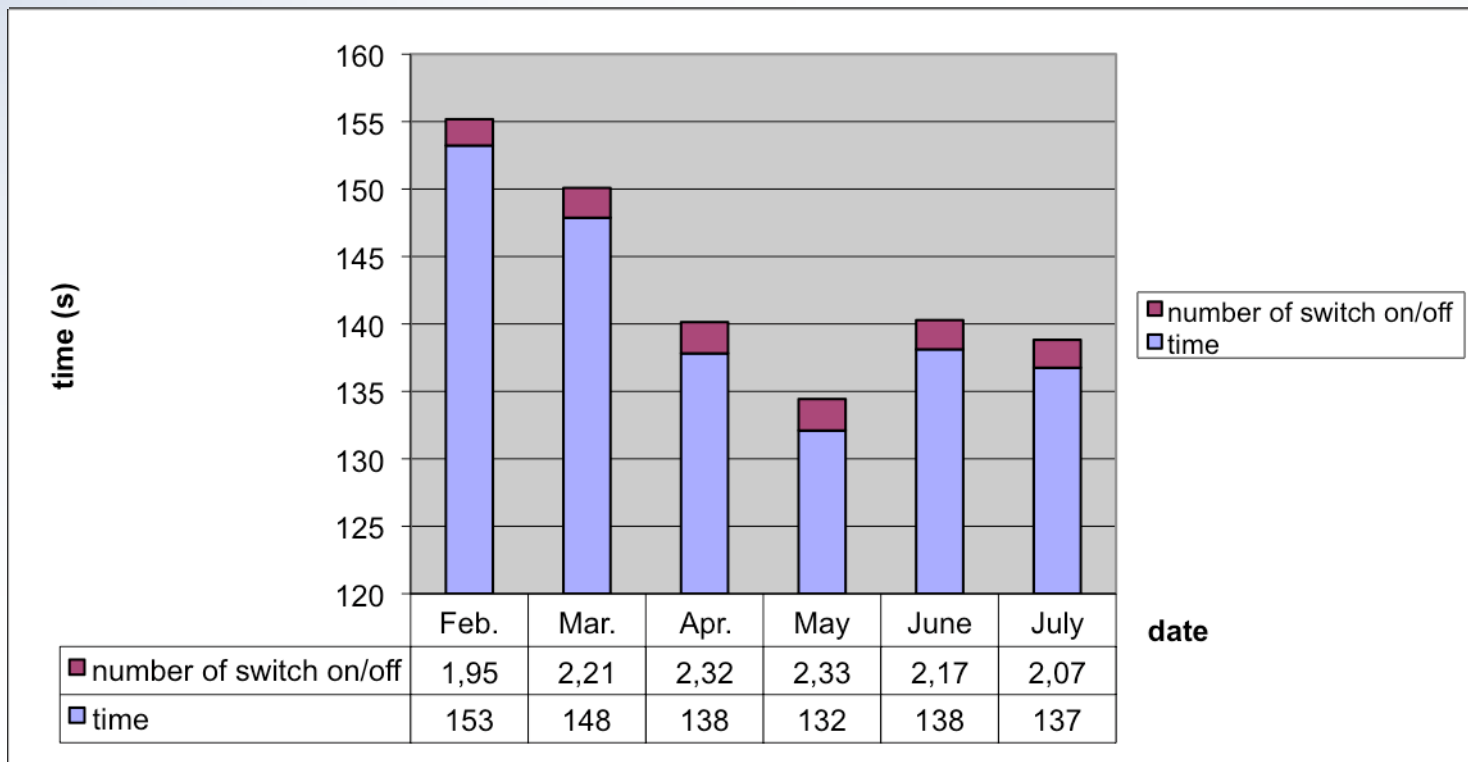
Results

3. Longitudinal analysis of power consumption (N=1, 6 months, 14 Hz)
 - Usage of the electric kettle (preparation of tee)



Results

3. Longitudinal analysis of power consumption (N=1, 6 months, 14 Hz)



Conclusions

- Continuous monitoring of activities
 - has been perceived as useful by professional caregivers and the elderly for relevant aspects
 - especially safety, mobility and social contacts
 - is technically feasible for specific activities
 - focus on preparation of food and beverage
 - is difficult to evaluate
 - cross-sectional vs. longitudinal section study
 - labelling of data
- Outlook
 - Development of sensor sets and sensor fusion approaches for the identification of long-term changes in behaviour