TECHNISCHE UNIVERSITÄT
CAROLO-WILHELMINA
ZU BRAUNSCHWEIG

Sensing Technologies and the Player-Middleware for Context-Awareness in Kitchen Environments

INSS 2007

[1]Radu Bogdan Rusu, Alexis Maldonado, Michael Beetz,
[2]Benedikt Hörnler, Gerhard Rigoll,
[3] Albrecht Schmidt,
[4]Matthias Kranz

[1]Intellient Autonomous Systems Group, Technische Universität München (TUM)
[2]Lehrstuhl für Mensch-Maschine-Kommunikation, Technische Universität München (TUM)
[3]Fraunhofer IAIS, Sankt Augustin and B-IT, University of Bonn
[4]Distributed and Ubiquitous Systems Group, Technische Universität Braunschweig

Talk Overview

- **Introduction: AwareKitchen Research Project**
- **Related Work**
- **Sensing Systems and Middleware**
- **Cuts like a knife – Context Inference Employing a Sensor augmented Knife**
- **Sounds like a cut – Context Inference using Audio Sensor Data**
- **Outlook and Applications**

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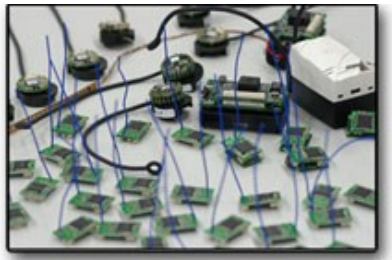
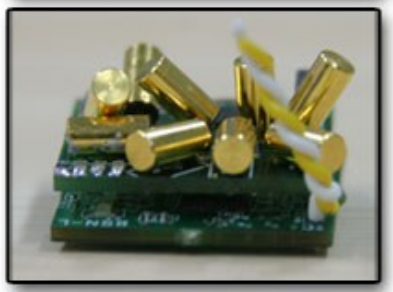
AwareKitchen

Overview: The AwareKitchen Research Project










Goals of The AwareKitchen Research Project

Goals of the AwareKitchen Research Project:

- **long-term monitoring**
- **health care**
- **assisted living**

by

- **understanding human activity**
- **representations of activity and context**
- **developing models**
- **plan-based control e.g. for robots**

Related Work

- **technologically related work**
  - Chen et al. “Bathroom activity monitoring based on sound” [Pervasive 2006]

  →environmental microphones
  - Amft et al. “Analysis of chewing sounds for dietary monitoring”

  → body worn microphones
- **semantically related work**
  - Gellersen et al. “The MediaCup: Awareness technology embedded in a everyday object” [HUC 1999]

  →cups
  - Tapia et al. “The design of a portable kit of wireless sensors for naturalistic data collection” [Pervasive 2006]

  →importance of real-world data for “robust and promising context detection algorithms”

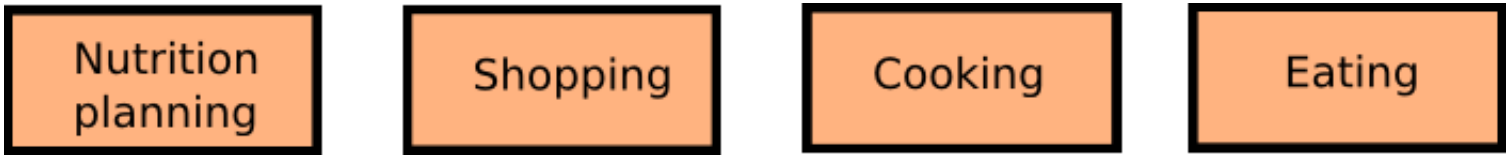
Related Work

- **timely related work**
  - Taylor et al. “Augmenting refrigerator magnets: why less is sometimes more” [NordiCHI 2006]

  → planning, organization, assigning tasks
  - Mankoff et al. “Using low-cost sensing to support nutritional awareness” [UbiComp 2002]

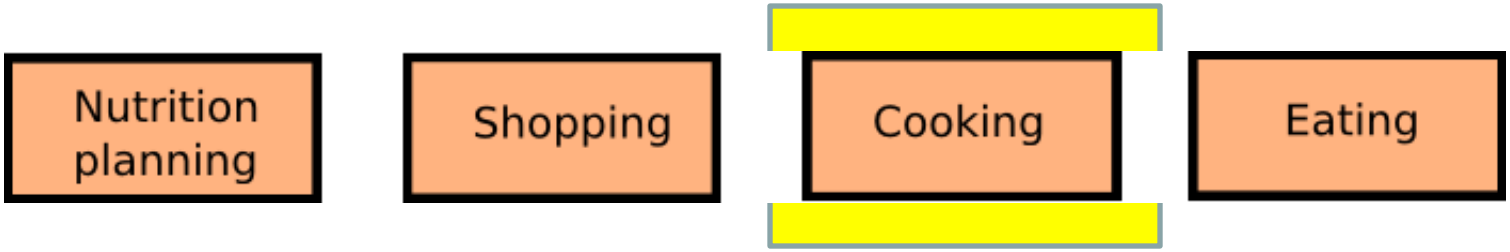
  → shopping lists
  - Chang et al. “Diet-aware dining table: Observing dietary behaviors over a tabletop surface”

  → monitoring eating



Related Work

Cooking itself has so far not been researched on!



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System and Middleware

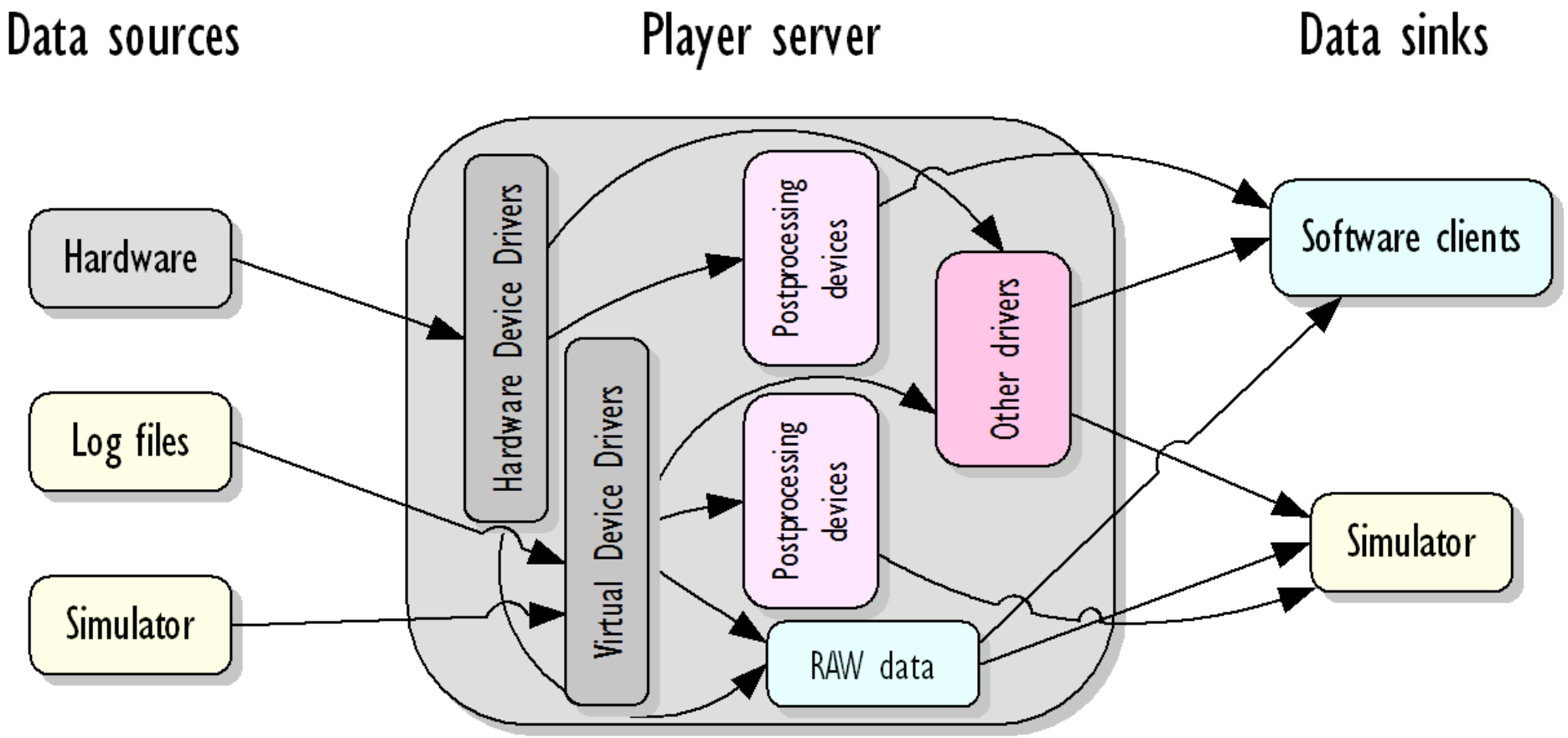
System and Middleware

Player/Stage as Middleware for

Ubiquitous Computing Systems

- **originating from the robotics domain, constantly being developed for about 10 years now (!)**
- **support for a huge variety of sensors and actuators**
- **publish/subscribe data exchange mode**
- **fixed set of data formats**
- **tool chain support, e.g.:**
  - camera -> computer vision -> marker detection -> marker information
- **2D/3D visualization and simulation support**
- **logging and replay**

Player/Stage Middleware for Pervasive Computing

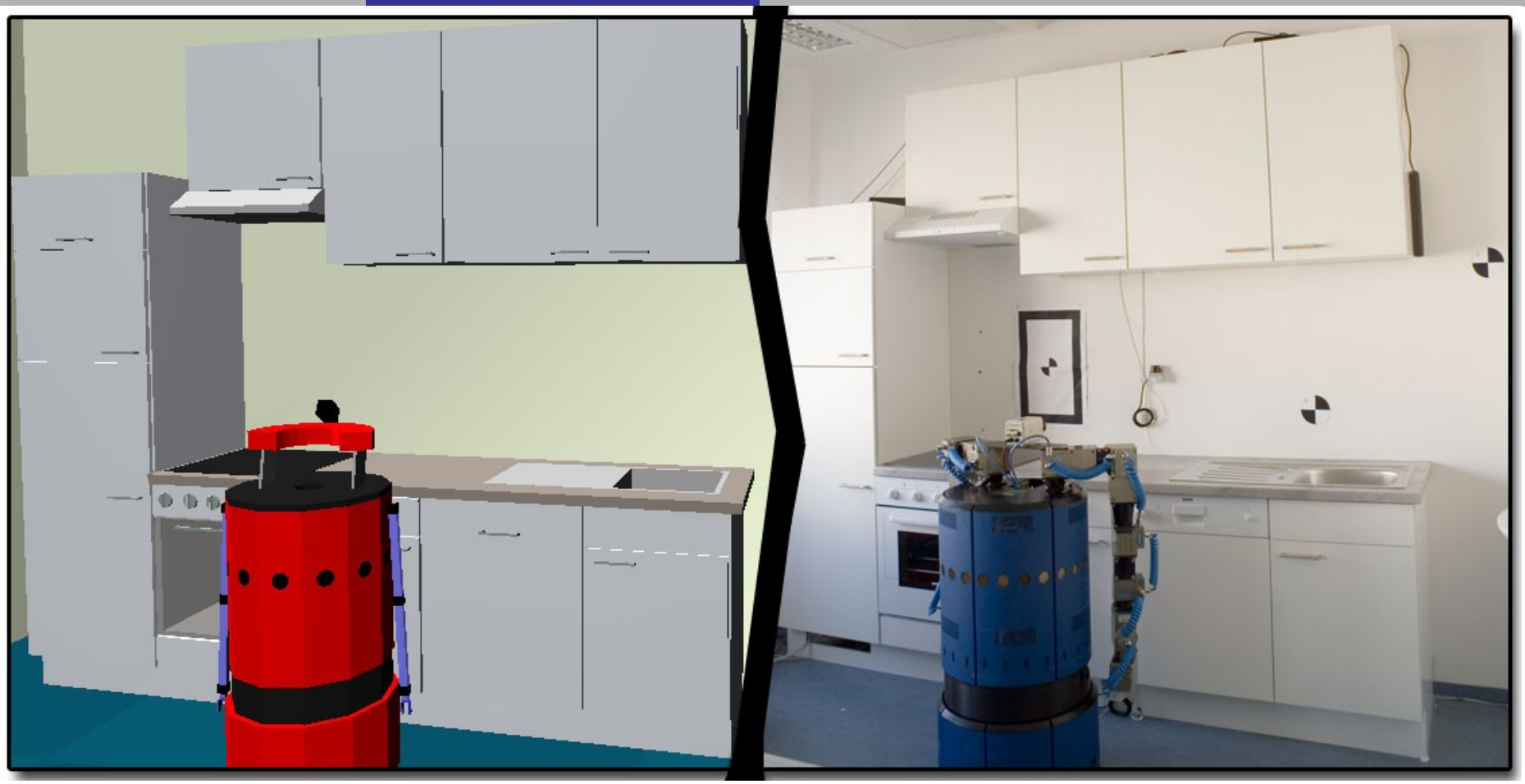


Contributions to Player/Stage

New drivers for Player/Stage developed:

- Wireless Sensor Network nodes - with a wide variety of different sensor nodes, ranging from the cParts and pParts Particles from TecO/Particle Computers to the Porcupines, or the Mica2 and Mica2Dots from Crossbow;
- RFID technologies - several readers such as the Inside M/R300, the Skyetek M1 and the Skyetek M1-mini are now supported;
- Inertial Measurement Units - supporting the XSens MT9 as well as the XSens MTx, which provide drift-free 3D orientation and kinematic data.

System Support: 2D and 3D Simulator & Visualiser



3D model and real kitchen: visualization support by Player/Stage

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Context-Awareness

Context-Awareness: Knife

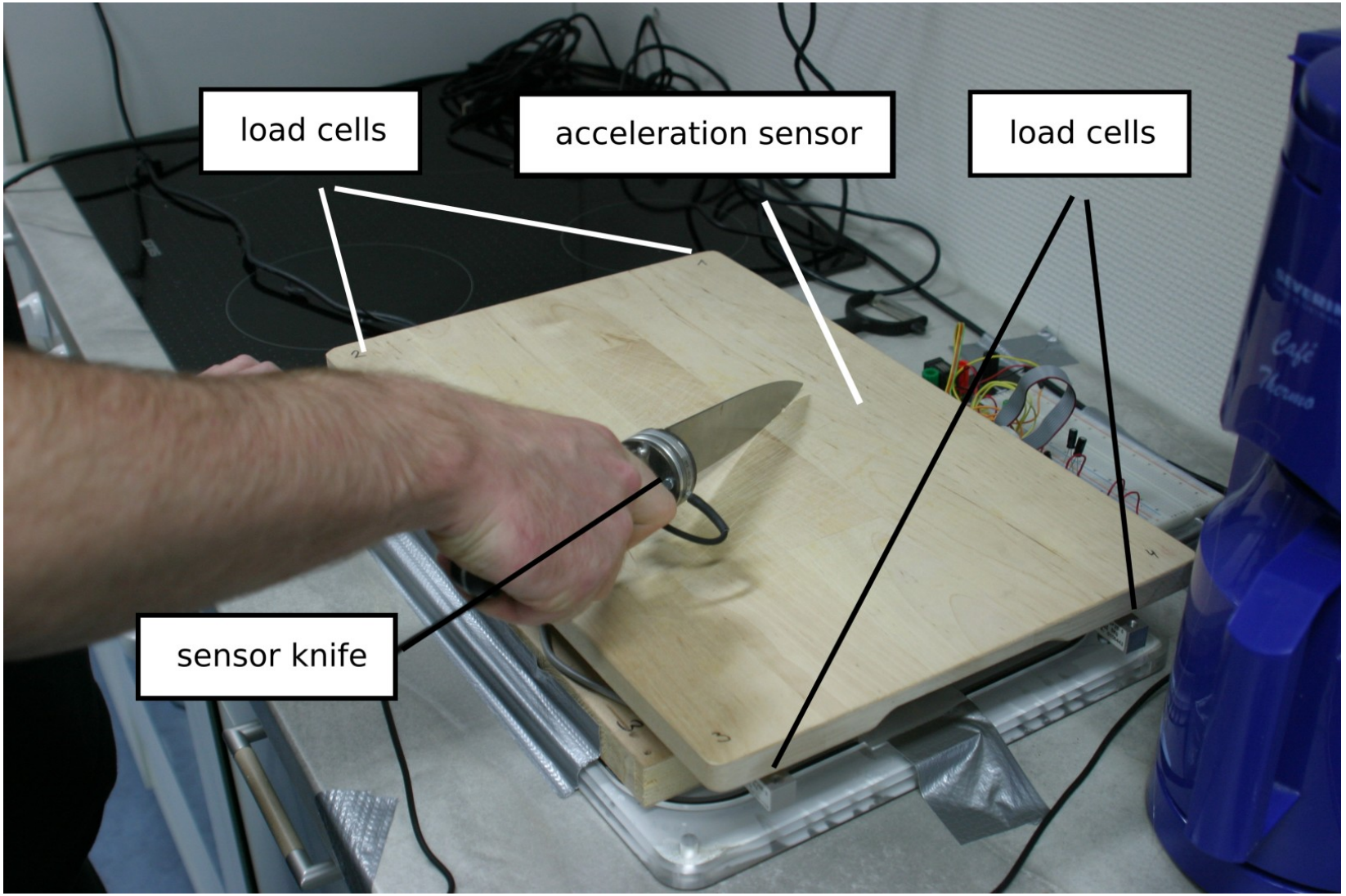
challenges on pervasive computing systems:

- **understanding human activities**
- **characterizing them into detailed and expressive models**

needed:

- **sensors**
- **specialized tools for acquiring context**
- **highly desirable:**
  - built into every day object
  - not affecting the affordances of the objects
  - invisible?

Context-Awareness: Knife

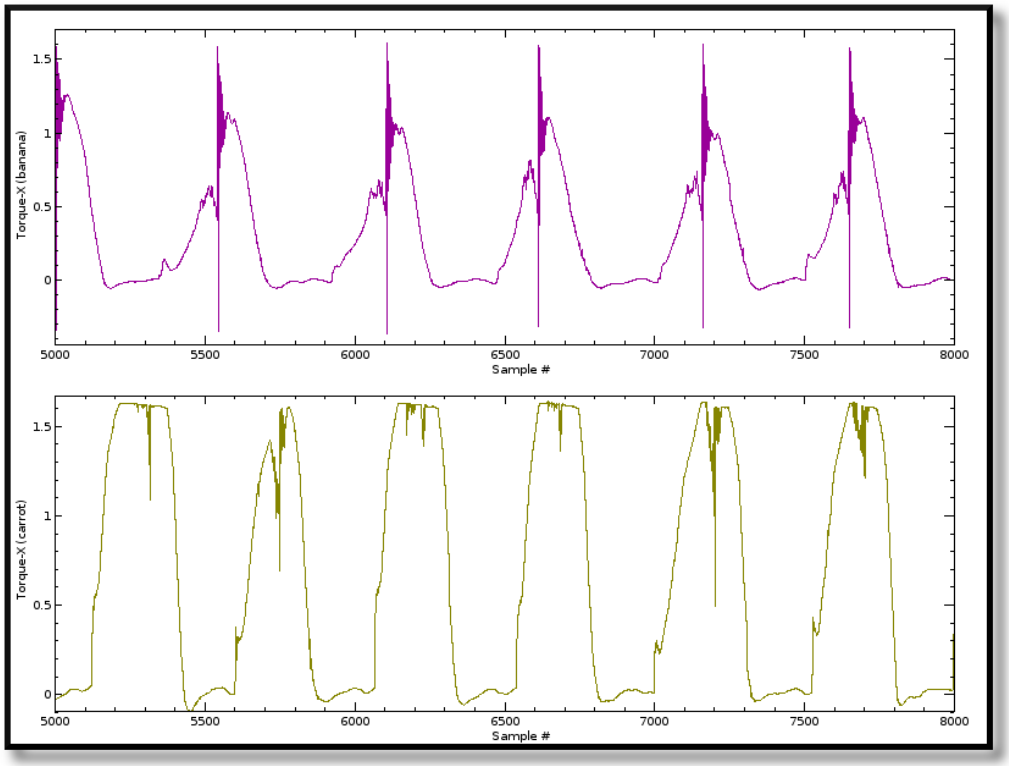

load cells
acceleration sensor
load cells
sensor knife

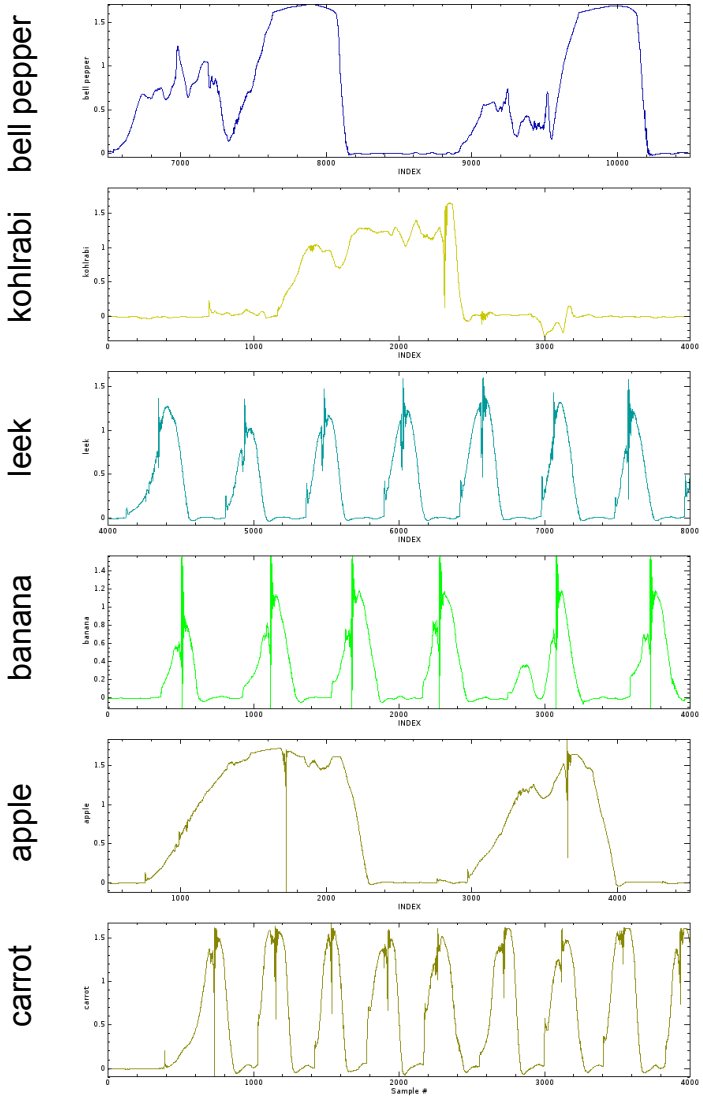
Context-Awareness: Knife

Cutting fruits and vegetables with the sensor-equipped knife on the cutting board.

Context-Awareness: Knife

Visualization of one axis of the SI-40-20 ATI Industrial Automation force/torque sensor conn. to a National Instruments PCI-622 data acquisition card





Context-Awareness: Knife

no Sauerkraut has been cut... ,)

Context-Awareness: Knife

Results from initial classification:

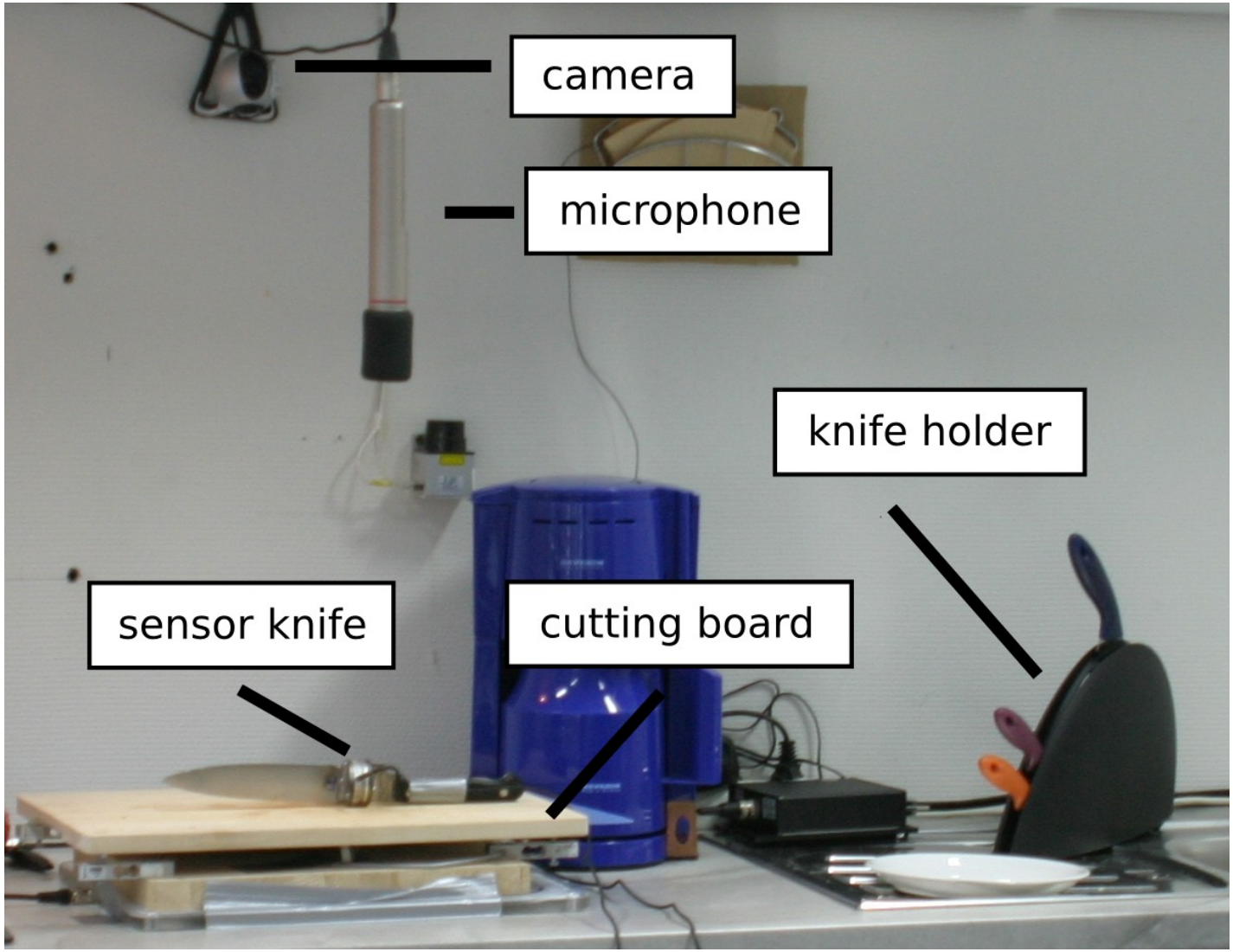
classified as ->	apple	carrot	kohlrabi	banana	leek	pepper
apple	27	0	0	5	0	2
carrot	0	102	3	4	5	9
kohlrabi	3	0	183	0	1	9
banana	0	0	0	167	0	0
leek	0	2	0	2	179	4
pepper	2	17	29	1	9	89

TABLE II

CONFUSION MATRIX OF THE BEST CLASSIFICATION RESULT USING THE KNIFE DATA.

Context-Awareness: Audio

Context-Awareness: Audio



Context-Awareness: Audio

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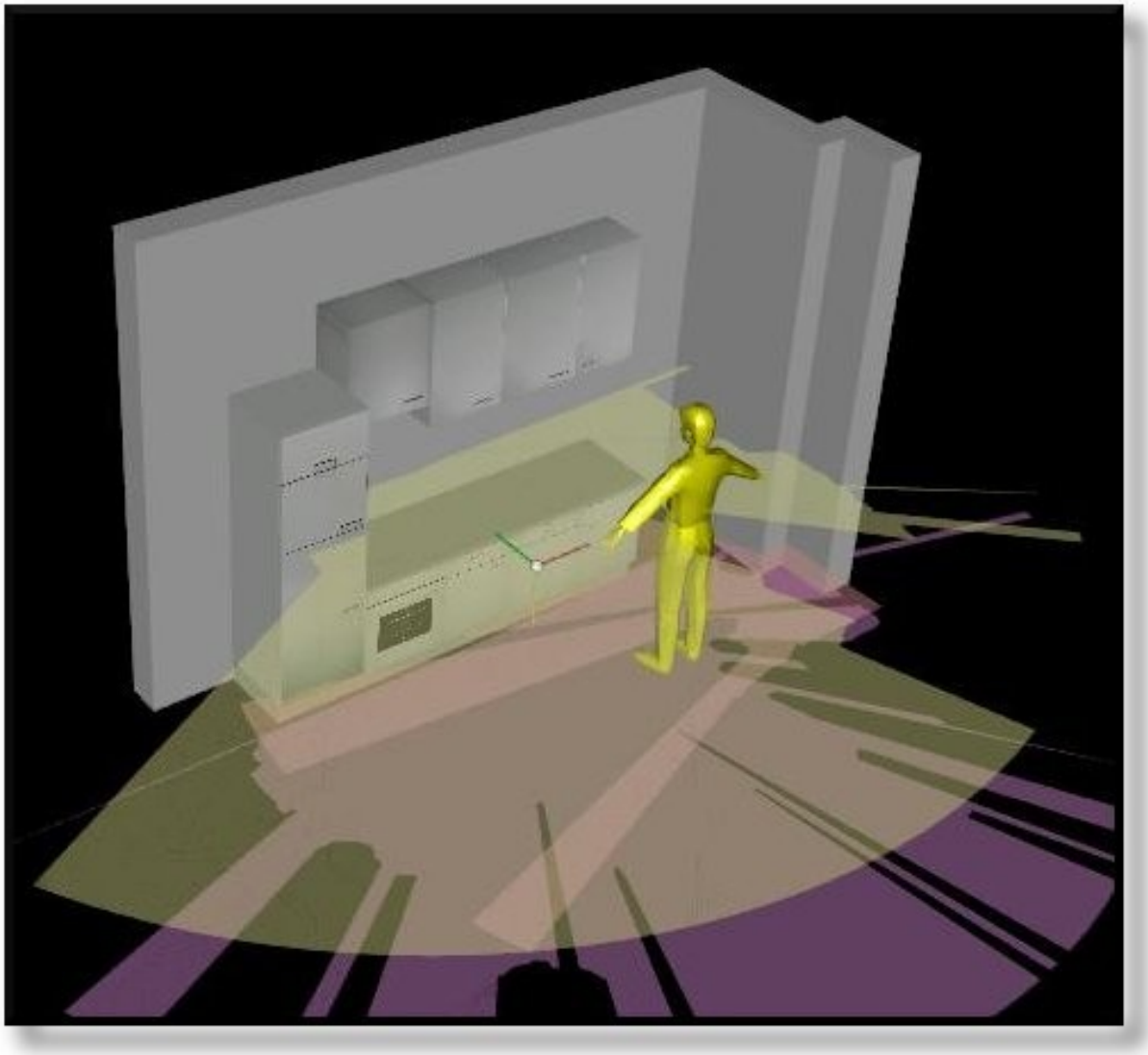
Outlook and Applications

Outlook and Applications

Context awareness:

Laser scanners allow to detect the position and orientation and derive the number of people in the kitchen.

(counting feets and chests ,)



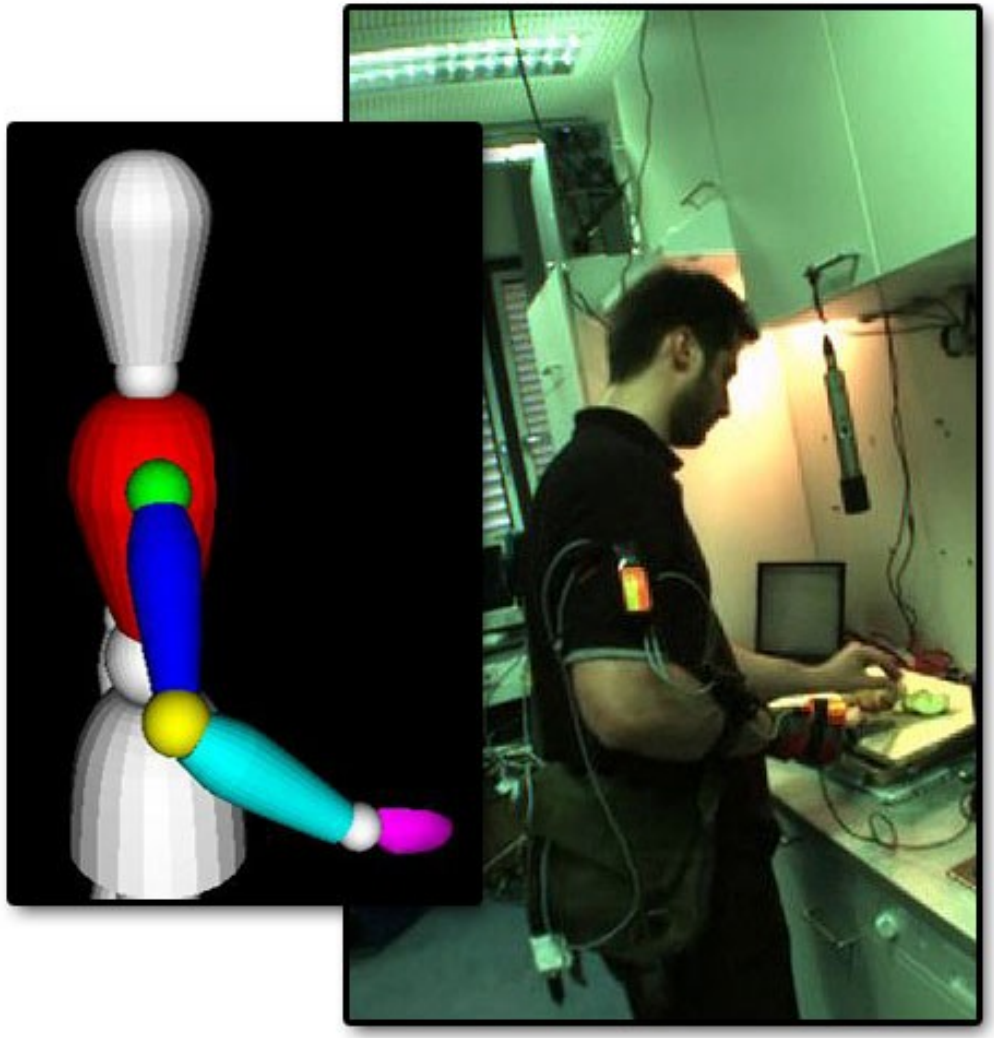
Overview: The AwareKitchen Research Project

Outlook and Applications

Building activity models from XSens inertial sensors.

Goal: Let the robot learn!

(opening cupboards, shelfs, making a dining table)



Outlook and Applications

ongoing research:

- **sensor fusing on the**
  - **audio**
  - **video**
  - **knife and**
  - **cutting board for better classification results**
- **application, e.g.: “Learn to Cook like a Chef in 30 Days”**

Questions

Questions?

Thank You!

AwareKitchen Research Video @ Pervasive 2007

VIDEO

The AwareKitchen Project Video