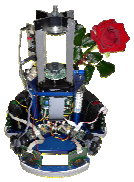


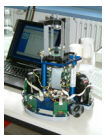
ROSES

ROobot assisted SEnsor networkS

Computer Networks and Communication Systems (Dept. of Computer Science 7), University of Erlangen-Nuremberg

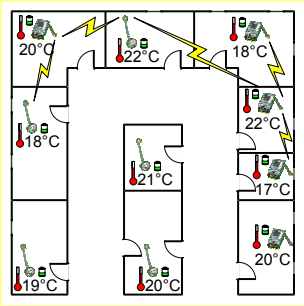
Introduction

The development and the control of self-organizing, self-configuring, self-healing, self-managing, and adaptive communication systems and networks are primary research aspects of the Autonomous Systems group at the chair for Computer Networks and Communication Systems.

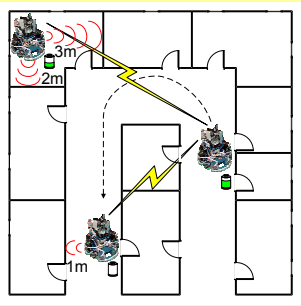


The employed embedded systems, e.g. sensor motes and mobile robots, are getting smaller, more mobile, and more energy aware. Novel mechanisms in operating systems, in the communication infrastructure, and in applications provide enormous energy savings. Sensor motes are used e.g. for the collection, the processing, and the communication of measurement data. Another research aspect of our group is the combination of mobile robot systems with stationary sensor networks. Such mobility enhancements as well as the limited resources in typical sensor networks lead to new problems, challenges, and solution spaces in terms of efficient data management and communication. In addition to engineering methods we investigate in bio-inspired methodologies learnt from cell and molecular biology to address these issues.

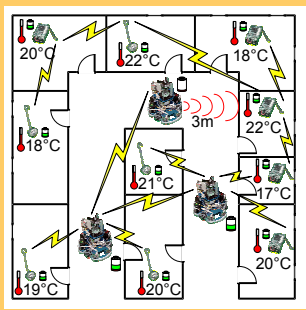
Sensor Networks



Mobile Robots



Autonomous Sensor/Actuator Networks

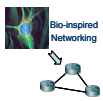


Research Goals

- Energy efficient operation, communication, and navigation
- Sensor assisted localization and navigation
- Quality of service aware communication in heterogeneous mobile networks with dynamic topology
- Optimized task allocation and communication based on application and energy constraints
- Secure communication and data management in mobile sensor networks

Solution Space

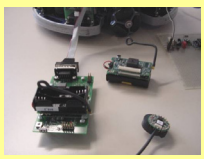
- Novel models for energy and application aware communication
- Combination of different localization techniques for optimized high-precision navigation
- Bio-inspired communication methods for information exchange and task allocation



- Integration of mobile robots and stationary sensor nodes to autonomous mobile sensor/actuator networks

Autonomous Sensor/Actuator Networks

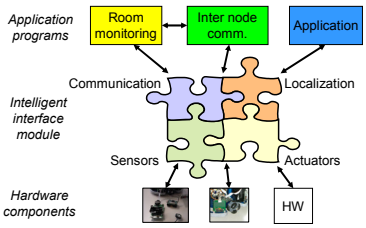
- Sensor assisted teams of robots
  - Localization and navigation
  - Communication infrastructure
- Robot assisted mobile sensor networks
  - Repair, energy source
  - Communication relay
- Self-organization and emergent behavior of autonomous systems



Current Activities

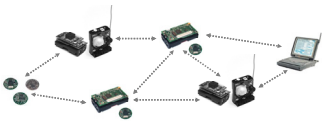
- Implementation of an interface for interactions between Mica2 motes and the Robertino
- Goals
  - Utilization of the resources in the sensor network for assistance of the robot, e.g. for navigation
  - Utilization of the robots as a communication relay to a global network, e.g. the Internet

Architecture



Sensor Networks

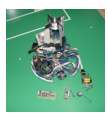
- Sensor motes: sensors, processing, wireless radio communication
- Sensor networks: many small, cheap, communicating, energy-aware sensor motes
- Application to: logistics, security, environment, agriculture, health care, home automation, pervasive computing, …
- Research issues: addressing, ad hoc routing, group communication, filtering, task allocation, coordination, energy efficiency, time synchronization, coverage, localization, security, quality of service, ...



Current Activities

- Lab environment using Mica2 motes
- Evaluation of ad hoc routing algorithms
- Integration of “real” sensor motes in simulation techniques
- Integration of energy constraints in simulators/ emulators

Application Scenarios



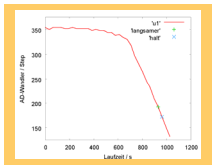
- Navigation assisted by active sensor nodes
  - Navigation in office and lab environments
  - Employment of sensor motes as intelligent landmarks and as communication relays
- Information / communication assistance
  - Audiovisual communication between people assisted by robots and wireless real-time communication
- Exploration and monitoring of unknown surroundings
  - Mapping of unknown corridors assisted by self-configuring sensor networks

Mobile Robots

- Cooperating mobile autonomous systems
- Application to: security, attendance, entertainment, ...
- Research issues: localization, navigation, cooperation, coordination, tracking, …

Current Activities

- Battery management of the robot
  - Special circuit for voltage measurement at the battery
  - Connection to the AD converter of the installed micro controller
- Interface to sensors and actuators
  - Implementation as independent modules with a common interface
  - Gateway for network access
  - Real-time behavior of the control
- Goals
  - Further development of the module with extensions for localization, navigation, etc. considering different environmental parameters, e.g. energy



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Hard- and Software

- Mica2/Mica2dot Motes (www.xbow.com)
- Scatterweb Motes (www.scatterweb.org)
- Robertino (www.openrobertino.org) (developed at Fraunhofer AIS)
- TinyOS (www.tinyos.net) Standard OS for many sensor motes
- SWANS / TOSSIM / ATEmu Simulator/Emulator for TinyOS based motes
- AnyLogic/OPNET/OMNET++/NS-2 Network simulation tools