Mobile robot using different senses

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Overview

- Motivation
  - State of the art
- Experimental set-up
  - Mobile robot
  - Sensor system
- Experiments
  - 1-Dimensional experiments in a corridor
  - 2-Dimensional experiments in large room
- Findings
- Conclusions
- Outlook

Motivation

Senses for Robots
- Sight (Cameras)
- Hearing (Microphones)
- Touch (Tactile sensors)
- *Smell* (Gas sensor system)
- Taste (Electronic tongue)

Extending the possibilities
- Electronic Watchman can oversee chemical stocks and detect leakages

Robots with Gas Sensors: Applications

Biomimetic
- Path Finder
- Virtual Umbilical
- Repellent Marker

Potential Applications
- Trail following
  - Trail defined life time
- Marking
  - Mark of Cleaned Floor
- Source Detection
  - Direction finding
    - Rotating Robot
      Short Distance (Duckett et al.)
    - Three dimensional Odour Compass
      - Defined air stream (Nakamoto et al.)
  - Detection of odour plumes
    - Plume tracking (Russel et al.)
      - Defined air stream needed

Robots with Gas Sensors: Applications

Source Detection

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    - Defined air stream needed
- Convection / Diffusion profile
  - Map Building
    - No Defined Airstream needed

Experimental: Mobile Robot "Arthur"

Mobile Robot "ATRV-Jr"
- Skid Steering
- Standard PC inside
- Ultrasonic sensors
- Wireless Ethernet

Additional Sensors
- Laser range finder
- Stereoscopic camera System
- Gas sensor system mounted inside the robot, behind front window

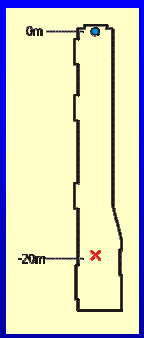
Experimental: Sensor System

VOCmeter Vario
- Commercially available
- Lightweight, small
- Low power consumption (24V DC supply possible)
- RS-232 interface
- Various sensors types available (MOX, QMB, U/I)
- Up to 8 sensors, connected with thin flexible cables

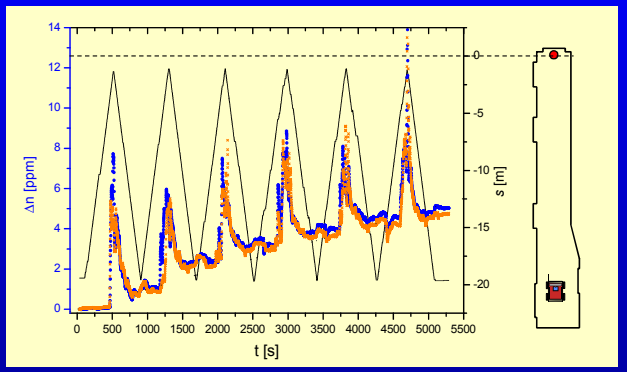
1-Dimensional Location

Locations
- No ventilation!
- No personnel traffic

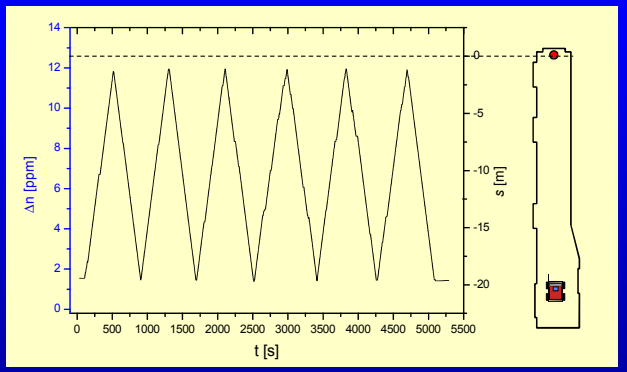
Experiments
- Analyte used: Ethanol
- Recordings
  - odometry, sensor system, laser range finder,
  - temperature, humidity (offline)



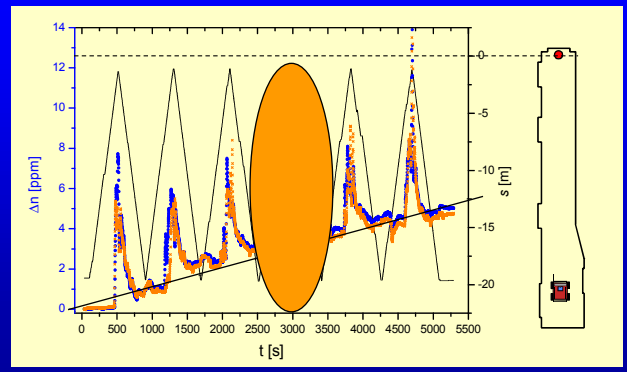
Results: 1-Dimensional Location



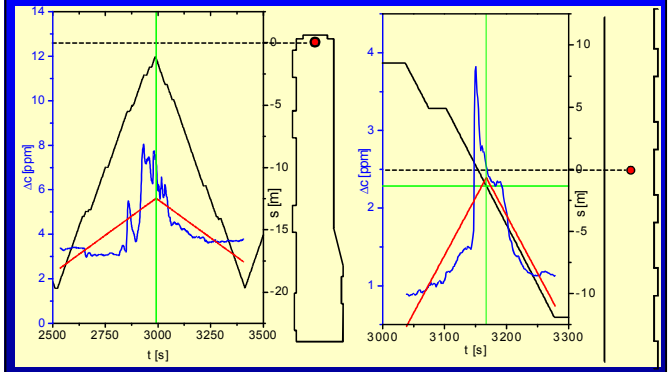
Results: 1-Dimensional Location



Results: 1-Dimensional Location

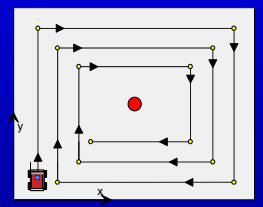


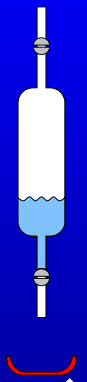
Determination of Source Position



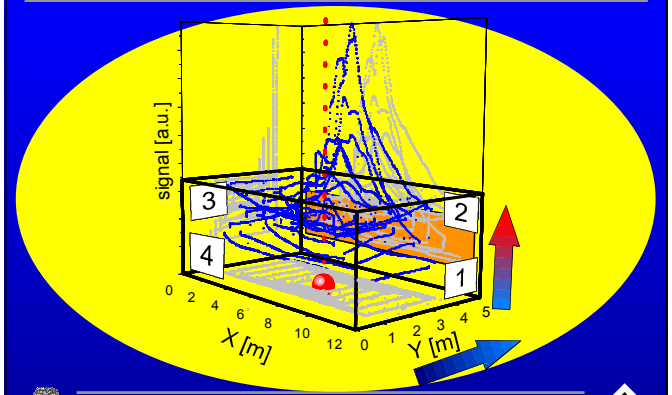
2-Dimensional Location

- Unventilated
- One side of the room is a window front
- The automatic source was placed in the middle of the room
- The robot's path describes a rectangular helix

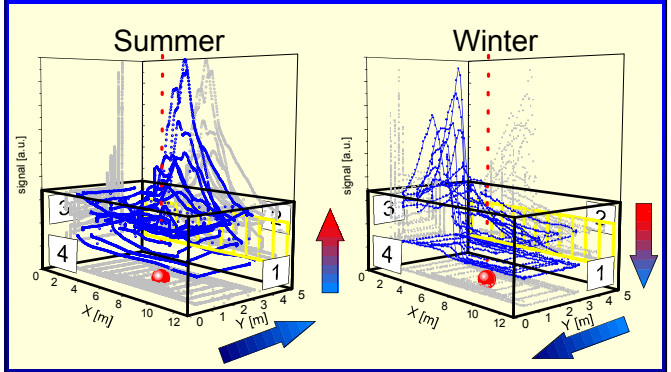




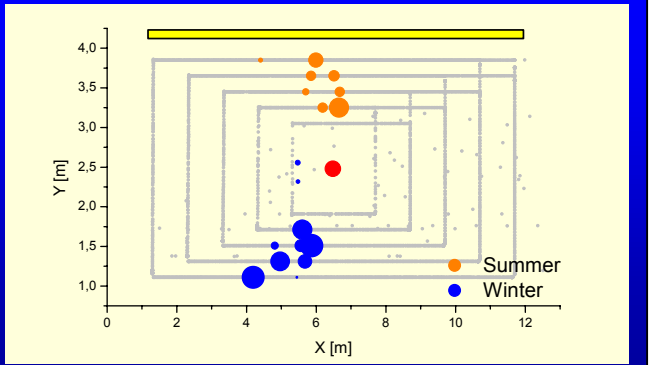
Results 2-Dimensional Location



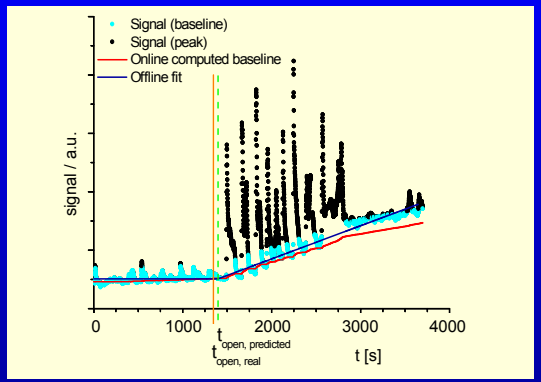
Comparison Summer - Winter



Peaks / Position



Time of Occurrence



Findings

- Signal nearly independent of stick position
- Simple mounting of the sensor, without fan, without pumping unit, sufficient
- Meaningful measurements only during movement
- Even small leaks can be detected

Conclusion

- In a 1-dimensional environment the position of the source can be estimated within a range of 1m
- In 1- and 2-dimensional environment the time of occurrence of the leak can be computed with good precision
- The measured concentration profile requires time consuming search strategies e.g. map building, this is possible because of the stable concentration profile

Outlook

- Implementation of a feedback from the sensor signal evaluation to the driving programme
- Larger rooms
- Classification of the analyte
  - Using a sensor system with different sensors including QMBs and pattern recognition software
- Testing in real world environment

Acknowledgements

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Sensing organs for mobile robots

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Thank You