Introduction to Mobile Robotics

Welcome

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Organization

- Tu 11:00 – 13:00
  Fr 11:00 – 12:00
  - lectures, discussions
- Fr 12:00 – 1:00pm
  - homework, practical exercises

- Web page:
  - www.informatik.uni-freiburg.de/~ais/
Goal of this course

- Provide an overview of problems / approaches in mobile robotics
- Probabilistic reasoning: Dealing with noisy data
- Hands-on experience
AI View on Mobile Robotics

World model

Control system

Sensor data

Actions
Robotics Yesterday
Current Trends in Robotics

Robots are moving away from factory floors to

- Entertainment, toys
- Personal services
- Medical, surgery
- Industrial automation (mining, harvesting, ...)
- Hazardous environments (space, underwater)
Robotics Today
The Helpmate System
Mobile Manipulation

[Brock et al., Robotics Lab, Stanford University, 2002]
Mobile Manipulation
Humanoids: P2

Honda P2
Team NimbRo (Freiburg/Bonn)

[courtesy by Sven Behnke]
Emotional Robots: Cog & Kismet

Kismet.QT3-T1-10f.mov

[Brooks et al., MIT AI Lab, 1993-today]
DARPA Grand Challenge

[Courtesy by Sebastian Thrun]
Shakey the robot
General Background

- Autonomous, automaton
  - self-willed (Greek, auto+matos)

- Robot
  - Karel Capek in 1923 play R.U.R. (Rossum’s Universal Robots)
    - labor (Czech or Polish, robota)
    - workman (Czech or Polish, robotnik)
Asimov’s Three Laws of Robotics

1. A robot may not injure a human being, or, through inaction, allow a human being to come to harm.

2. A robot must obey the orders given it by human beings except when such orders would conflict with the first law.

3. A robot must protect its own existence as long as such protection does not conflict with the first or second law.

[Runaround, 1942]
Wiener, Cybernetics

- Studied regulatory systems and their application to control (anti-aircraft gun)

- “it has long been clear to me that the modern ultra-rapid computing machine was in principle an ideal central nervous system to an apparatus for automatic control; and its input and output need not be in the form of numbers or diagrams, but might very well be, respectively, the readings of artificial sensors such as photoelectric cells or thermometers, and the performance of motors or solenoids”.

[Electronics, 1949]
Trends in Robotics Research

**Classical Robotics (mid-70’s)**
• exact models
• no sensing necessary

**Reactive Paradigm (mid-80’s)**
• no models
• relies heavily on good sensing

**Hybrids (since 90’s)**
• model-based at higher levels
• reactive at lower levels

**Probabilistic Robotics (since mid-90’s)**
• seamless integration of models and sensing
• inaccurate models, inaccurate sensors
Brief Case Study: Museum Tour-Guide Robots

Rhino, 1997

Minerva, 1998
Rhino (Univ. Bonn + CMU, 1997)
Minerva  (CMU + Univ. Bonn, 1998)
Components of Typical Robots

- cameras
- sonars
- laser
- base

sensors

actuators
A Good Robot Control System

See blackboard
Architecture of the Control System