Intelligent Robotics

TAMS demonstration

Lecturer

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@ TAMS Group

Outline of today's lecture

- Short introduction of TAMS group
- Mobile robots introduction
  - TASER
  - Pioneer robot
  - Humanoid robot
  - Sky cleaner
  - Gecko climbing robot
  - Telebot project
  - GZ-I modular robot
- Demonstration
- Free discussion

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Our TAMS group

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Research prototypes – TASER

- Taser
  - Service-robot of the University of Hamburg
  - Mobile platform with differential drive
  - Two Mitsubishi PA10-6C manipulators
  - Two 3-finger robotic hands
  - Stereovision camera head
  - Omni-directional vision system
  - Two SICK laser range finders
  - Pentium 4 control PC
  - Wireless LAN communication

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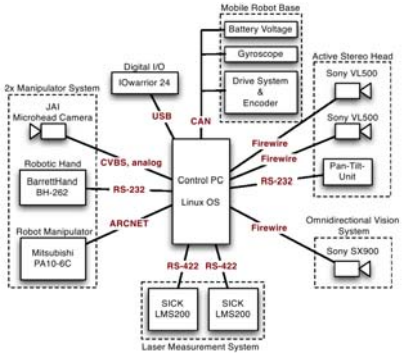
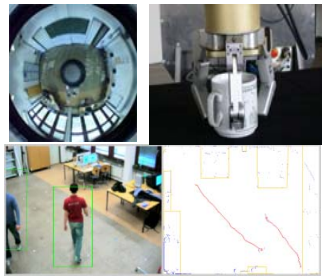
Research prototypes – TASER



Research prototypes – TASER

- Taser
  - Mobile manipulation
  - Grasping
  - Mobile robot navigation
  - People tracking
  - 3D image processing
  - Man-machine interaction



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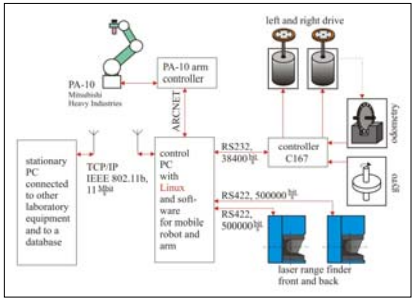
Research prototypes – old platform



Testing and demos

Research prototypes – Pioneers

- Pioneer robots
  - Pioneer is a family of mobile robot with two-wheel or four-wheel-drive. They are small, intelligent robots developed by Dr. Kurt Konolige of SRI International, Inc, and Stanford University.
  - Pioneer robots contain all of the basic components for sensing and navigation in a real-world environment.
  - They are all managed via an onboard microcontroller and server software

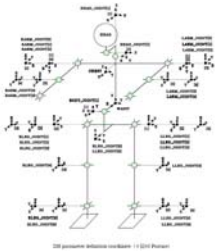
MobileRobots Inc
(formerly ActivMedia Robotics, LLC)
19 Columbia Drive, Amherst, NH 03031 US,
voice +1-603-881-7960; fax +1-603-881-3818

Research prototypes – Pioneers

- Applications
  - Mapping
  - Teleoperation
  - Localization
  - Monitoring
  - Reconnaissance
  - Vision tracking
  - Manipulation
  - Cooperation
  - Other behaviors

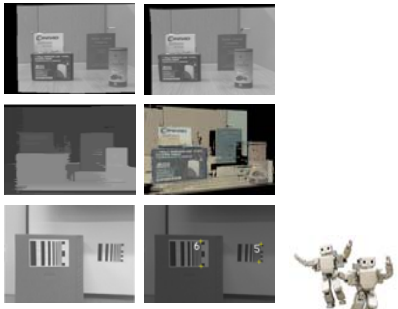
Research prototypes – Humanoid robot

- Tams humanoid robots
  - 2 HOAP- 2 der Fujitsu Automation Co., Ltd.
  - 25 DOF
    - Legs DOF: 2 x 6
    - Arm DOF: 2 x 5
    - Head DOF: 2
    - Body DOF: 1
    - Five-finger Hands
  - Weight 7kg
  - Height 50 cm
  - USB Interface (USB 1.1)
  - Geode GX1 CPU
  - 2 Logitech Quickcams with ¼ inch CMOS Sensor



Research prototypes – Humanoid robot

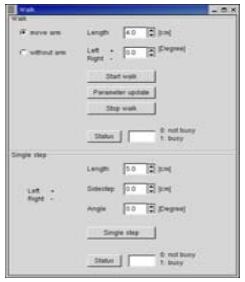
- Hoap 2
  - 3D Reconstruction
  - Self-Localisation
  - Navigation

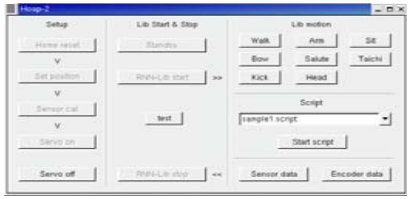


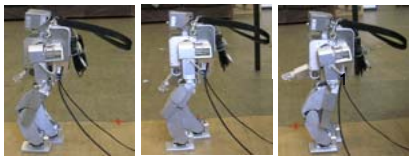
TAMS Humanoid Robots

Research prototypes – Humanoid robot

- Hoap 2
  - Motion control

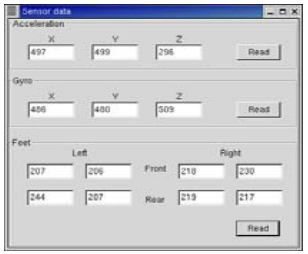


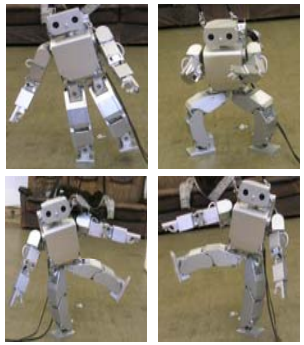




Research prototypes – Humanoid robot

- Hoap 2
  - Balance
  - Human-robot interaction





Research prototypes – Aibo

- Sony Aibo
  - 25 cm long
  - With camera, microphone and other sensors
  - With communication interface

http://support.sony-europe.com/aibo/

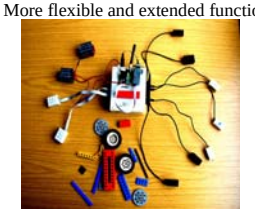
Research prototypes – Aibo

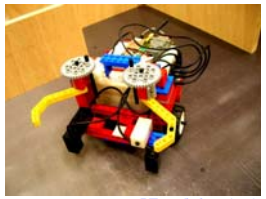
- Application
  - Locomotion
  - Human-robot interface
  - Robocup

http://support.sony-europe.com/aibo/

Research prototypes – Telebot

- Telebot (TAMS group based on cooperation with BUAA, 2006)
  - 9 channels for sensor inputs; 4 outputs for actuators
  - Communication interface
  - Java and C++ programming easy
  - More flexible and extended functions





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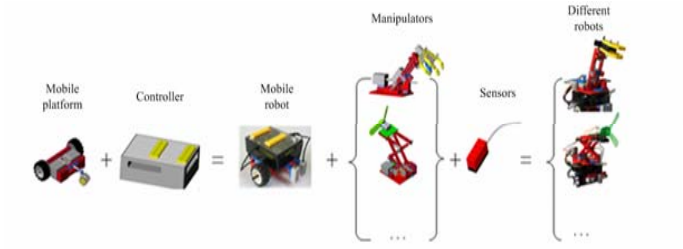
Research prototypes – Telebot

- A new kind of education robotic system for practical courses whose object is to offer a chance to different levels of students to acquire knowledge about robotics;
- More flexible mechanical parts based on LEGO bricks and our newly designed output and input bricks;
- Embedded software hierarchy;
- Easy-to-use programming environment in Java or C language, depending on the students' standard of knowledge.

Research prototypes – Telebot



Research prototypes – Telebot

- Application
  - Moving along a line
  - Avoid an obstacle
  - Looking for an object
  - Following a moving object
  - Mapping the scenario

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Testing and demos

Research prototypes – Sky Cleaner

- Since 1996, our international group has been developed four Sky Cleaners fully pneumatic climbing robots for cleaning the glass-wall of high-rise buildings.
- No motor for actuation
- Several non-linear algorithms for the cylinder's movement control are proposed and tested on Sky Cleaners.
- Recently, considering the effects of friction and movement acceleration of the cylinder, a compensating variable bang-bang controller is presented to control the cylinder movement to keep the merits and eliminate the oscillation.

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Research prototypes – Sky Cleaner

1997 → *1999* → *2001* → *2006*

"Sky Cleaner-I"

"Sky Cleaner-II"

"Sky Cleaner-III"

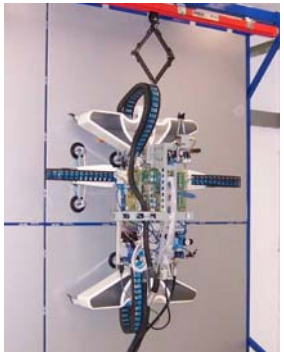
"Sky Cleaner-IV"

Research prototypes – Sky Cleaner

- Advantage
  - Lightweight
  - Passive compliance, safer than driven by motors
- Disadvantage
  - Nonlinearities and low stiffness

Research prototypes – Sky Cleaner

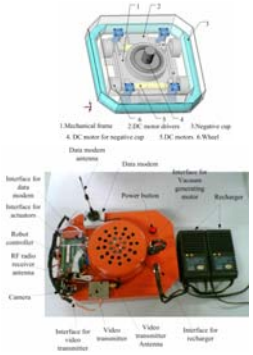
- A following unit for protection
- A supporting vehicle for air, water, and power.
- Sky Cleaner robot
  - X and Y cylinders composed of the robot.
  - A waist joint in the center
  - Four foot cylinders to lift and lower vacuum suckers
  - Real-time control system



Testing and demos

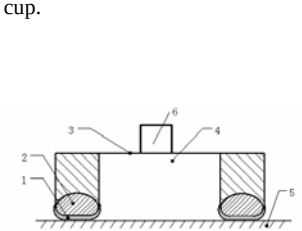
Research prototypes – Gecko robot

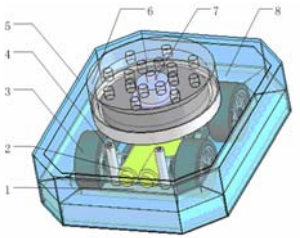
- First version
  - A lightweight smart wall-climbing robot last year, which was developed as a flexible mobile platform carrying a CCD camera and other sensors (2004).
- The second version
  - We improved the first version for several aspects in 2005-2006.
  - Much lighter and smaller
  - With sensors and wireless interface
  - Controlled in two different ways



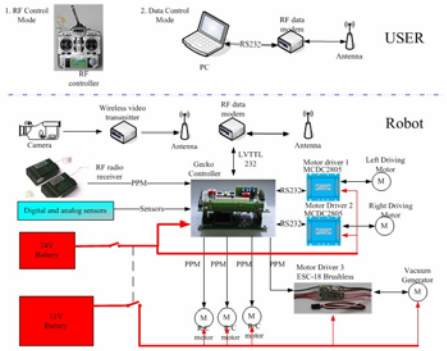
Research prototypes – Gecko robot

- The moving body is inside the negative pressure cup. The rubber gasbag is charged for airproofing. The two part of the robot are connected by four pillars. The motor to generate negative pressure is on the top of the cup.





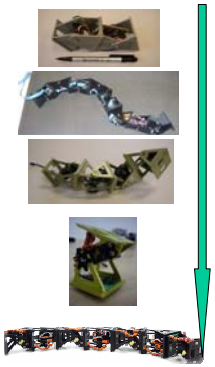
Research prototypes – Gecko robot



Testing and demos

Research prototypes – Modular robot

- Y1 module, 2004
- Y1 modular minimal configuration, 2005
- Y1 pitching-yawing connecting research, 2006
- GZ-I mechanical improvement design, 2006
- GZ-I system integration, 2007
- Related research, 2008.

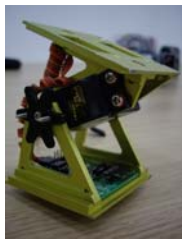


Research prototypes – Modular robot

- Main idea: Building robots composed of **modules**
- The design is focused on the module, not on a particular robot
- The different combinations of modules are called **configurations**
- Some advantages:
  - Versatility
  - Fast prototyping
  - Testing new ideas

Research prototypes – Modular robot

- GZ-I was developed in 2006 in cooperation with my colleague Juan González-Gómez. This system has been developed and is currently still under improvement by our consortium.
  - *Low-cost mechanical design with only six parts in aluminium making up a strong module;*
  - *Simple robust modules assembling manually and in a quick-to-build, easy-to-handle design;*
  - *Four faces for interconnecting modules to implement pitching and yawing movements and two crossed connecting modes so that the system can be extended to build different kinds of inspired robots*
  - *Onboard controller and sensors completing the system and making sensor-servo-based active perception of the environment possible.*



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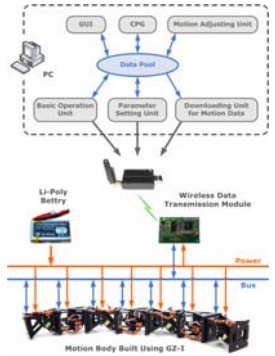
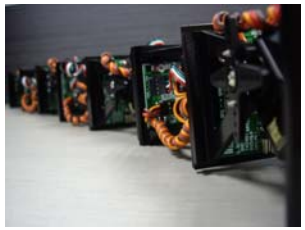
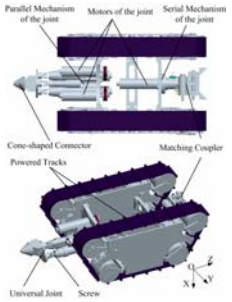


Testing and demos



Other prototype – JL-I

- JL-I with three uniform modules was developed.
- 35 centimetres long, 25 centimetres wide and 15 centimetres high.
- Two powered tracks, a serial mechanism, a parallel mechanism, and a docking mechanism.
- Changing its posture by pitching, yawing and rotating.



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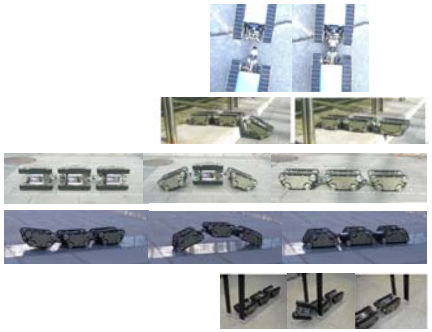
Other prototype – JL-I

- Docking process
- Crossing a step
- 90° self-recovery
- 180° self-recovery
- Crossing a narrow fence



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Test and demos

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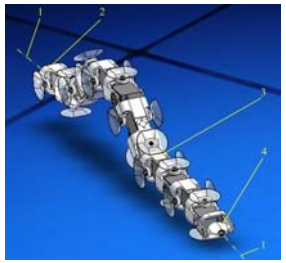
Other prototype – ZC-I caterpillar

- Quick-to-assemble mechanical structure and low-frequency vibrating passive attachment principle.
- Active joints actuated by RC servos endow the connecting modules with the ability of changing shapes in two dimensions.
- Various locomotion capabilities will be achieved based on an inspired control model to produce rhythmic motion.



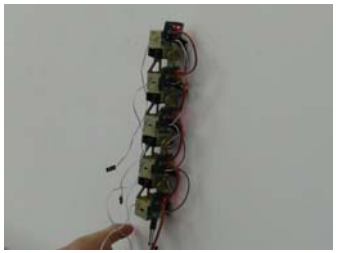
Picture taken from a 3D-animation of the planned robotic caterpillar in a variety of postures.

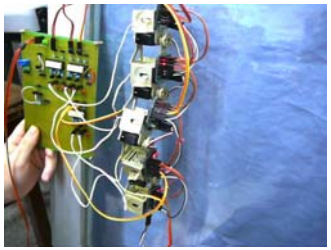
Other prototype – ZC-I caterpillar

- The major challenges in designing: the smaller dimension and the ability to attach to the wall safely and move flexibly.
- Eleven cross-connected modules for traveling.
- Only two kinds of modules: the head and tail module; the body module.
- The mechanical structure can be reconstructed and is flexible due to its similar modules and special connection joints.

Picture taken from a 3D-animation of the planned robotic caterpillar in a variety of postures.

Test and demos





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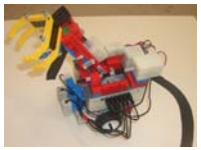
Demonstration for today



TAMS Humanoid Robots

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