Proseminar Roboter und Aktivmedien

Educational robots achievements and challenging

Lecturer

Houxiang Zhang

TAMS, Department of Informatics
University of Hamburg, Germany

@Tams/hzhang

Outline of today's lecture

- What is an edutainment robot ?
- Review of edutainment robots
  - Brief introduction to the research background
  - Several famous prototypes
  - Challenging issues
- Introduction to Telebot system
  - Brief introduction to the Telebot project
  - Telebot system
    - Specification
    - Components
    - Software hierarchy
  - Applications
- Summary

Acknowledgments

- Special thanks to the E-Learning-Consortium Hamburg (ELCH) for supporting "Telebot" , an educational robotic system.

E-LEARNING CONSORTIUM Hamburg

- Also, thanks for the ARMS Group at Beijing University of Aeronautics and Astronautics (BUAA) for the technical cooperating on educational robotic projects.

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What is an edutainment robot?

- An **edutainment robot** is a robot that has been designed for the purpose of edutainment and entertainment.
- Robotics has emerged as a useful tool in education because robots provide ideas of science and technology.
- Robotics connects the student with the science and technology easily




Reading material

- ***Building Robots with LEGO Mindstorms NXT;*** by, Mario Ferrari, Guilio Ferrari, and David Astolfo
- ***The LEGO MINDSTORMS NXT Zoo! - A Kid-Friendly Guide to Building Animals with the NXT Robotics System;*** by Fay Rhodes
- ***Robotics Courses for Children as a Motivation Tool: The Chilean Experience,*** J. Ruiz-del-Solar, R. Avilés, IEEE Transaction on Education, Vol. 4, No. 4, pp. 474-480, November 2004.


http://mindstorms.lego.com/Books/

Web links on edutainment robots

- **IEEE Robotics and Automation Society(RAS)**
  - http://www.ncsu.edu/IEEE-RAS
- **European Robotics research Network (EURON)**
  - http://www.euron.org/
- **Lego mindstorms**
  - http://mindstorms.lego.com/default.aspx?domainredir=www.legomindstorms.com
- **Telebot project**
  - http://tams-www.informatik.uni-hamburg.de/people/hzhang/projects/index.php?content=Telerobot

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Brief introduction to research background

- Education robots in EU and U.S.A
- Many famous products such as Lego and Fischertechnik
- Education robot in Asia
- Many different robotic systems are included in this field
  - Research robotic prototype
  - Pure educational robots
  - Entertainment robots
  - Modular robots

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Research prototypes

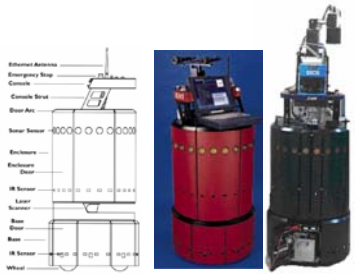
Research prototypes – Pioneers

- Pioneer robots
  - Pioneers are a family of mobile robots 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 – B21

- B21 Robot
  - A sophisticated mobile robot with up to three Intel Pentium processors on board.
  - It has different kinds of on-board sensors for high-performance navigation tasks.



http://www.cercia.ac.uk/our_services/facilities/b21.php

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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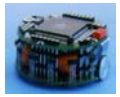
Research prototypes – Khepera

- Khepera robot
  - It measures only about 60 mm in diameter.
  - Additional modules with cameras, grippers and many other features are available.
  - More than 700 units have already been sold (by the end of 1998).



http://diwww.epfl.ch/lami/robots/K-family/ K-Team.html

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Education and entertainment robots

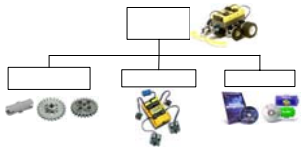
Edutainment robots – Aibo

- Sony Aibo
  - 25 cm long
  - Camera, microphone and other sensors
  - Communication interface

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

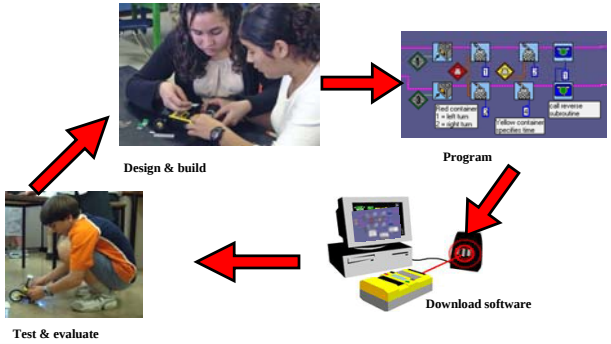
Edutainment robots – Lego mindstorms

- Lego mindstorms
  - Developed in cooperation with MIT Media Lab researchers in 1998.
  - RCX
    - 3 sensory inputs and 3 motor outputs.
    - includes a display and buttons for selecting programs and viewing status of in/outputs
    - includes an IR serial port, through which it is programmed
  - Robotics Invention System (RIS) and easy-to-use GUI



http://mindstorms.lego.com/

Edutainment robots –Lego



Lego mindstorms

- **Lego Mindstorms**

The latest product in the Mindstorms series is Mindstorms NXT, released in August 2006. The kit includes three servo motors, a touch sensor, a light sensor (now with the ability to differentiate between colors based on grayscale readings), a new sound sensor, an ultrasonic sensor and a new NXT 'Intelligent Brick'.
The kit is sold for $249 USD.

Available in GUC Library: Mario Ferrari, Giulio Ferrari, Ralph Hempel, *Building Robots With Lego Mindstorms : The Ultimate Tool for Mindstorms Maniacs*. Syngress Publishing; 1 edition, 2001.

Lego mindstorms

http://mindstorms.lego.com/Overview/

Edutainment robots – Fischertechnik

- Fischertechnik (Arthur Fischer in 1965)
  - Contains a great amount of educational aspects, both with respect to programming and especially with respect to the construction of the robots.
  - Contains a central processing unit, two motors, six switches, two light sensors and one light source.
  - The programming interface for the Fischertechnik robots is quite similar to that of LEGO Mindstorms
  - A bit expensive

http://www.fischertechnik.de/en/index.aspx

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Other toys

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Modular robots

Edutainment robots – 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

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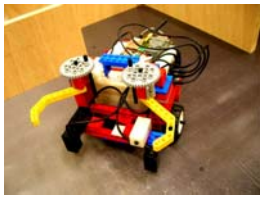
Intelligent Robotics

Telebot: a Flexible Educational Robotic System for a Practical Course

Lecturers

Houxiang Zhang

TAMS, Department of Informatics
University of Hamburg, Germany



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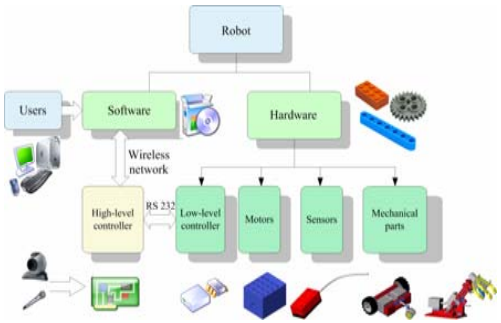
Overview of the Telebot



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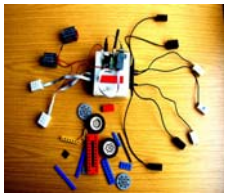
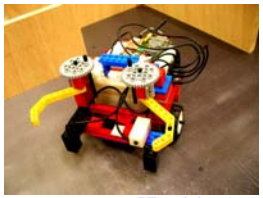
Telebot system introduction

- 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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Telebot system

- A new kind of educational 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.

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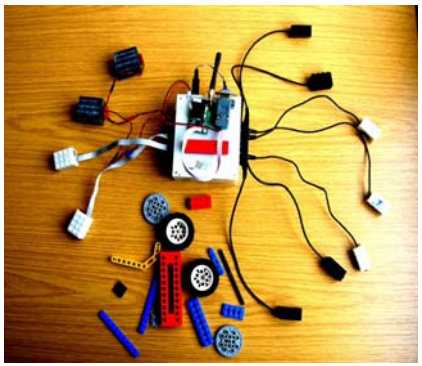
Components of the Telebot system



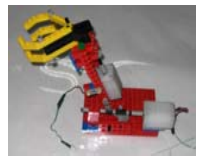
Components of the Telebot system

Components (cont')

- Lego 9640 set 1 set
- 1 battery 1 X 8 /set
- Wireless serial interface 1 X 2 /set
- Actuators 1 set
- Sensors 1 set
- Microcontroller 1 set
- A box for all components 1 set

Mechanical system

- Functionality
- Extensibility
- Easy handling
- Low cost



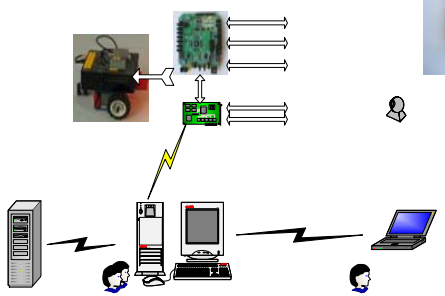
Components (cont')

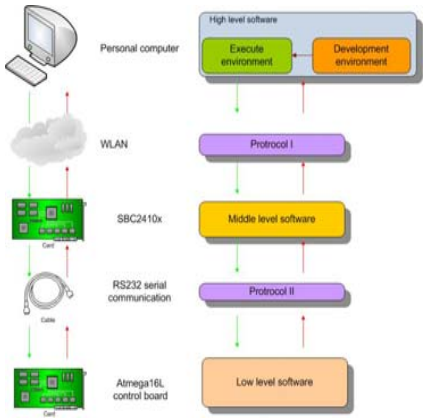
- Lego 9640 set
- 1 battery
- Wireless serial interface
- Actuators
- Sensors
- Microcontroller
- A box for all components

Hardware realization: sensors

Kinds	Purposes	Number	Photo
Color sensor	Detect black and white	2	
Object sensor	Detect objects in front	2	
Light sensor	Detect an illuminant object such as a candle or a lamp	2	
Touch sensor	Switch	2	

Hardware realization



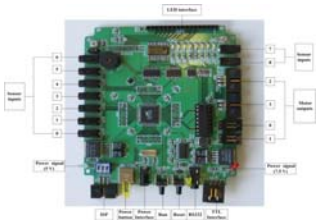


Specifications of the hardware

- Enough I/O resources
  - inputs: switches and analog sensors
  - outputs: 2 motors (PWM), 2 motors (on-off)
- CCD input
- Remote operation
- Wireless communication
- Online debugging

Hardware realization: controller B

- ATmega16 microprocessor.
- The sensor channels from 0 to 6 can be used as digital or analog inputs; 7 and 8 can only be used in a digital way.
- Power supply should be 8.4V-24V
- Two communication interfaces on board: RS232 and TTL
- ISP for downloading the drivers
- Motor outputs 0 and 1 can be controlled by PWM signals; 2 and 3 are only under the on-off mode.



In-System Programming *(abbreviated ISP) is the ability of some programmable logic devices, microcontrollers, and other programmable electronic chips to be programmed while installed in a complete system, rather than requiring the chip to be programmed prior to installing it into the system.*

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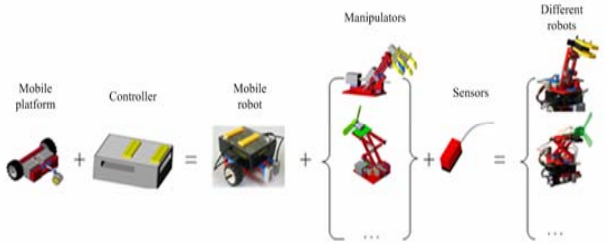
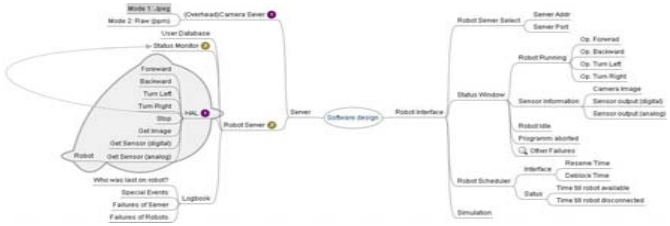
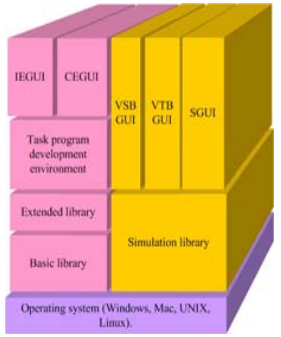
System integration



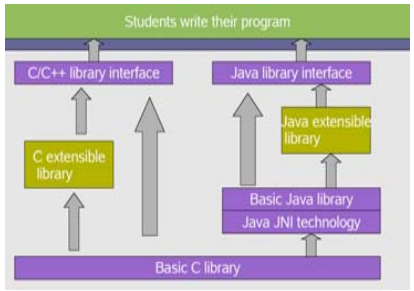
Software hierarchy



Program development environment

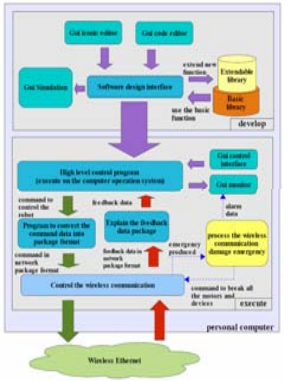


Library structure

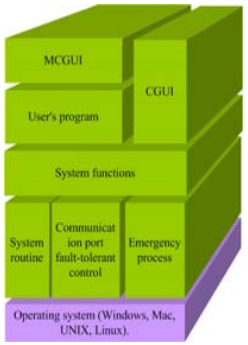


High level part

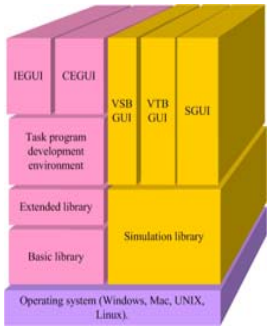
- Providing a flexible, friendly program edit environment for the user;
- Providing a security mechanism for the user to program the telerobot;
- Controlling the wireless communication between personal computer and the telerobot;
- Providing a simulation interface.

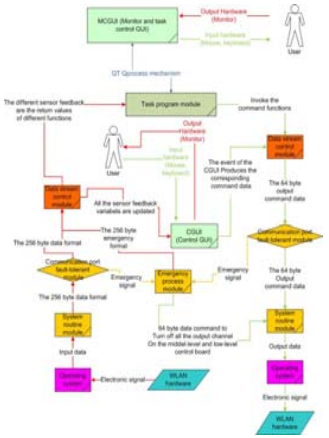


Task program executing environment



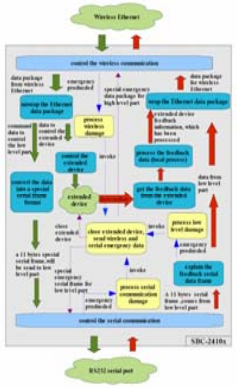
Task program development environment

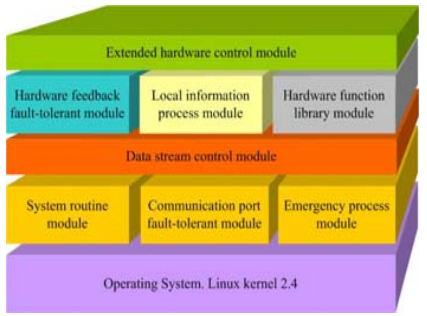


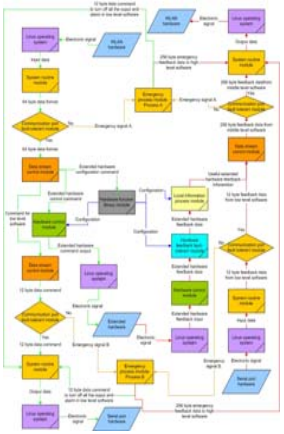


Middle level part

- Controlling the wireless communication between PC and the telerobot;
- Controlling the serial communication between embedded system control board (SBC-2410X) and the micro control board (ATMEGA16L) on the robot;
- Actuating the extendible devices on the SBC-2410X;
- Analyzing tasks commands and monitoring local security.

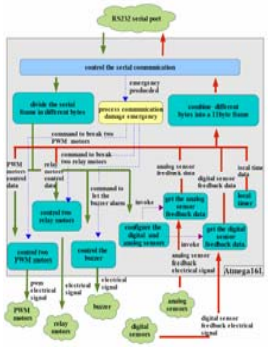


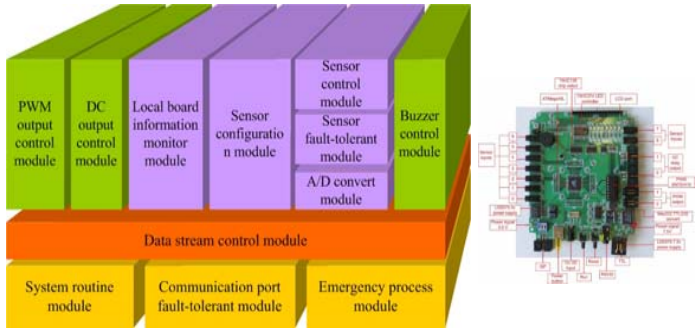


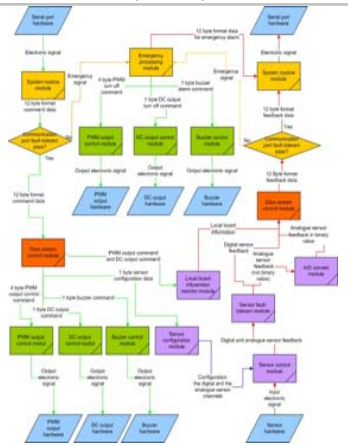


Low level part

- Controlling the communication between SBC-2410X and the ATMEGA-16Land board as mentioned above;
- Actuating four DC servo motors with PWM and relay signals;
- Collecting different digital and analogue sensors
- Information feedback.







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Possible tasks for our practical course

- Moving along a line
- Detecting and moving around an obstacle
- Looking for an object
- Following a moving object
- Mapping the scenario
- …

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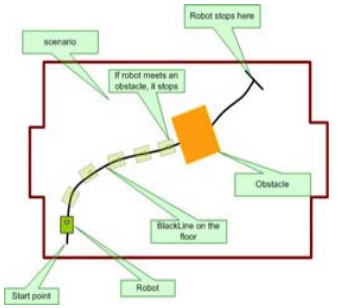
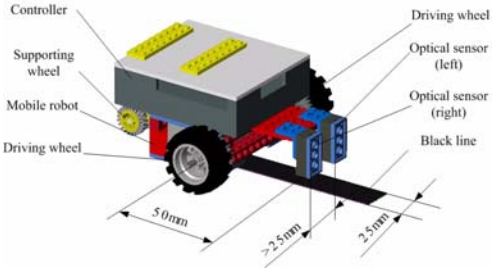
Moving along a line

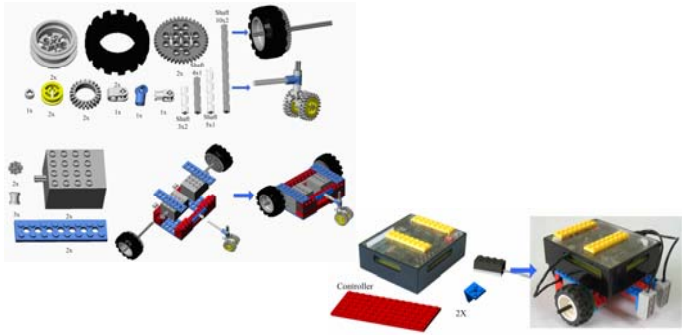


Implementation

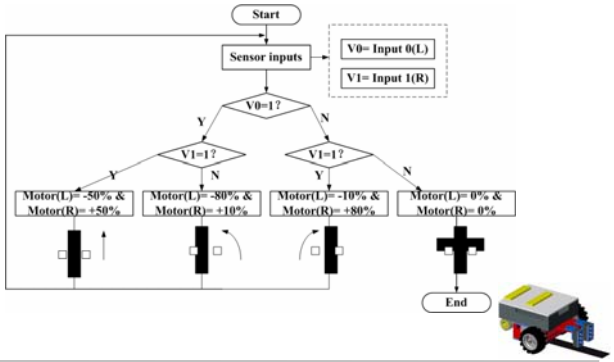
- Building the mechanical system
- Programming
- Testing



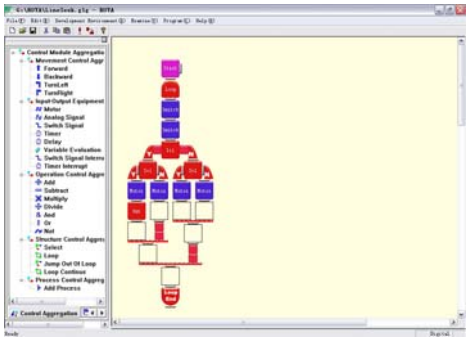
Building the mechanical system



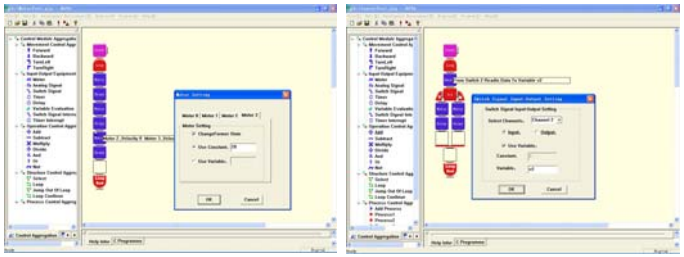
Programming the robot



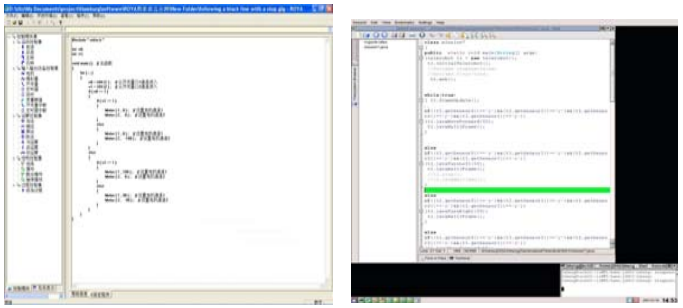
Iconic programming



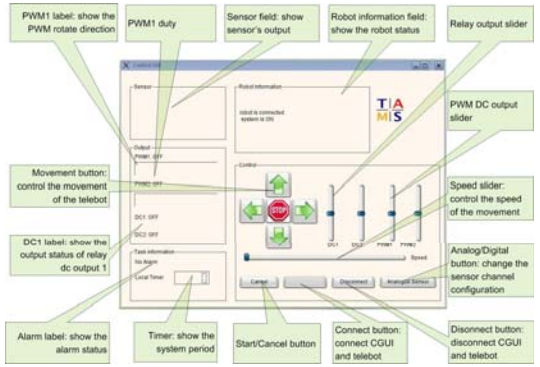
Setting the inputs and outputs



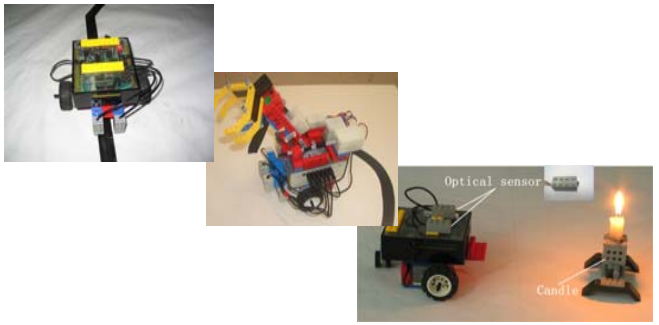
C and Java Programming environments



GUI



Testing and demos

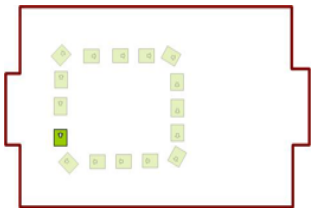


Possible tasks for our practical course

- Moving along a line
- Detecting and moving around an obstacle
- Looking for an object
- Following a moving object
- Mapping the scenario
- …

Control your robot move forward 1 meter

- Please build your own movement platform and let it move forward 1 meter in the scenario.
- **Problem:**
  - **Maybe the robot does not move so perfectly.**
- **Why?**
  - **We are not using the sensor to adjust the movement on time.**



Conclusions

- A new kind of education robotic system for practical course whose object is to offer a chance to different levels students to acquire knowledge about robotics;
- More flexible mechanical parts based on LEGO bricks and our new designed output and input bricks;
- Embedded software hierarchy;
- Iconic programming environment and Java and C language programming environment available according to students' knowledge background.

Related publications

- Houxiang Zhang, Weining Zheng, Shengyong Chen, Jianwei Zhang, Wei Wang, Guanghua Zong: Flexible Educational Robotic System for a Practical Course, Proceeding of 2007 IEEE International Conference on Integration Technology, Shenzhen, Guangdong, China, 20-24 March, pp.691-696, 2007.
- Houxiang Zhang, Tim Baier, Jianwei Zhang, Wei Wang, Rong Liu, Dazhai Li, Guanghua Zong: Building and Understanding Robotics-a Practical Course for Different Levels Education, 2006 IEEE International Conference on Robotics and Biomimetics, Kunming, China, 17-20 Dec., 2006, pp.61-66.
- Three project reports
- Online information
  - http://tams-www.informatik.uni-hamburg.de/people/hzhang/projects/TelerobotDocument/index.htm

Thanks for your attention!

Any questions?

Ph.D. ZHANG, Houxiang hzhang@informatik.uni-hamburg.de
Institute TAMS **Technical Aspects of Multimodal Systems** http://tams-www.informatik.uni-hamburg.de/hzhang