

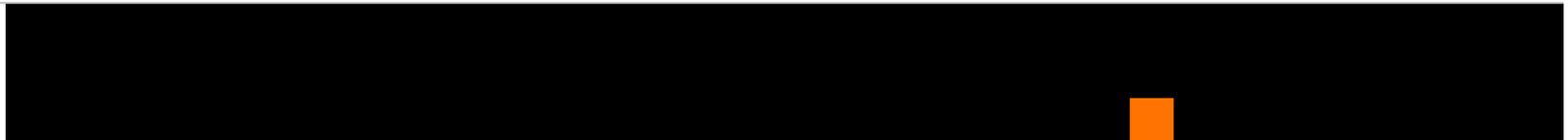
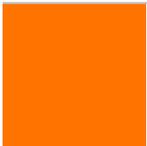
KUKA

KUKA youBot – a milestone for education and research in mobile manipulation

R. Bischoff

KUKA Laboratories GmbH
Augsburg, Germany

IEEE ICRA Workshop “A new generation of educational robots”
Shanghai International Convention Center, China
13 May 2011



Overview

- Short introduction to KUKA
- Motivation for research and education in mobile manipulation
- KUKA youBot
- BRICS Mobile Manipulation Challenge
- Results from first BRICS Research Camp
- Outlook



KUKA Laboratories GmbH

- core technology development
- technology platforms
- products for new markets

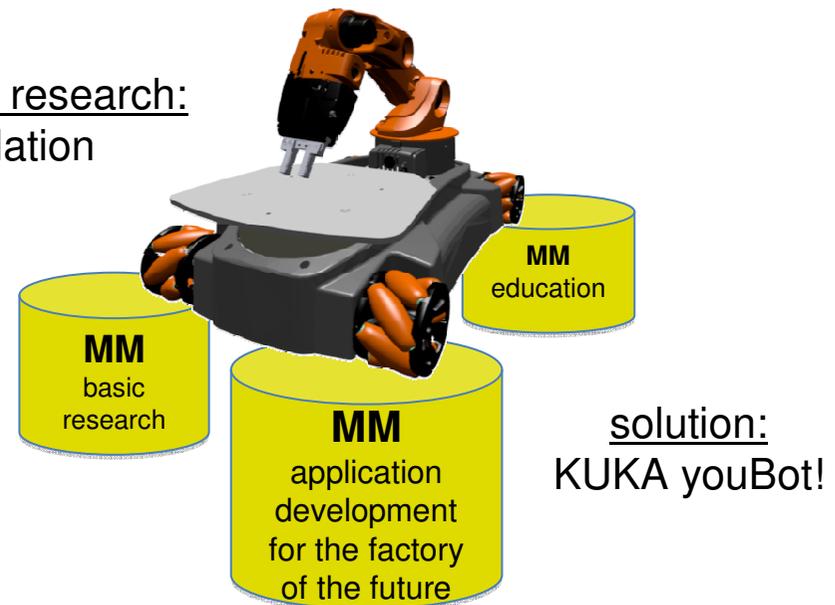
products for
research and education



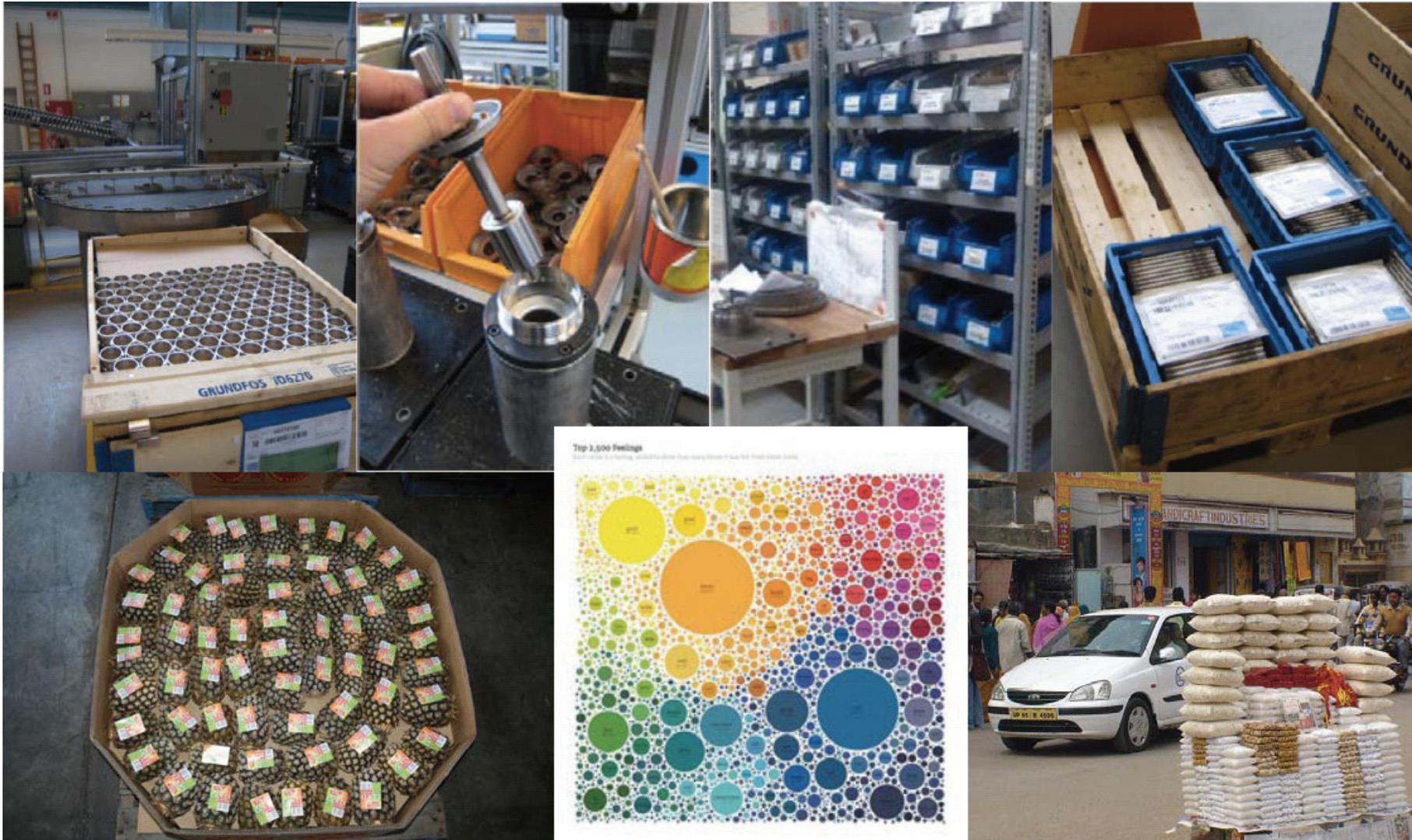
Motivation for developing products according to researchers' needs

- research market very small, but non-negligible
- marketing instrument
- today's students become engineers and decision makers
- researchers should focus on their research
- faster transfer of research results

Hot topic in robotics research:
mobile manipulation



Industrial relevance of mobile manipulation



KUKA youBot – a milestone for education and research in mobile manipulation



Open research problems in mobile manipulation

- seamless integration of planning and control
- cognitively plausible, task effective, and natural choreography of motion
- revision and adaptation of tasks and motion plans
- integration of 3D perception, mapping and modeling
- resource management (sensing for locomotion vs. sensing for manipulation)
- robotics software engineering (component models, model driven engineering)
- robot control architectures
- self-perception, self-modeling, self-awareness
- non-functional aspects: robustness and dependability, openness, reusability



IPA Rob@Work2



IPA Care-o-Bot



BRSU Johnny



DESIRE

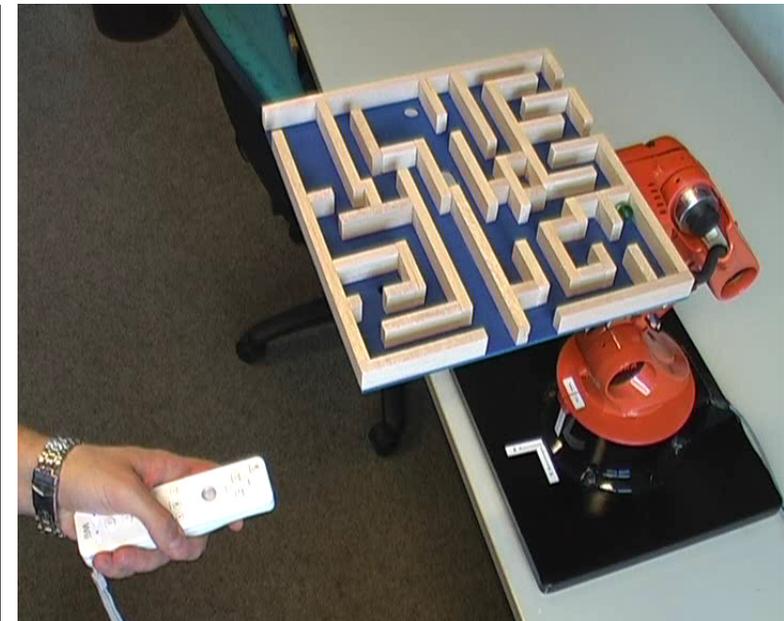
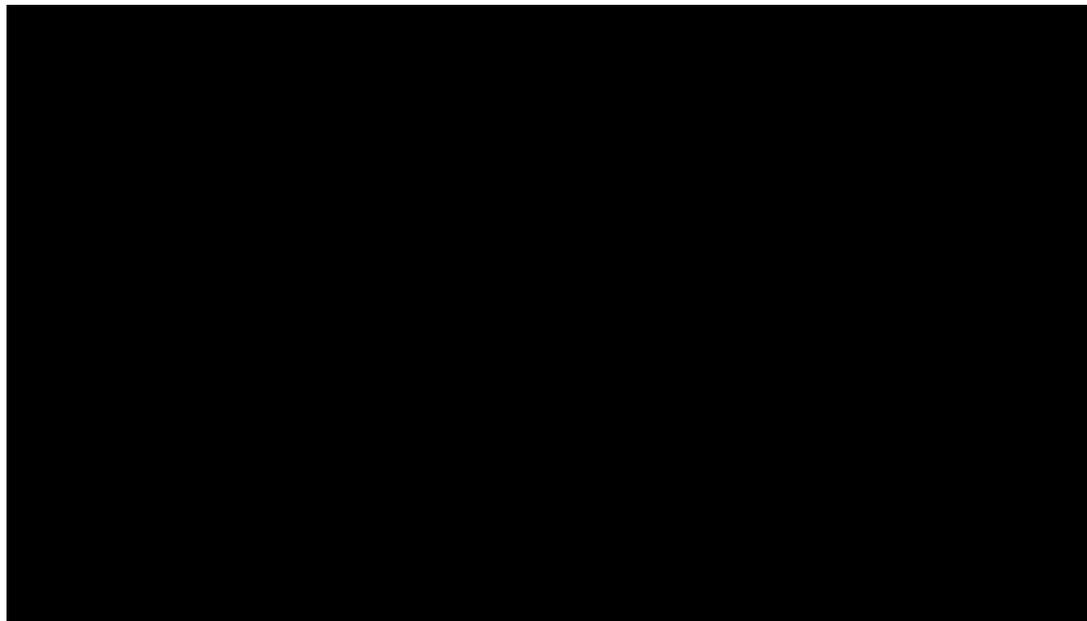


DLR
Justin



KUKA youBot – a new mobile manipulator for research and education

- omnidirectional mobile platform
- 5-DOF manipulator
- two-finger gripper
- real-time EtherCAT communication
- open interfaces
- arm and platform can be used independently



KUKA youBot at **AUTOMATICICA**
www.youbot-store.com

KUKA youBot arm and labyrinth – remotely
controlled by Nintendo Wii controller
© University of Augsburg Software Engineering



KUKA youBot – a new mobile manipulator for research and education

youBot arm & gripper



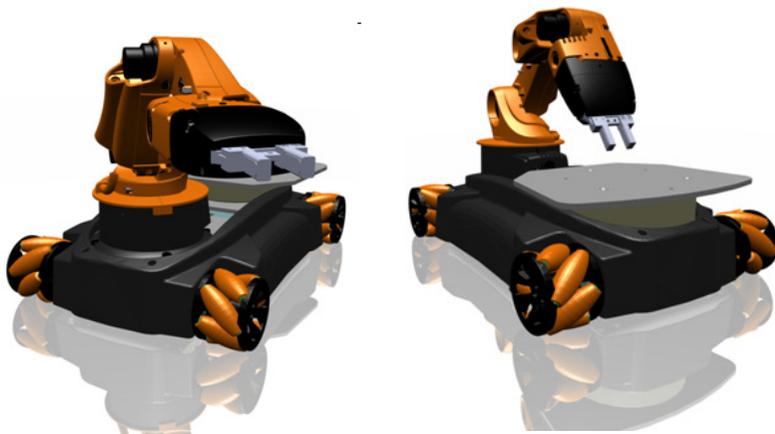
- 5 axes
- 2-finger gripper
- height: 655 mm
- mass: 6.3 kg
- payload: 0.5 kg
- magnesium cast
- 24 Volts

youBot platform



- 4 KUKA omniWheels
- length: 580 mm
- width: 360 mm
- weight: 24 kg
- payload: 20 kg
- steel structure
- 24 Volts

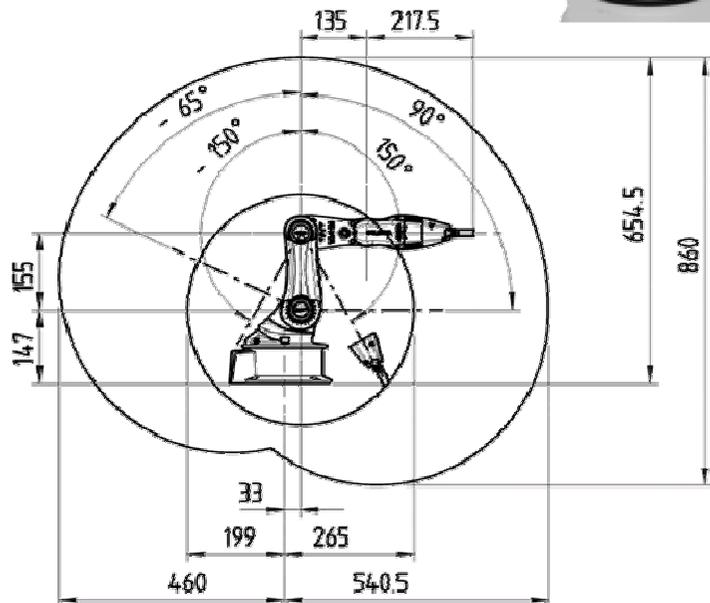
youBot System with 1 arm



youBot system with 2 arms



youBot arm + gripper



| General characteristics: youBot arm | |
|-------------------------------------|----------------------|
| Serial kinematics | 5 axes |
| Height | 655 mm |
| Work envelope | 0.513 m ³ |
| Weight | 6.3 kg |
| Payload | 0.5 kg |
| Structure | Magnesium cast |
| Positioning repeatability | 1 mm |
| Communication | EtherCAT |
| Voltage connection | 24 V |
| Power can be limited to | 80 W |



| Gripper data | Detachable, 2 fingers |
|--------------|-----------------------|
| Stroke | 20 mm |
| Range | 70 mm |



youBot platform



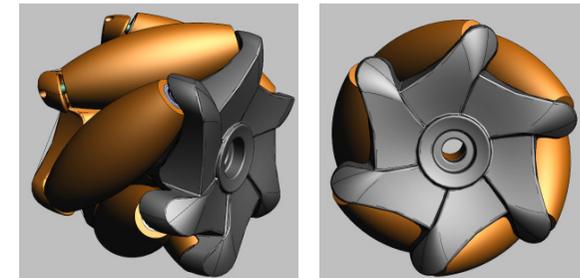
| General characteristics: youBot platform | |
|--|-------------------|
| Omnidirectional kinematics | 4 KUKA omniWheels |
| Length | 580 mm |
| Width | 380 mm |
| Height | 140 mm |
| Clearance | 20 mm |
| Weight | 20 kg |
| Payload | 20 kg |
| Structure | Steel |
| Speed | 0.8 m/s |
| Communication | EtherCAT |
| Voltage connection | 24 V |

Energy supply

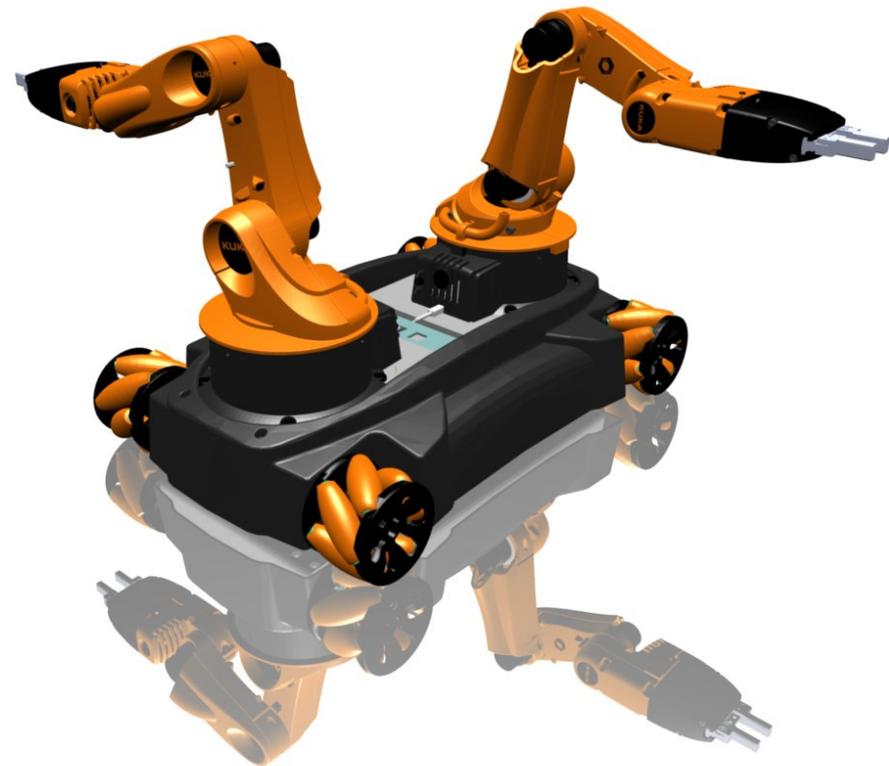
maintenance-free lead acid rechargeable batteries: 24 V, 5 Ah, 4 kg
 Approximate runtime of youBot mobile manipulator: 90 minutes
 power adapter: 200 W, 24 V

On-board PC

mini IT X PC-Board with embedded CPU (Intel Atom Dual Core), 2 GB RAM,
 32 GB Solid State Disk, 2 LAN Ports, 8 x USB, 6 x COM



youBot system



all pictures/videos rendered with
www.blender.org



KUKA youBot and omniMove system with KUKA Titan



KUKA youBot – a milestone for education and research in mobile manipulation

KUKA Laboratories GmbH | Rainer Bischoff | 13.05.2011 | Page 12

www.kuka-labs.com



Importance of the Internet

- viral marketing
 - from 0 to >20.000 Google hits in 10 days
- Tech Blogs
 - IEEE Spectrum
 - Hizook
 - Golem
 - botjunkie
- youTube video
 - > 10000 views
- webshop from 01.09.



KUKA

Select Language

Search

Desktop mobile manipulator for education and research

KEY FEATURES

- omnidirectional mobile platform
- 5-DOF manipulator
- two-finger gripper
- real-time EtherCAT communication
- open interfaces
- arm and platform can be used independently

← Back | Recommend this page | Print version | Top ^

Home | Sitemap | Imprint / Privacy Policy | Search | Contact

KUKA youBot
Phone: +49 8191 973-3231
Fax: +49 8191 973-3232

Market

- Universities, colleges
- research centers
- vocational schools, secondary schools

- list prices:
 - arm: 13.990,- EUR
 - platform: 9.990,- EUR
 - system with 1 arm: 19.990,- EUR
 - system with 2 arms: 32.990,- EUR
 - various discounts for academia

- sales:
 - Internet (via partner Locomotec)
 - www.youbot-store.com

This page is operated by Locomotec, the official KUKA youBot partner.

KUKA youBot store

Login Order Contact

Home Hardware Software Education Research Users Media



Hardware

- fully open platform providing access to hardware over EtherCAT
 - high precision specially designed and manufactured motors and gears
 - vehicle body consisting of durable steel frame with specially designed plastic cover
 - specially designed and manufactured omniwheels
 - suspended front axis
 - detachable 2-finger gripper with adjustable finger position
 - high quality components
- easily extendible to dual-arm system
- third party hardware including
 - 2D/3D laser range finders
 - stereo vision system
 - five-finger hand (available spring 2011)

youBot Hotline

+49 8191 973-3231
hotline@youbot-store.com

NEWS

KUKA youBot @ IROS 2010 - Taipei, Taiwan, October 04, 2010
Come and visit our booth at IROS 2010 in Taipei, Taiwan!
[more ...](#)

KUKA youBot on Facebook - Landsberg, September 21, 2010
Become a friend on Facebook!
www.facebook.com/KUKAyouBot
[more ...](#)

KUKA youBot on Twitter - Landsberg, September 08, 2010
Follow us on Twitter:
<http://twitter.com/KUKAyouBot>
[more ...](#)

KUKA youBot store online! - Landsberg, August 31, 2010
The KUKA youBot store is online!
[more ...](#)
[View all news](#)

Announcements

- First KUKA youBots will ship in December 2010.
- Universities and research facilities are eligible for a 20% academic discount on KUKA youBot hardware.
- Discounts do not apply to third party products.

Copyright © 2010 Locomotec. All rights reserved. Home | Terms and Conditions | Privacy Policy | Impressum



<http://www.facebook.com/KUKAyouBot>



<http://twitter.com/KUKAyouBot>



Invitation of 20 top PhD students from all over the world to an inspiring location

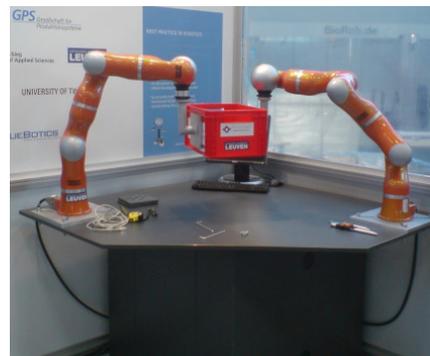
- Task:
 - identify best practice algorithms, e.g.:
Mobile Manipulation incl. inverse kinematics,
3D Perception and Modelling, SLAM, ...
 - Make sure everybody has a lot of fun and in the end also has a scientific benefit.
- Work with the latest and coolest pieces of robot hardware available today:



5 youBots



Care-o-Bot
with LWR



2 LWRs

BRICS - Best Practice in Robotics

1st BRICS Research Camp on Mobile Manipulation
Malaga, Costa de Sol, Spain
24 - 29 October 2010

The top 20 robotics Ph.D. students worldwide with a solid background in mobile manipulation are invited to gather for one week in a stimulating environment to explore, revise and improve what are considered the best practice algorithms in mobile manipulation today. The intended outcome of the research camp is an open source library of refactored and harmonized mobile manipulation algorithms.

We will provide

- an inspiring working environment
- travel grants to get to this inspiring working environment:
1250 € for European students, 2000 € for international students
- the latest and coolest pieces of robot hardware in mobile manipulation, especially for education and research in mobile manipulation
- a DVD with an initial set of software modules for mobile manipulation and 3D perception and modelling
- a fast Internet access
- two typical mobile manipulation tasks/scenarios

We expect in return

- a competitive solution to the given tasks either using the provided or self-developed algorithms for mobile manipulation demonstrated in two competitions on the last day of the research camp
- critical feedback and revisions of the provided hardware and software

Applications should include

- CV with publication list
- letters of reference from two different faculties

and should be sent to:

Thilo Zimmermann
Gesellschaft für Produktionssysteme GPS
Nobelstr. 12
D-70569 Stuttgart
GERMANY
email: zimmermann@gps-stuttgart.de

Schedule

June 15, 2010 Submission of applications
July 15, 2010 Notification of acceptance or rejection

Acknowledgement

This activity is supported by the European Commission ICT Challenge 2 under grant agreement no. 231940

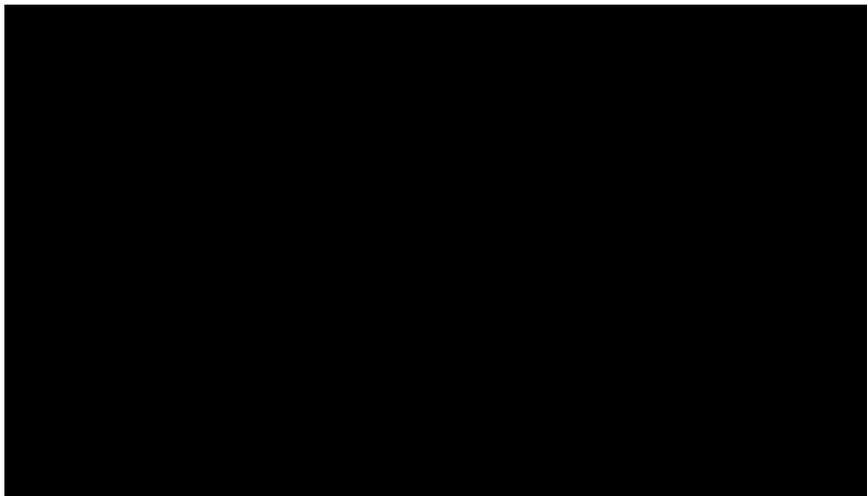
www.best-of-robotics.org



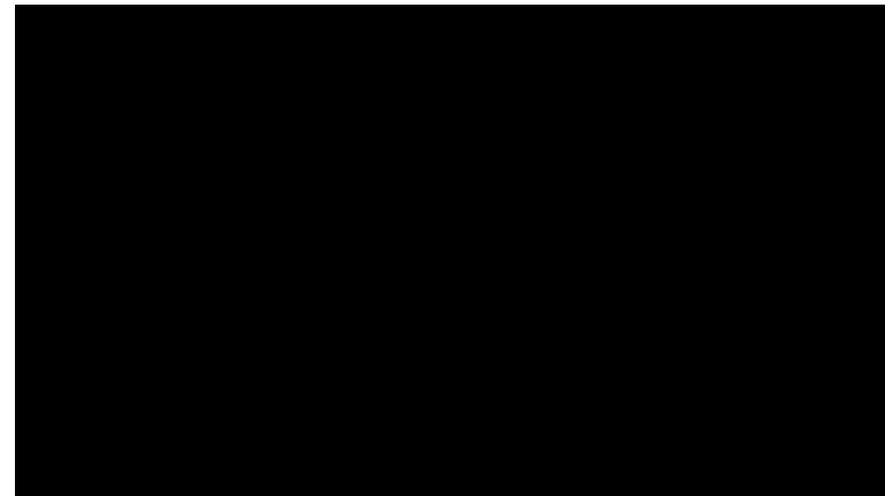
Best Practice in Robotics – BRICS Mobile Manipulation Challenges



Challenge 1:
place and pick up object while stopping

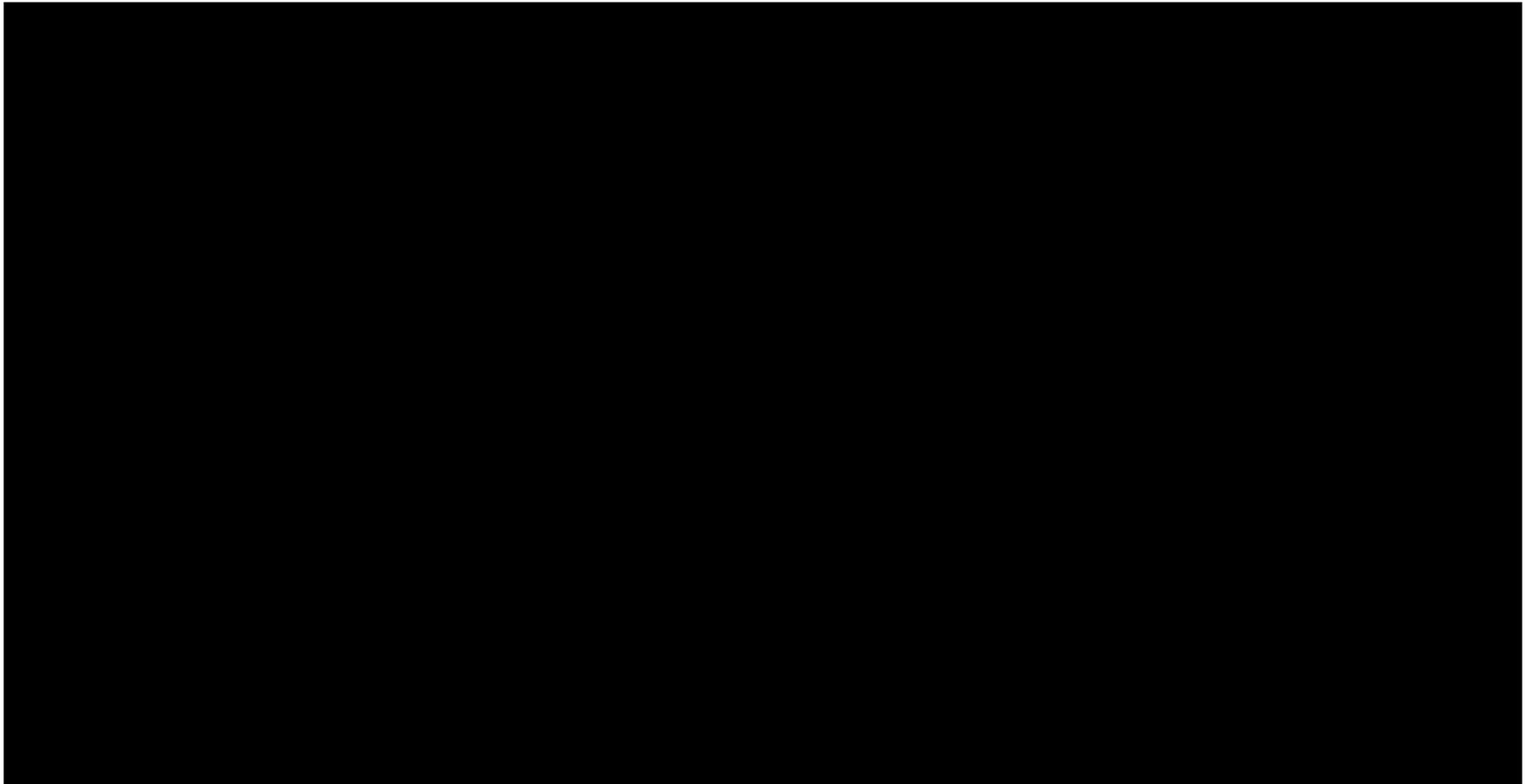


Challenge 2:
place and pick up object while moving



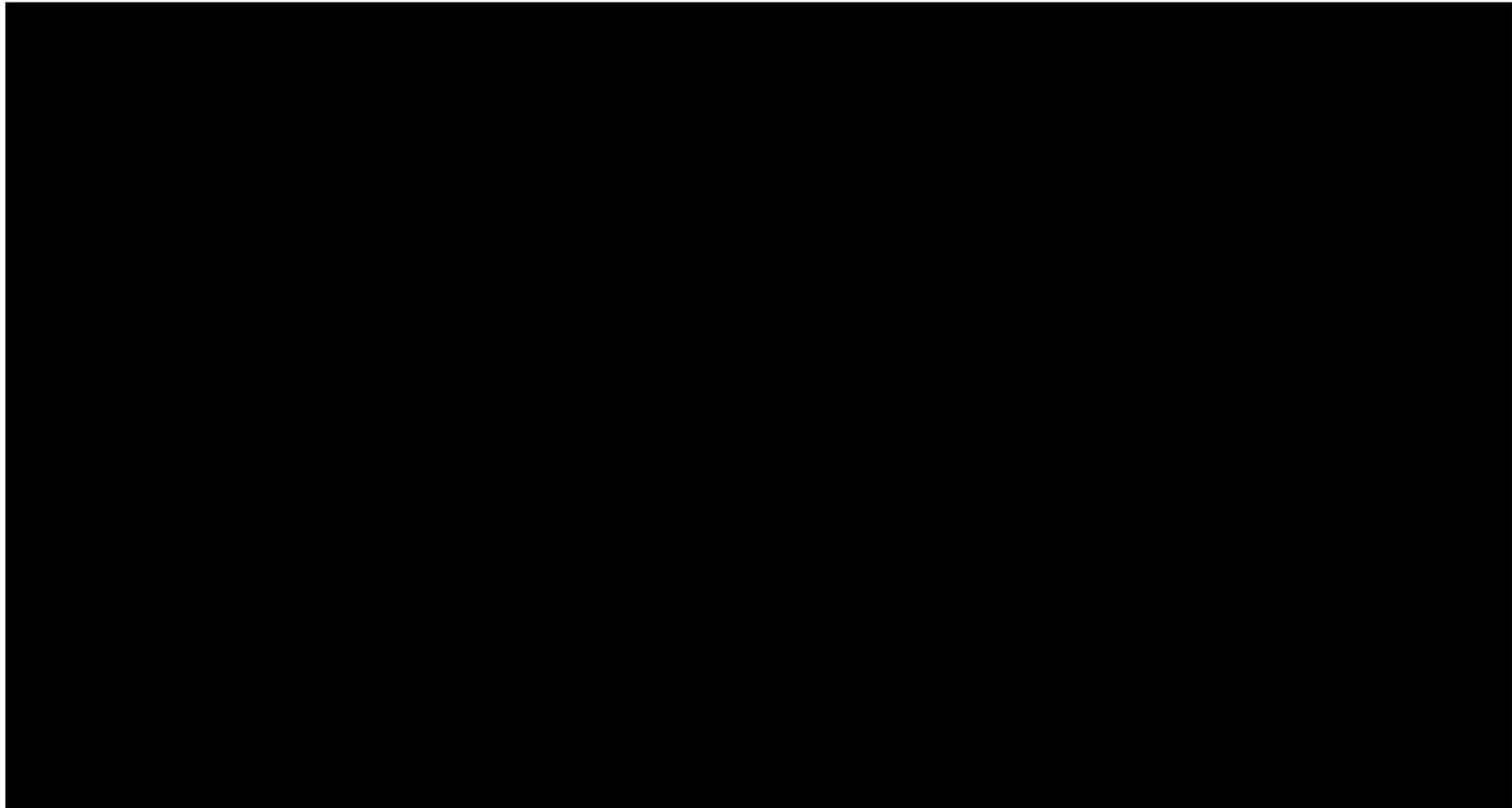
Best Practice in Robotics – BRICS Mobile Manipulation Challenges

Challenge 3: hand over object while moving



Best Practice in Robotics – BRICS Mobile Manipulation Challenges

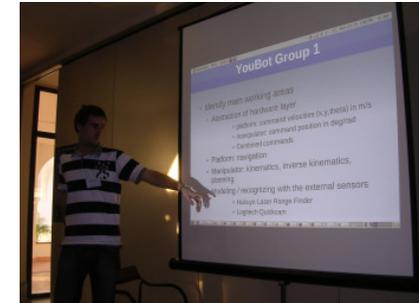
Challenge 4: demonstrate the re-use of software on different robot hardware



Schedule of the first day (Monday, October 25, 2010)

| | |
|---------------|--|
| 07:30 – 08:15 | Breakfast |
| 08:15 – 09:00 | Welcome <ul style="list-style-type: none"> • Rainer Bischoff and Erwin Prassler Introduction • Erwin Prassler: BRICS (20 min) • Erwin Prassler: Objectives and expected results of research camp (15 min) • Thilo Zimmermann: Organizational issues (10 min) |
| 09:00 – 09:45 | Presentation of hardware (without interfaces) <ul style="list-style-type: none"> • Rainer Bischoff: youBot • Rainer Bischoff: two-arm system • Alexander Bubeck: Care-O-bot • Tim Guhl: Safety Introduction |
| 09:45 – 10:15 | Putting your hands on the hardware |
| 10:15 – 10:45 | In the bar: Setting up the teams (Alexander Bubeck) |
| 10:45 – 11:15 | Lesson on “So far so Good Practice Interfaces” (20+10) <ul style="list-style-type: none"> • Özgür Sen: youBot interface • Herman Bruyninckx: FRI / LBR • Florian Weißhardt: Care-o-Bot |
| 11:15 – 11:30 | Alexander Bubeck: Infrastructure and tools |
| 11:30 – 13:00 | Teamwork work on tasks with the support of the coaches |
| 13:00 – 14:30 | Lunch |
| 14:30 – 15:00 | “After lunch” lesson on Best Practice <ul style="list-style-type: none"> • Jan Paulus: OODL |
| 15:00 – 18:00 | Teamwork work on tasks with the support of the coaches |
| 18:00 – 20:00 | Debriefing <ul style="list-style-type: none"> • Presentation of results by teams <ul style="list-style-type: none"> – Demo and explanation of software / – Presentation (4 slides) <ul style="list-style-type: none"> • What have you done? • How have you done it? • What major problems and challenges had to be solved? • Which major insights and lessons have you gained? • Discussion of open issues • Guest lecture: Christoph Borst |
| 20:00 – 21:00 | Dinner |
| 21:00 – | In the bar: open discussion on best practice issues In the lab: further programming for the hardcore hackers |

Reports by each of the 6 groups



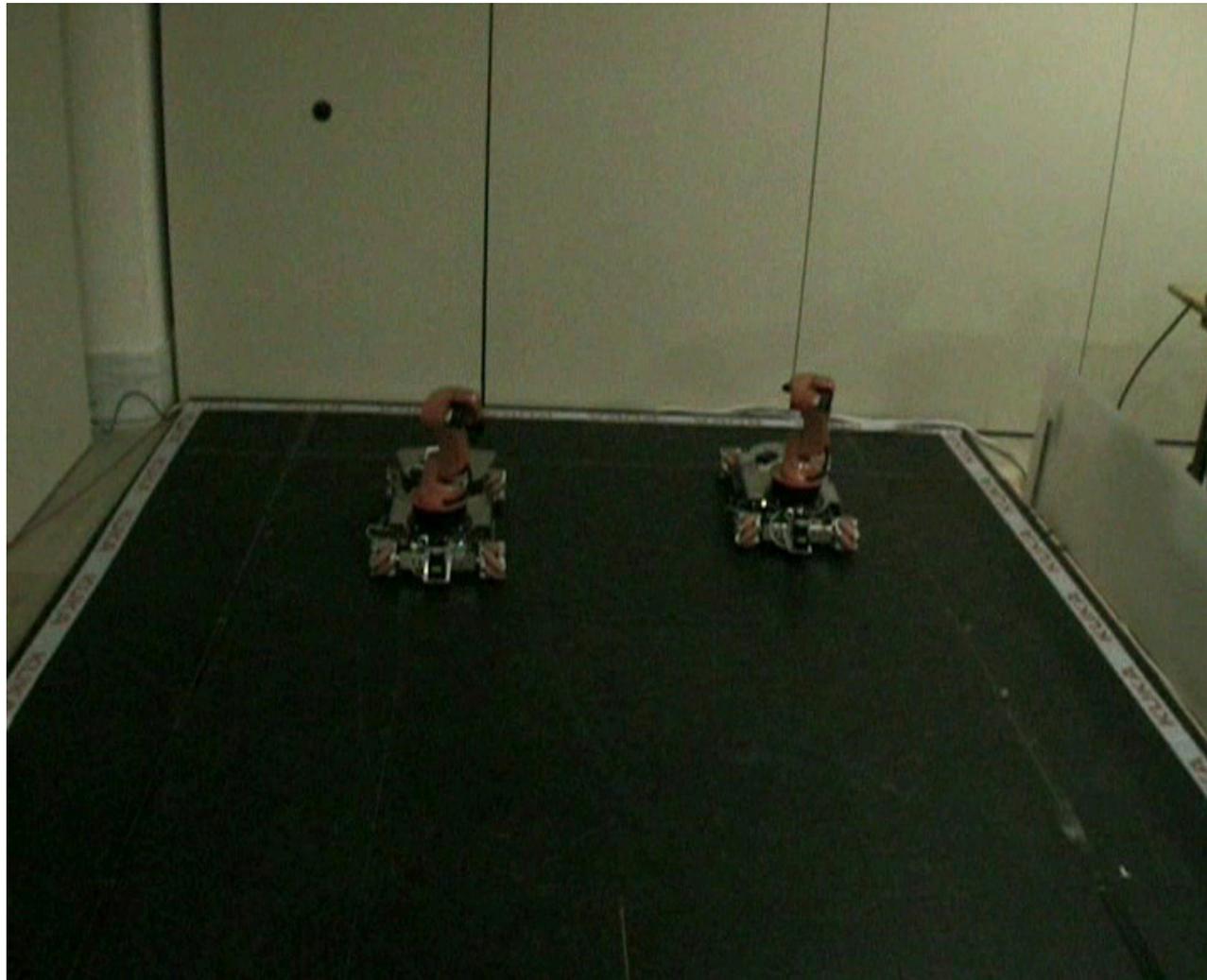
Preparation of next day



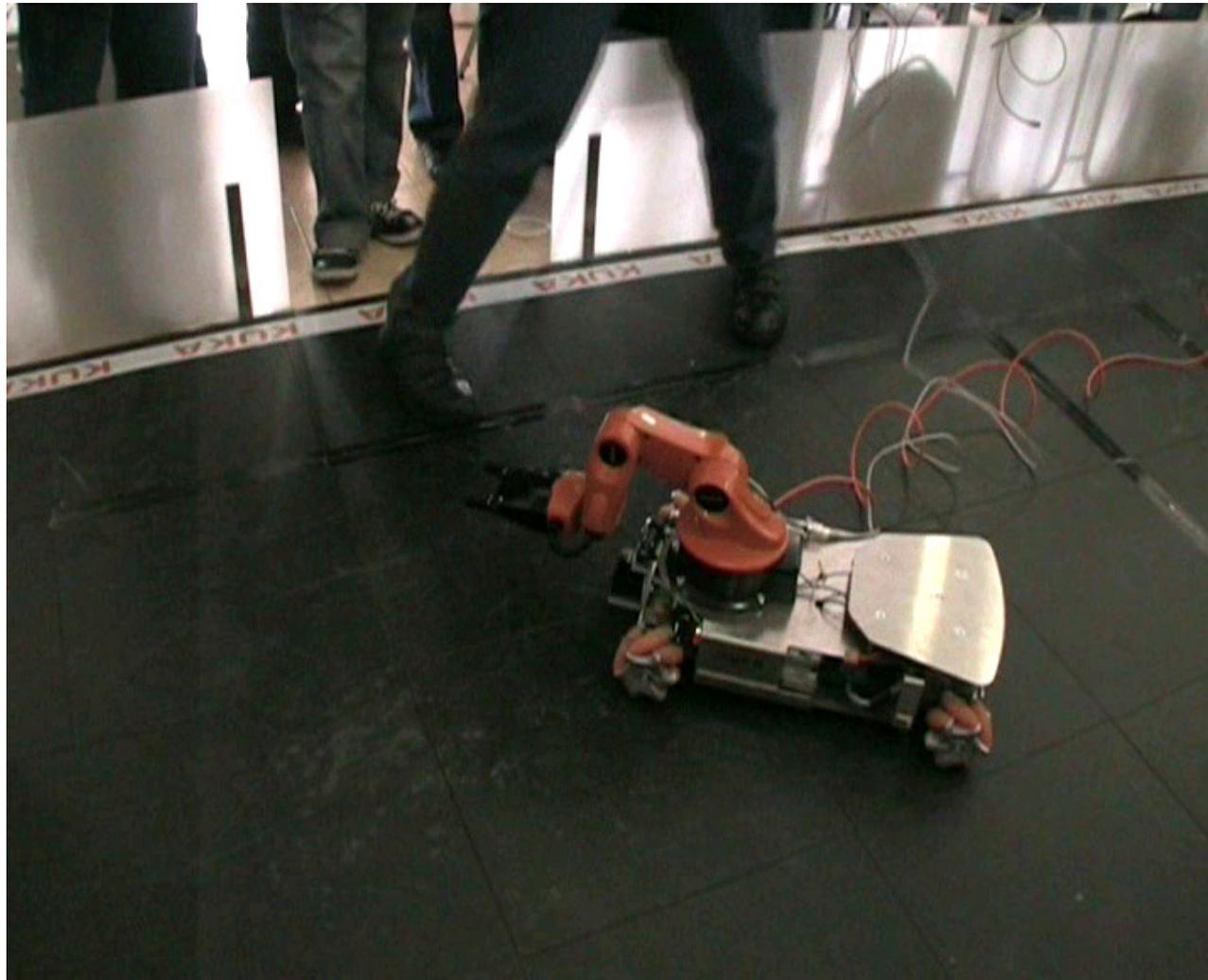
Programming till 1:30 am!



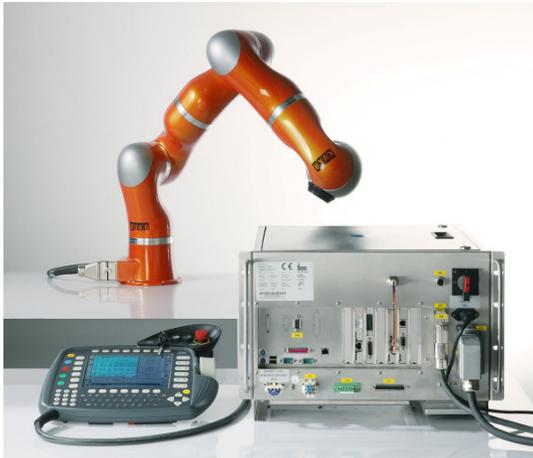
Results – youBot



Results – youBot



KUKA products for research and education



KUKA Lightweight Robot

- industry-proven robot arm controller
- control cycle 1 ms
- Fast Research Interface (1 – 100 ms access to LWR control parameters)



KUKA omniRob

- advanced controller for mobile manipulation
- control cycle 1 ms
- Fast Research Interface (in work)



KUKA youBot

- open source controller
- control cycle <1 ms
- direct access to drive position, velocity and current control



scalability



scalability



Summary and conclusions

- KUKA youBot – an exciting new robot for education and research in mobile manipulation
- new ways for KUKA to address the market and the robotics community
 - open source
 - new marketing
 - sales and support over the Internet
- BRICS – Best practice in robotics
- mobile manipulation challenges



Outlook

- RoboCup@Work – a new league
- Exhibition / demonstration: RoboCup Istanbul, July 5-11 July 2011



Thank you! – Questions?



Rainer.Bischoff@kuka.com

