"Personal" Robotics: through a Game to the Science

Roman M. Lutchin, Vladimir I.Kiyaev

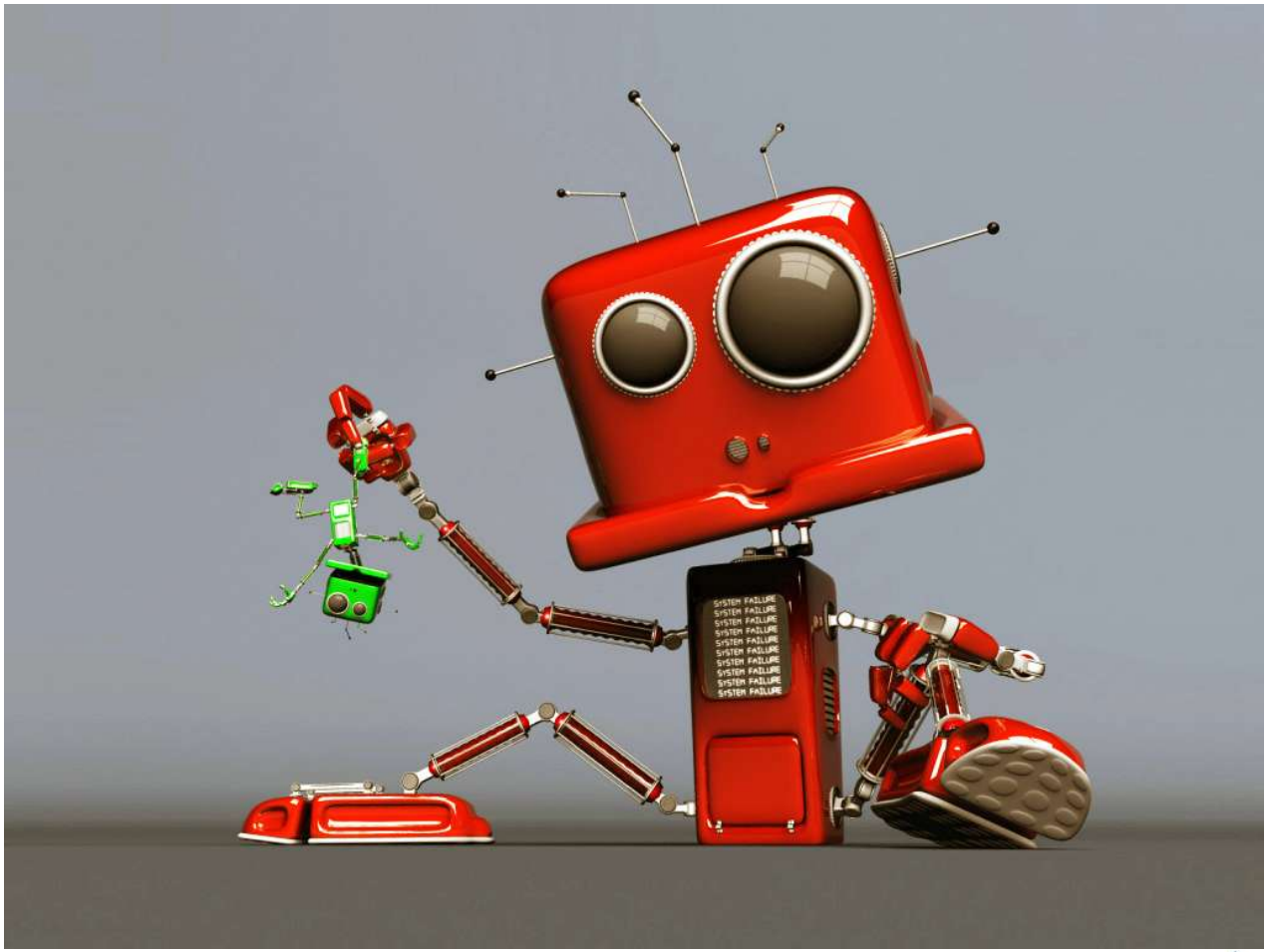
Saint-Petersburg State University

9-th Conference of Open Innovations Community FRUCT
1-st Regional MeeGo Summit Russia-Finland
AMICT 2011 Workshop

Petrozavodsk, Russia, 25-29 April 2011

SPRINT
SPbSU-Intel Laboratory

"Personal" Robotics — What is it?



Cybernetics and Robotics at the Universities

Training directions of specialists, bachelors and masters:

010500 - Applied Mathematics and Computer Science

010600 - Applied Mathematics and Physics

011000 - Mechanics. Applied Mathematics

160400 - Traffic Control and Navigation Systems

220200 - Automation and Control

220400 - Mechatronics and Robotics

Cyber-Physical Systems

Cyber-Physical System integrates the abilities to computing, communication and storage of information for monitoring and/or facilities control of the physical world objects.

Such System should do it safely, securely, efficiently and do it in real time.

Cyber-Physical Systems must be mobile, extensible, efficient and adaptive.

Workshop of the National Science Foundation for cyber-physical systems: «NSF Workshop On Cyber-Physical Systems»,
Oct. 16 - 17, 2006, Austin, TX, USA
http://varma.ece.cmu.edu/cps/

National Science Foundation (NSF) Programs of Cyber-Physical Systems

Economic Context: Calibrating US Competitiveness

- Goals of a CPS research program
  - A new science for future engineered and monitored systems (10-20 year perspective)
  - Physical and cyber design that is deeply integrated

3

Cyber-Physical Systems.
http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=13385

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Educational & Research Cyber Physical Laboratory

Transport Vehicles Driving and Universal Pegulators (Principal – RSA corr.- member, professor V.A.Yakubovitch)

4-th wheels TV

3-th wheels TV

Walking and unconventionalTV

Control in network systems and group control (Principal - professor A.S.Matveev)

Groups of mobile robots and ensembles of unmanned aircraft

(together with the System Programming Chair, Principal - professor O.N.Granitchin)

Nonlinear systems, oscillations and chaos control (Principal - professor A.L.Fradkov)

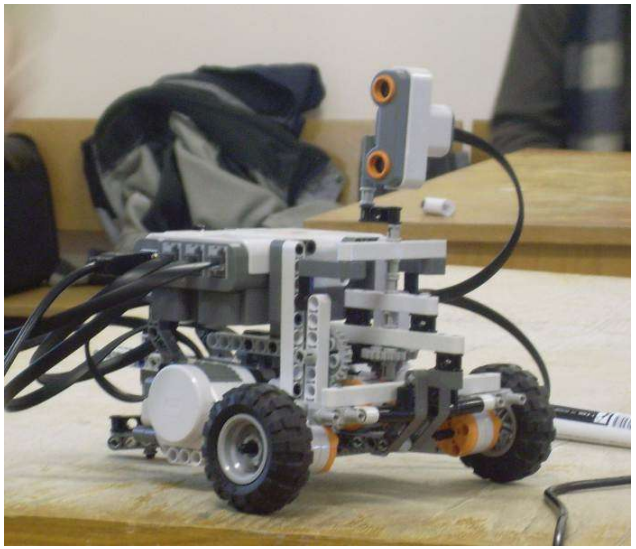
Pendulum on a cart

Furuta pendulum

Robot-gymnast

Vibration thrusters

Sample tasks and research topics for 2-year students of Mathematics and Mechanics Department of Saint- Petersburg State University



1. Stabilization of inverted pendulum on a cart
2. Robot-cyclist
3. Robot-motorist
4. Robot-lion and robot-antelope (the pursuit problem)
5. Controlling of the robot-segway
6. Controlling of the robot-gymnast
7. Controlling of the robot via Bluetooth
8. Managing of a mobile robots team

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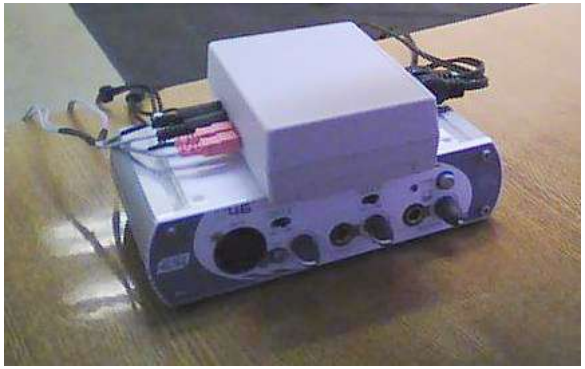
Project: Real-time allocation of voice signal from the mixture with a microphone array and a camera

Principal - professor A.E. Barabanov

A stand and a prototype of a system for suppressing extraneous speech and music signals in the transmission of the speech signal from the Speaker sitting in front of a microphone array and camera is designed.

A laptop equipped with multiple microphones and cameras is the basic unit.

A program for separation of the votes from a mixture of signals is developed.



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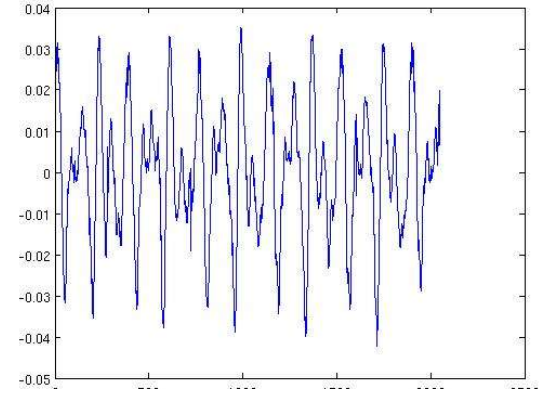

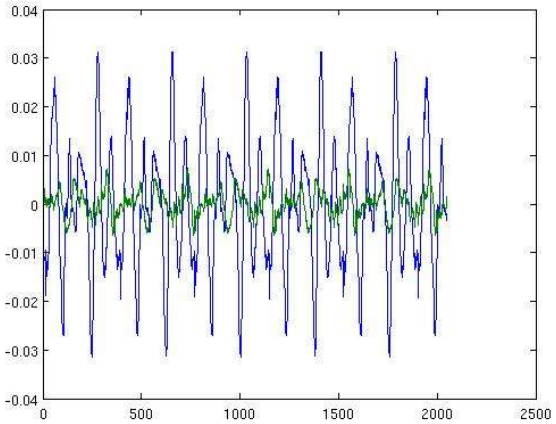

The program determines the position of Speaker over the phase shift of harmonics in the incoming signal. Red dots indicate the recognized position of mouth of students who have worked in the project. The system monitors their movements in real time.

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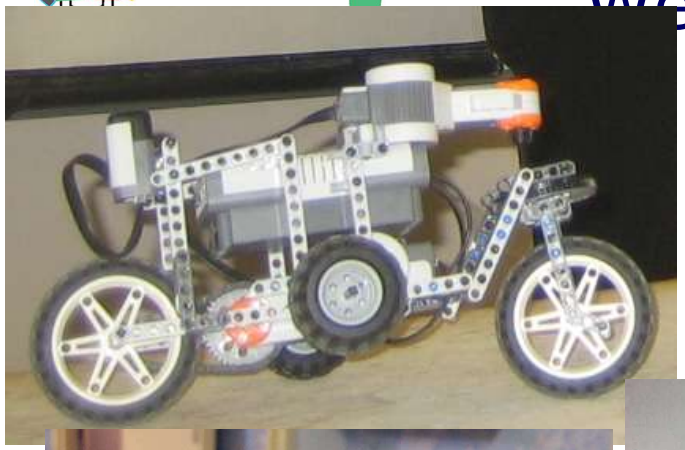
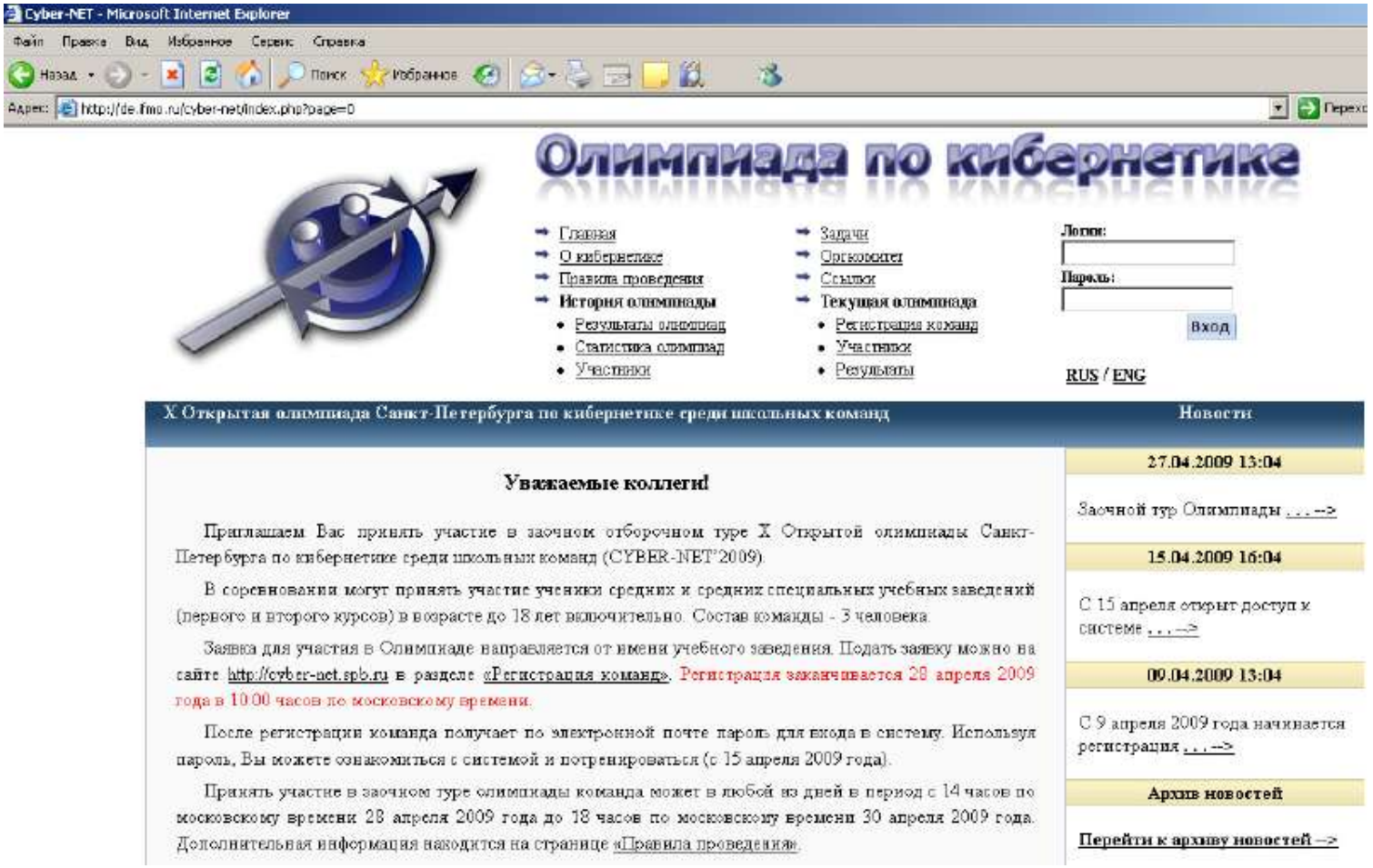
Robot’s Show as part of the 49-th Mathematics and Mechanics Department Week of of St. Petersburg State University



Cybernetics in school: science at the crossroads of mathematics, physics and computer science

School Olympiads on cybernetics in St. Petersburg: 10 Olympiads in 1999 – 2009 (cyber-net.spb.ru)



LEGO Mindstorms NXT – a new generation of Cyber Construction Set

LEGO Mindstorms NXT:

- extensible set of sensors and actuators (motors, lamps, loudspeakers)
- control from the PC and stand-alone control
- communication via infrared or Bluetooth to PC, video camera, smartphones, mobile phones

LEGO Mindstorms NXT – a new generation of Cyber Construction Set

The Robot Brain - block NXT

1. Intelligent LEGO ® block NXT controlled by a computer - Robot’s Brain

2. Touch sensors - allow the robot to react to the surrounding obstacles.

3. Sound sensor (microphone) - allows the robot to react to the sound level.

4. The ambient light sensor - allows you to respond to changes in lighting or color.

5. Ultrasonic sensor - enables to determine the distance to the object and respond to the motion.

Programming Systems

1. NXT-G
   Introduction course: http://learning.9151394.ru/course/view.php?id=280#Constr1
2. Robot C
3. Microsoft Robotics Studio
4. Robolab 2.9
5. Control with MATLAB:
   - ECRobot (Monami Ltd, Japan)
   - RWTH - Mindstorms NXT Toolbox (Aachen TU, Germany)

A seminar of Theoretical Cybernetics Chair

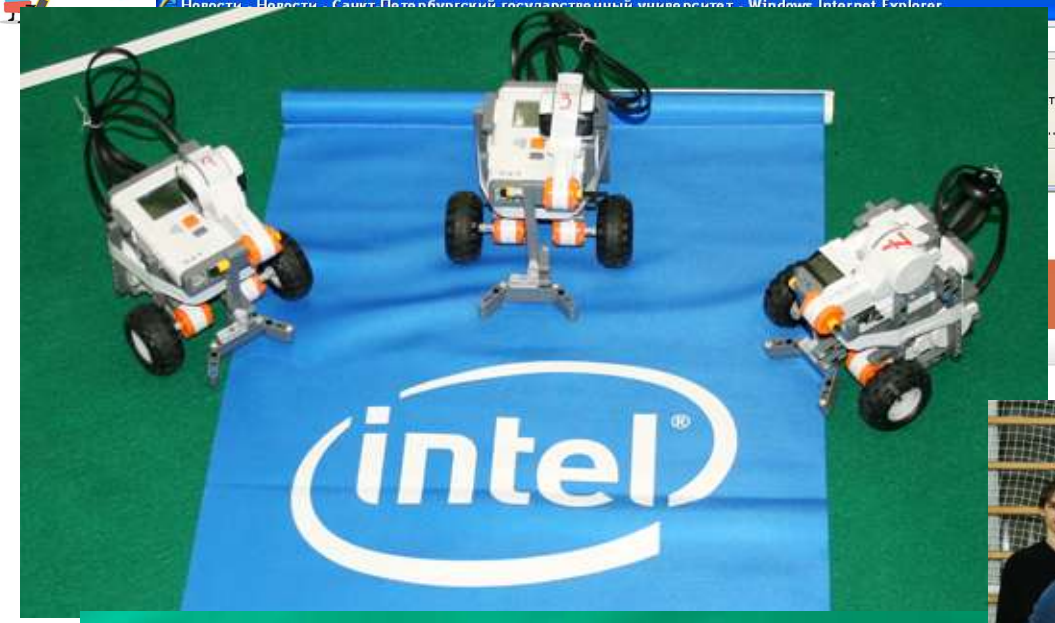
Students, post graduate students and students
of Physics and Mathematics Lyceum № 239

And what is moving over there?

The authors of a pendulum on a cart

Schoolchilds of 8-th class of PhML № 239
Olga и Anna Bogdanoff

Robot soccer players of MMD



There are little TV-shows about us!

RF, 5-th channel

SPb, Piter TV

SPb, STO

RF, NTV

RF, RIA «News»

RF, ITAR TASS

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Robo Cup-2010 and Regional stage of Robotics 2011

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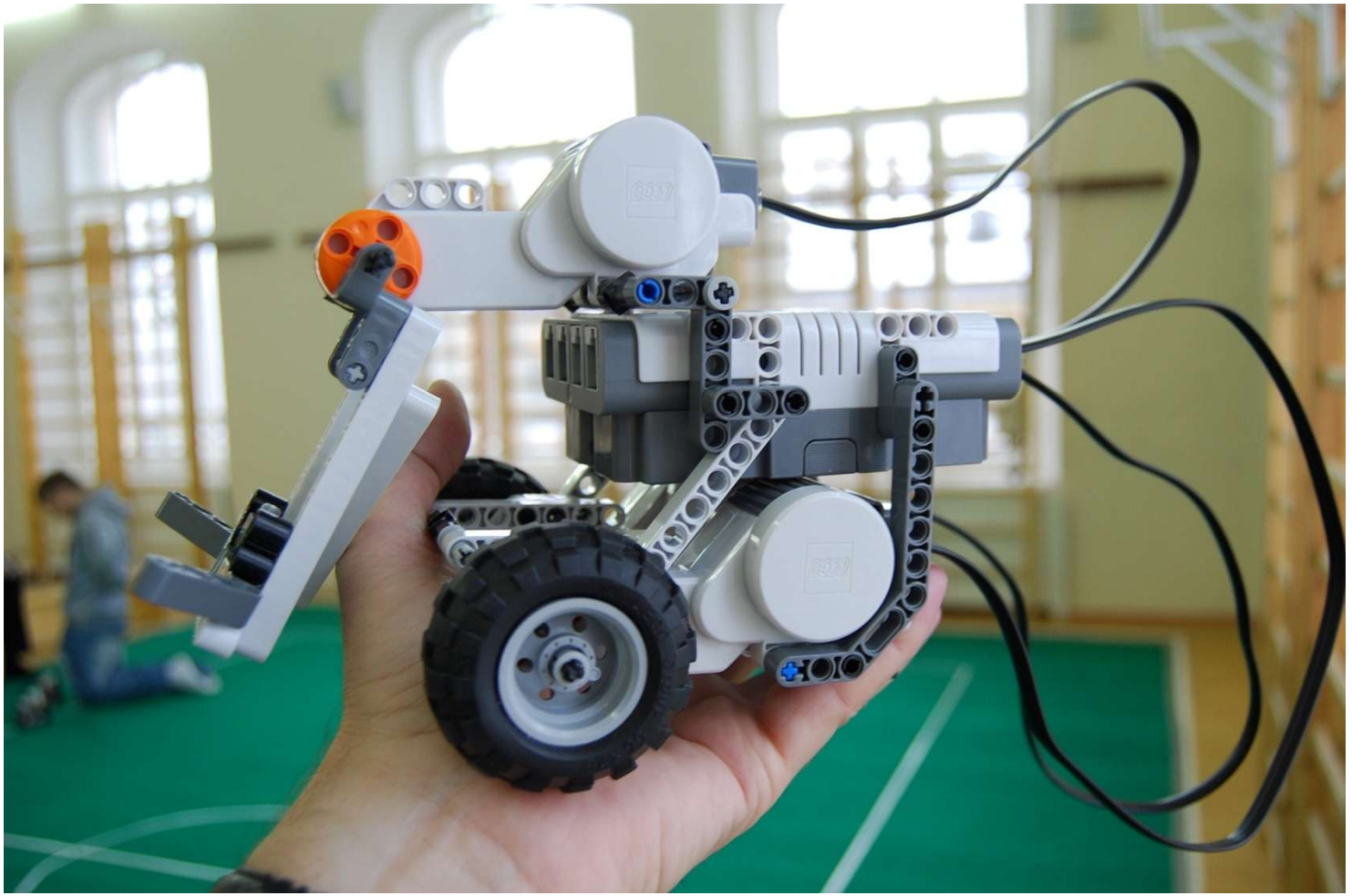

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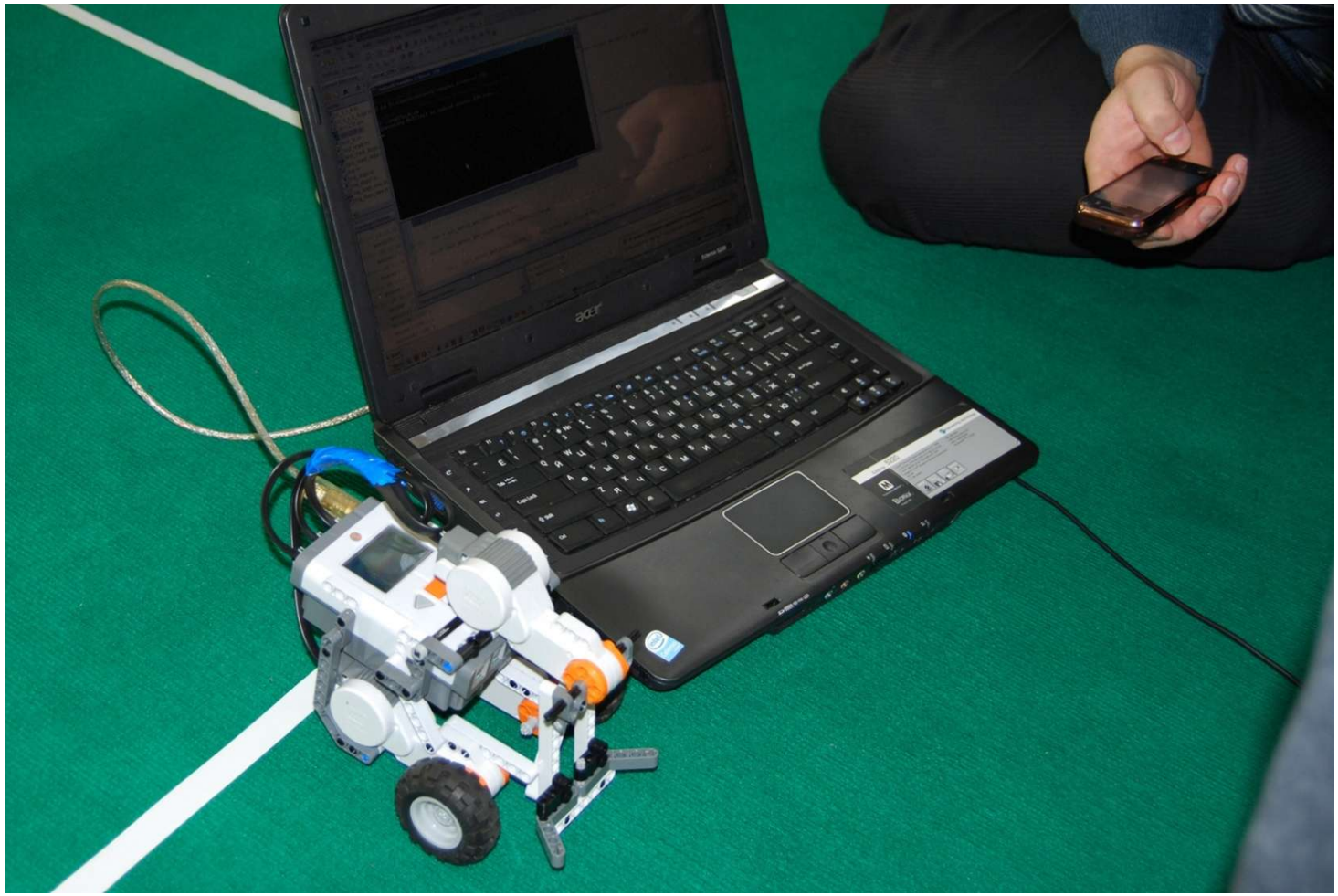
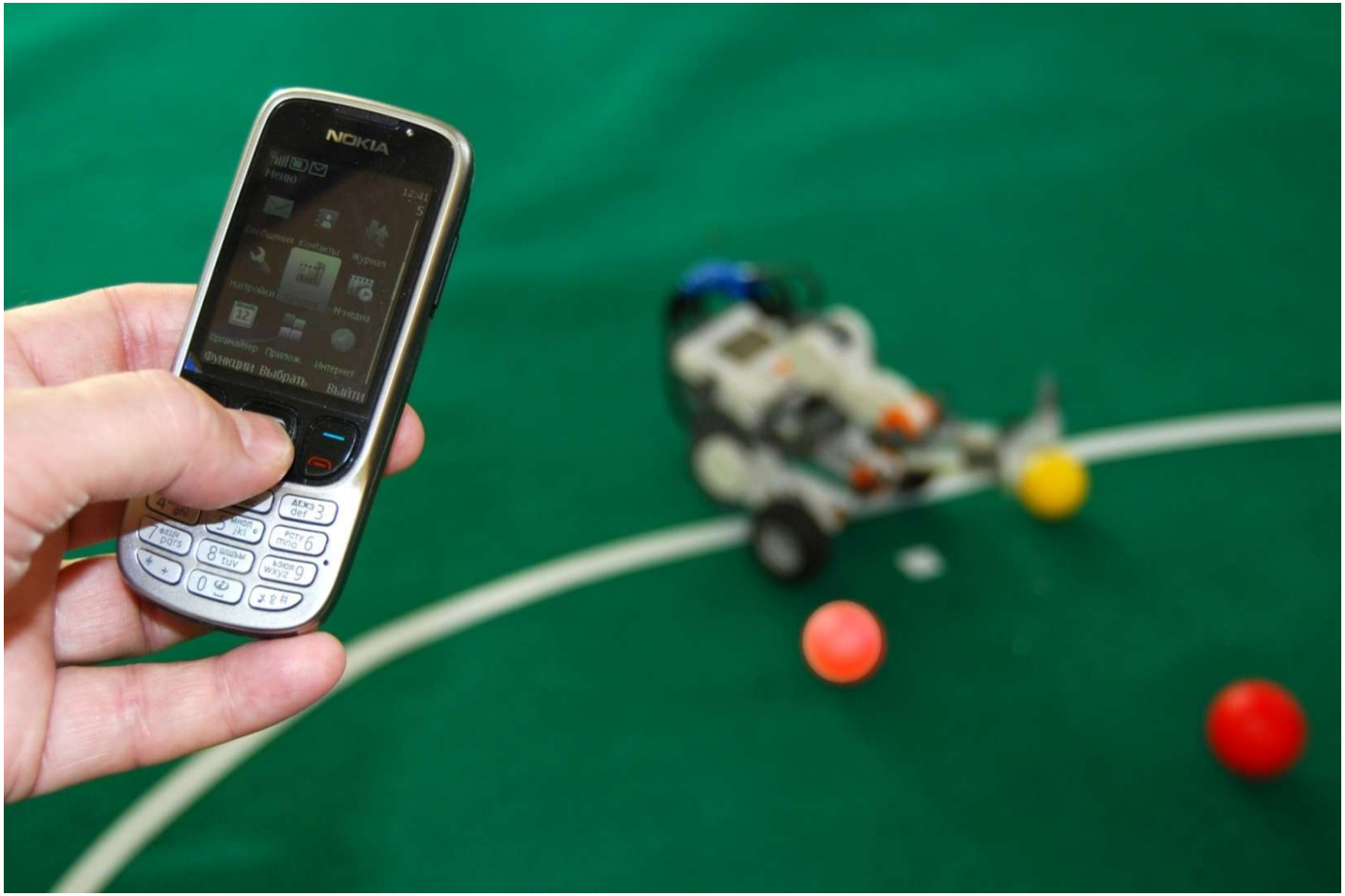


Robo Cup-2010 and Regional stage of Robotics 2011



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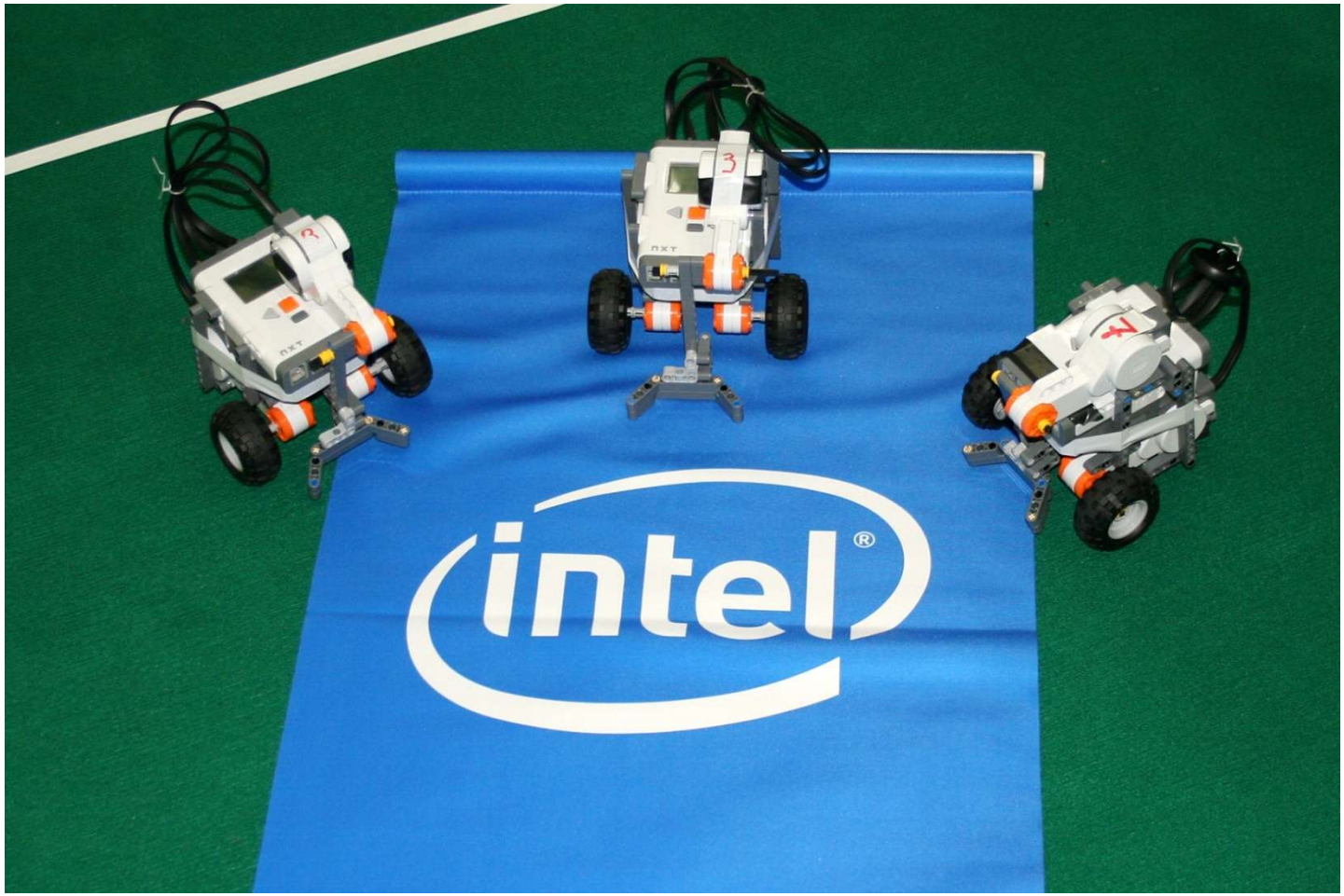
Robot Cup-2010 and Regional stage of Robotics 2011



The winners of the SPb Robot Soccer Cup - 2010

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The Awardees of Robo Cups

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Robot Soccer – what is it?

- Sport competitions
- Research tools
- Educational tools

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Robot Soccer – what is it?

International organizations:

- Robot Soccer World Cup (RoboCup)
- Federation oh International Robot-soccer
  Association (FIRA)

Junior international organizations:

- First LEGO League (**FLL**)
- RoboCup Junior

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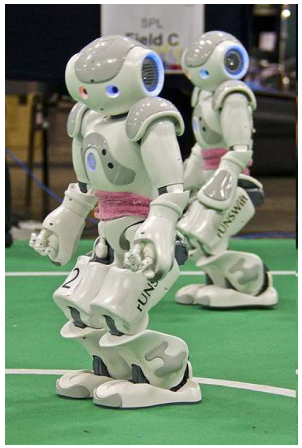
RoboCup - Robot Soccer World Cup

Four competitive sections consisting of several leagues

- Soccer
  - Simulation
  - Small Size
  - Middle Size
  - Standard Platform
  - Humanoid
- Rescue
  - Rescue Robot
  - Rescue Simulation
- Junior
  - Soccer
  - Dance
  - Rescue
  - Common
- @Home



And what we have in Russia?

Two or three Universities bought the FIRA team

In 2004 a team from St-Petersburg Polytechnic University took 2-nd place in the league RoboCup Simulation

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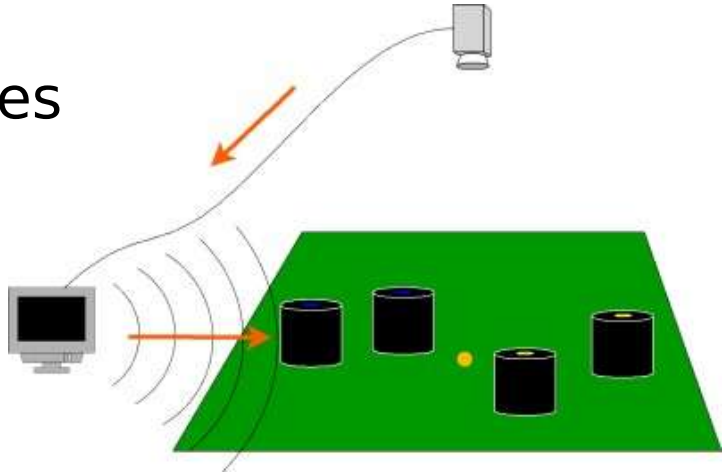
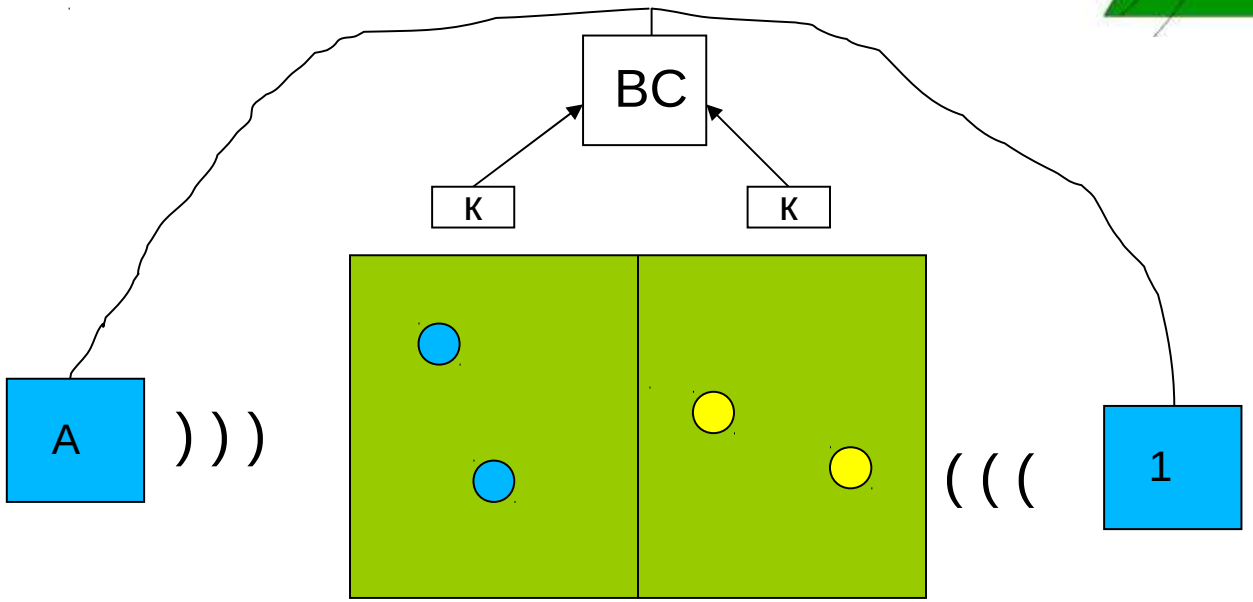
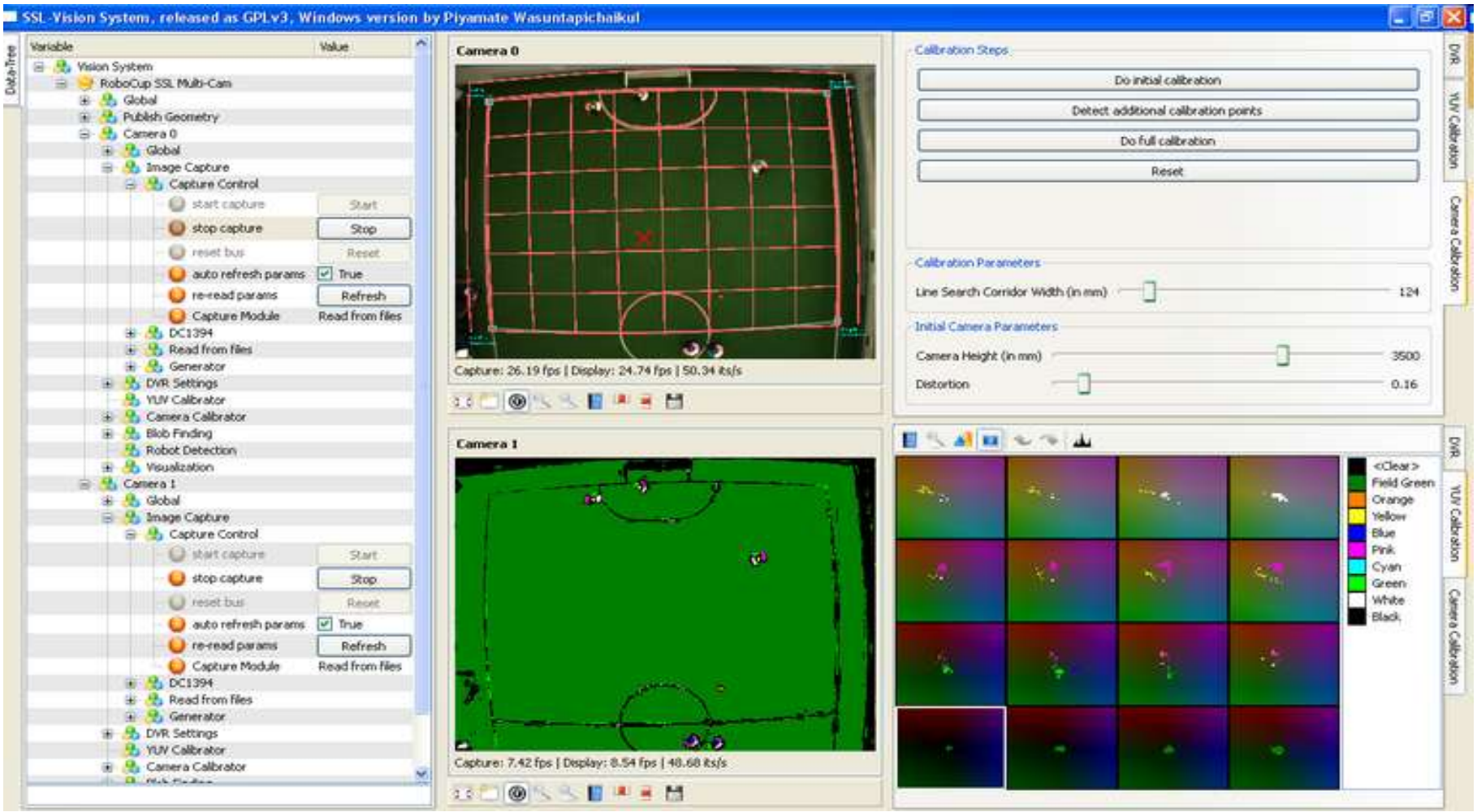
Progress Directions

- Controlled robots soccer
- Soccer over RoboCup Junior Rules
- Semiautomatic Soccer
- Soccer over RoboCup SSL Rules





SSL-Vision



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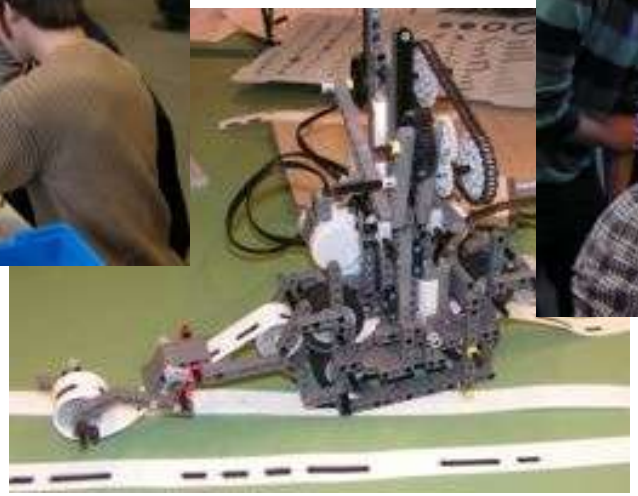
Science Objectives

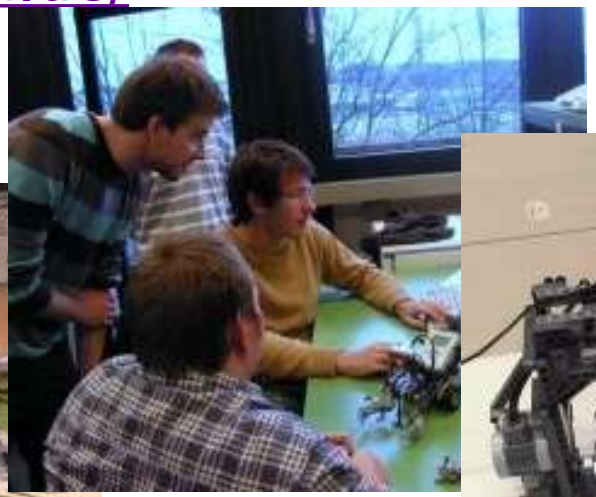
- Identification of the gaming locations
- Zoning
- Command transfer to executing objects
- Collision avoidance
- Holding up to the point
- Lead to the position
- Situation "Pass / Shock"

The use of the LEGO cyber building blocks in Education

MATLAB meets MINDSTORMS

LEGO Laboratory
Technical University in Aachen, Germany
http://www.mindstorms.rwth-aachen.de/





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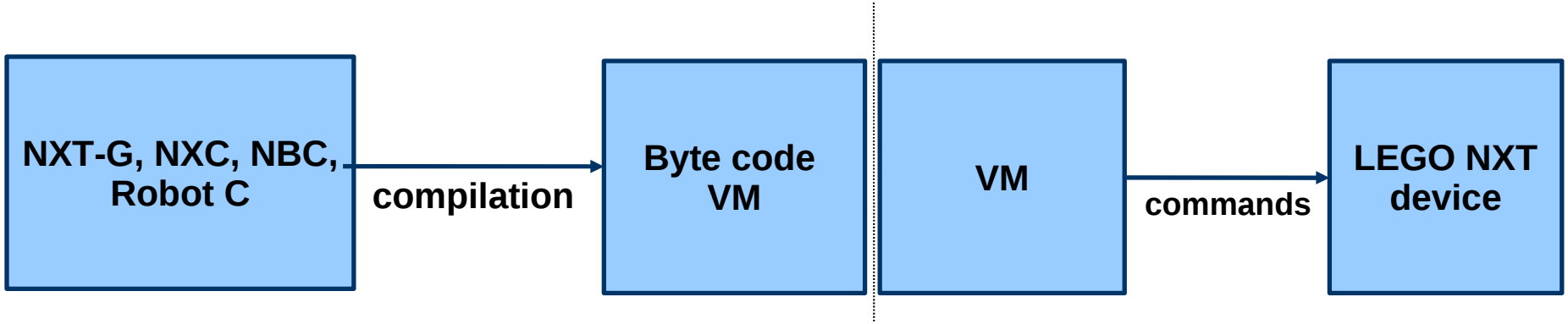
Strategies of operation with VM



Plus :

+ universality
+ availability of drivers
+ autonomy

Minus:

- productivity loss
- RAM is a busy
- ROM is a busy

Alternative: contact with the commands directly?

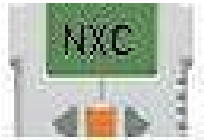
Do not use a virtual machine!

LEGO NXT Software

- NXT-G

NATIONAL INSTRUMENTS LabVIEW

- NXC



- NBC

- RobotC

ROBOTC

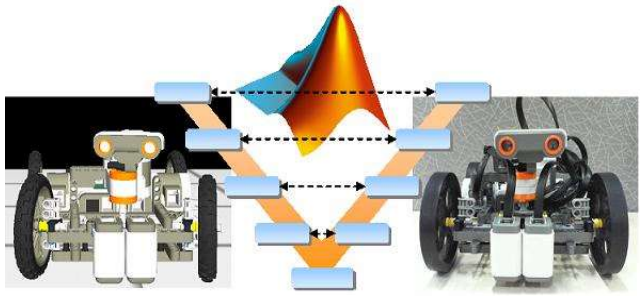
- LeJos

LEJOS
Java for LEGO Mindstorms

- RWTH MatLab Toolbox

MATLAB meets MINDSTORMS

ECRobot



nxtOSEK

nxtOSEK/JSP
ANSI C/C++ with OSEK/μITRON RTOS

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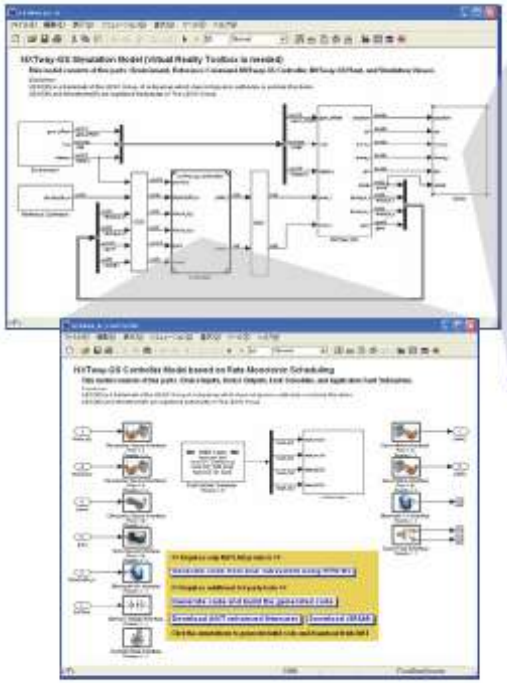
Stages of embedded systems programming

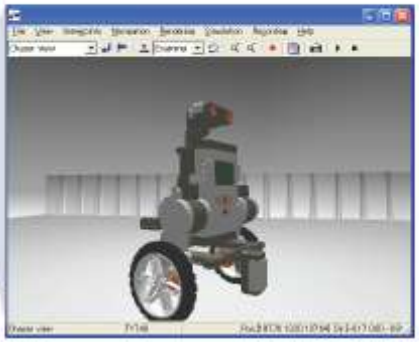
Benefits of MOP:

- early detection of control system errors
- relieving the burden to the installation
- performance testing by imitation modelling
- it is easier to improve the modules when we verify control system
- it is easier to optimize the interaction between modules
- code autogeneration leads to saving of time

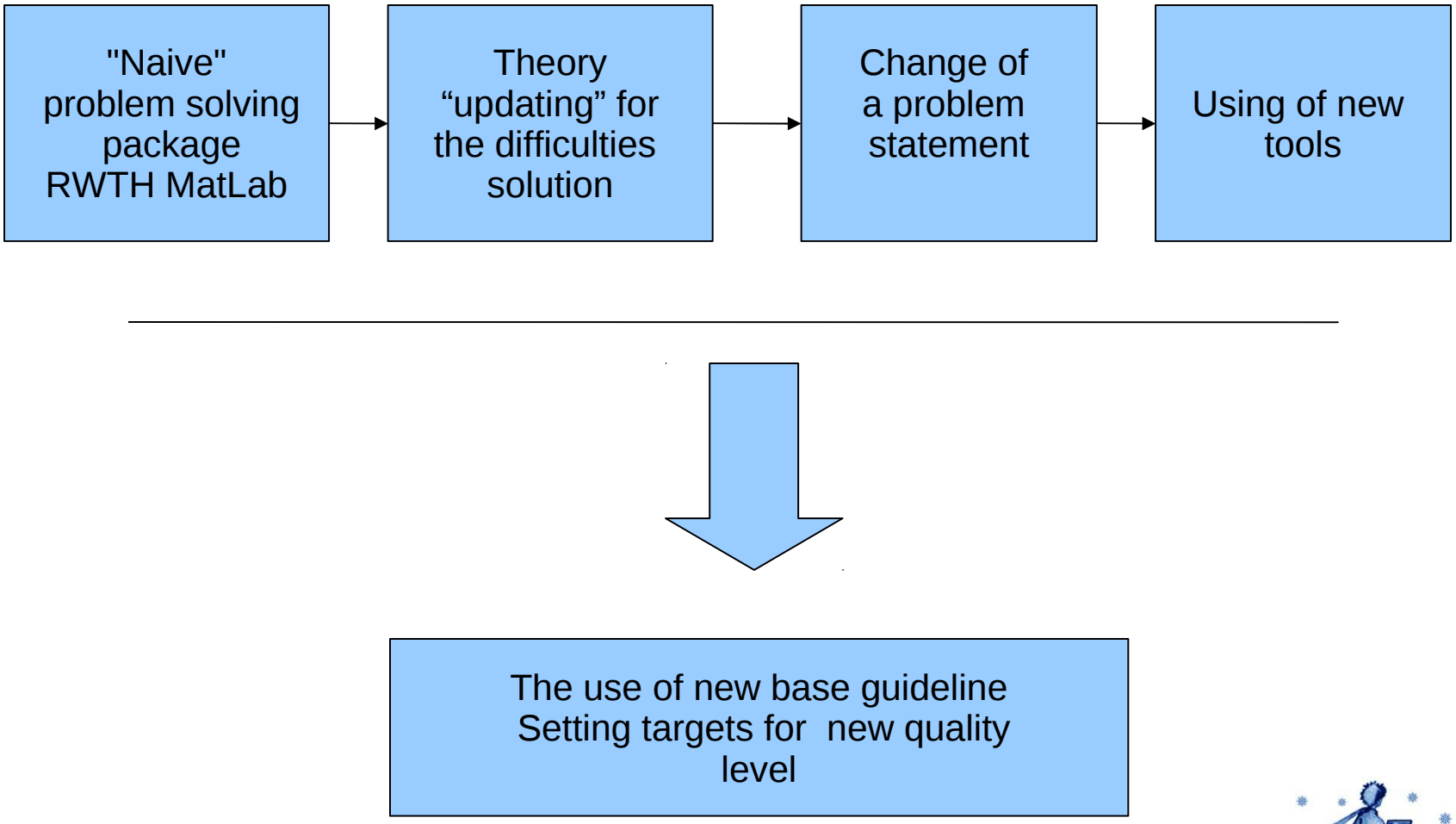
Industrial use of MOP

Embedded Success dSPACE





Training model



Graphical instrument QReal

GI QReal is developed as a scientific research project on object-oriented modeling

GI has a wide application using the platforms and programming languages:

- UML 2.2
- Hardware description language
- Programming language for the Android and MeeGo platforms
- Parallel program description language for OpenMP

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Graphical instrument QReal

- Quickly creating and modifying of visual programming languages
- Technology for industrial projects
- Friendly user interface
- - mouse gestures
- - visual debugger
- Integration with version control systems

Graphical instrument QReal

- Runs under Windows ®, GNU Linux, Mac OS X
- Distributed as Open Source under GNU GPL
- Has a Russian language user interface
- Supports the standard firmware NXT, works with OS Embox

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Graphical instrument Qreal for robots programming

Qreal Robots – base facilities:

- Controlling of the Lego Robot ® Mindstorms ® NXT 2.0
- Work on the Bluetooth ® with the mapping of the program implementation
- The program is a set of blocks relating to control flow

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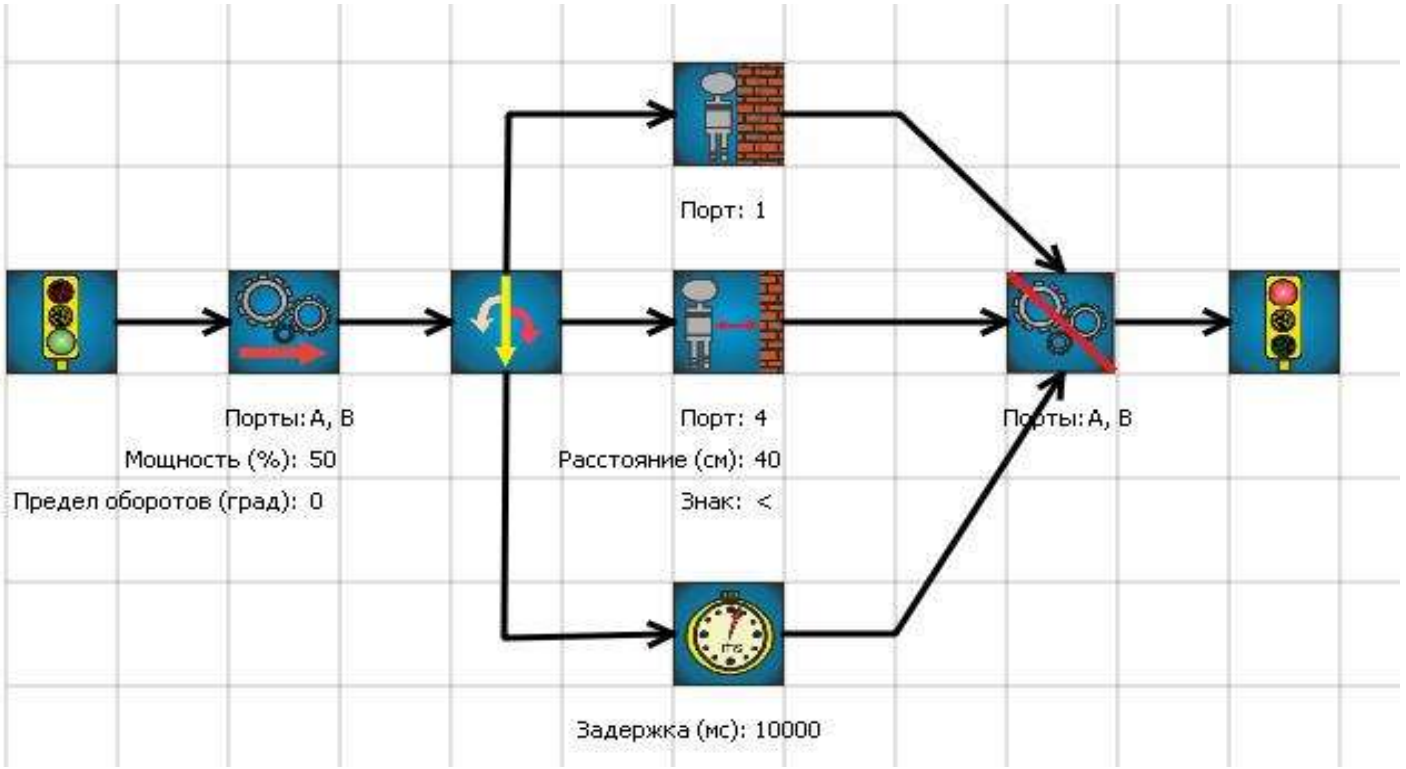
Supported units

- Three types of sensors from the set of NXT 2.0
- Motors and speakers control
- Branching, loops, parallel execution



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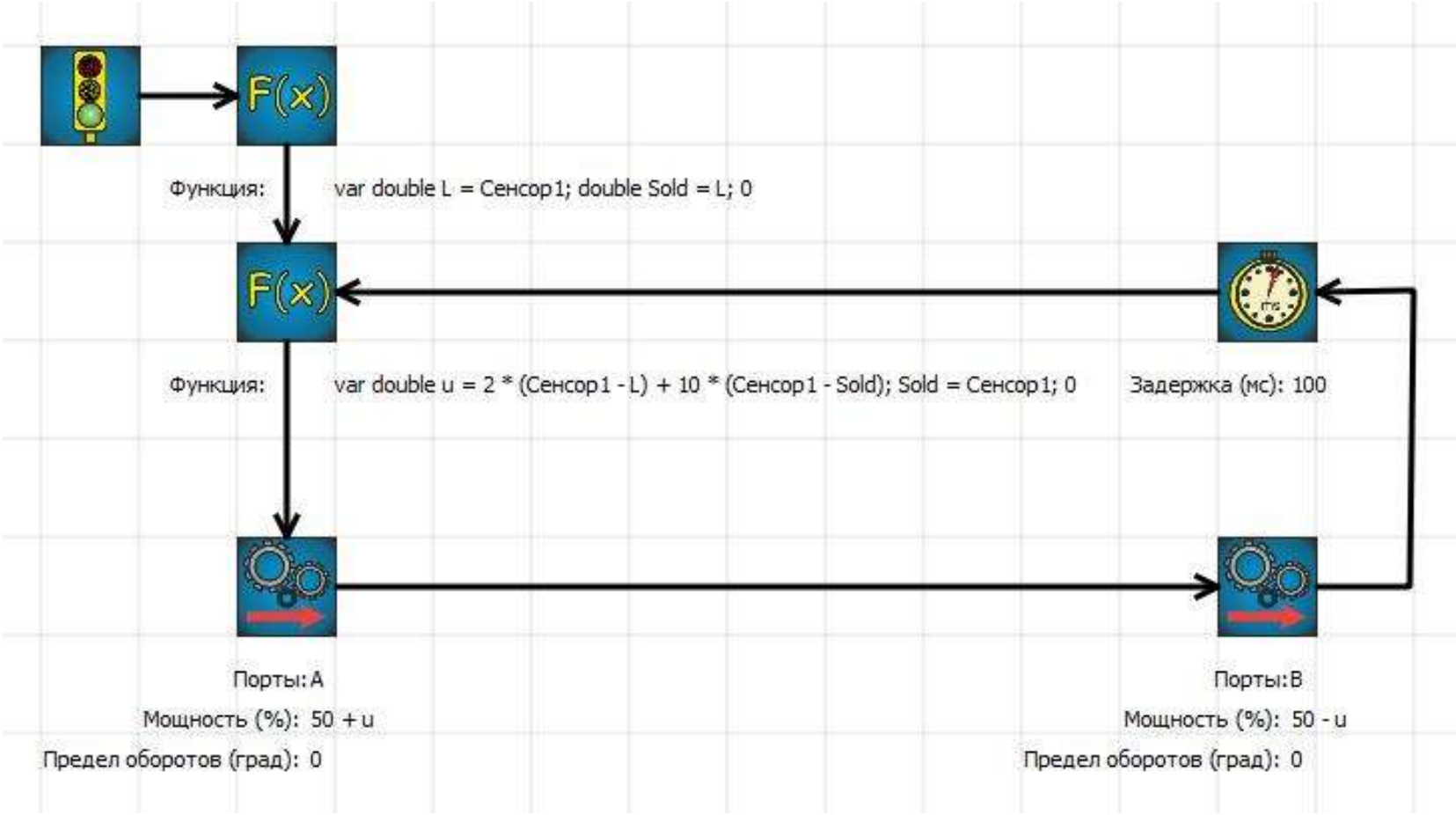
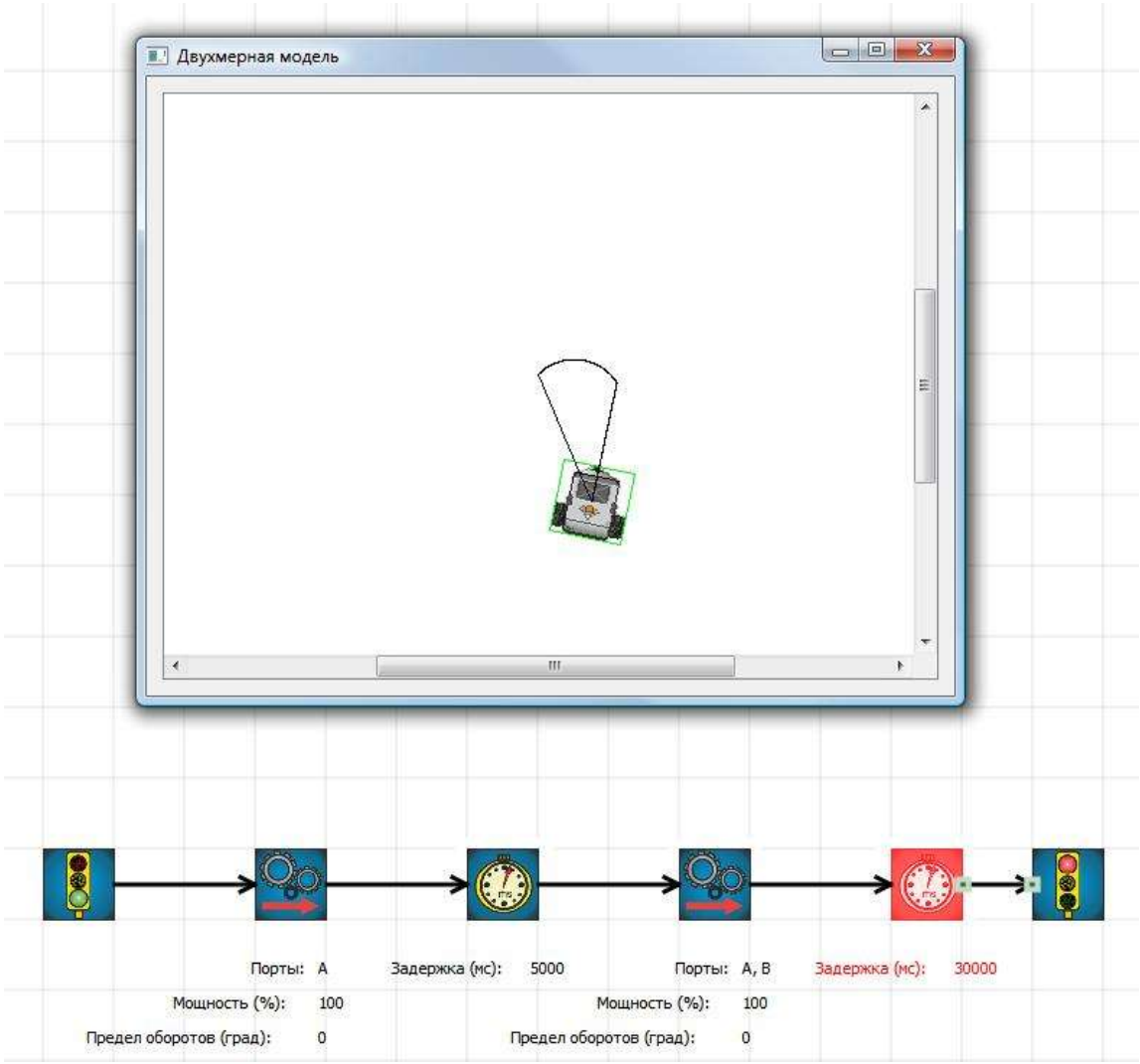
Mathematical expressions



Model of the robot on the screen



What's next in future?

As a part of the SPRINT Laboratory activities:
2011 - 2013 years.

1. Participation in "Atomosfera“ competition
2. Implementation of semi-automatic control of multi-agent network of mobile devices (wheel robots)
3. Transferring robot control system to the MeeGo platform (Tablet PC)

робофутбол.рф

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What's next in future?

4. Development of works on the Video Vision
5. Design of the controller and visual programming instrument QReal implementation
6. Training of Mathematics and Mechanics Department Team (St. Petersburg State University) to participate in International RoboCup Competitions

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What's next in future?

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Instead of the conclusion!

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