Experiences
with Tutorial Programs
for Simulated Robots

Hans-Dieter Burkhard, Monika Domanska
Humboldt University Berlin
Nevena Ackovska
University St. Cyril and Methodius, Skopje
Understanding emerges by doing:

- The best way to understand robotics is to program robots.
- But experiments with real robots are difficult and expensive.
- Alternative: Simulated robots in simulated environments.
A Simulation Environment

RoboCup 3D simulator SimSpark with simulated humanoid robots.

Physical simulation by Open Dynamic Engine (ODE) for body dynamics of robot Nao and the soccer environment.

Users can program own robot controls as “agents” which communicate with SimSpark by messages containing sensory information resp. action commands.
SimSpark

Communication via protocols (TCP)

Effector messages
Motor commands similar to real robot

Perceptor messages
Vision, acoustic, inertial, ....

Simulation of actions and percepts
- Virtual playground
- Virtual players
- Referee

Noise

Server and Monitor developed by volunteers of RoboCup community

Burkhard/Domanska/Ackovska
Agent in Simulation

SoccerServer: Simulation of physical world

playground

Perceptors → Agent → Effectors

think

sense

act

signals → actions
Joints of Robot Nao from Aldebaran

21 Servo-Motors:
- 2 head
- 4 per arm
- 5 per leg
- 1 hip
Nao in Simulation:
The joints

Example: $(rae \ 2.3)$.

Motor commands: Messages can be sent every 20 msec.

i.e. 1100 commands per second.

Burkhard/Domanska/Ackova

Opatija 2012
Motion Editor for designing keyframes

Keyframe:
Set of angles for special poses.
Information about actual angles at the joints.

Example:
(HJ (n laj3) (ax -1.02))
Further Perceptors

• Gyrometer
• Accelerometer
• Force Resistance Perceptor at the feets
• Vision Perceptor
• Hear Perceptor
• Game State Perceptor
Problems with SimSpark

• Difficult usage for inexperienced people.
• Large efforts for communication and message parsing.
• Existing programs too complicated or with “hidden” details (cf. our previous SimpleSoccer Project).

Beginners must handle all problems at once, can not concentrate on single aspects like "only reading perceptor values" or "only developing motions".
The RoboNewbie Project

Framework where user can concentrate on robotics aspects:
• Direct access to sensor/perceptor data.
• Easy understandable structure (sense-think-act).
• Basic motion skills.
• Simple examples/exercises for introduction.
• Open for challenging extensions including Machine Learning.

Usage by anybody interested in Robotics, especially for High Schools and Universities. Suited for e-learning.

Programs written in Java.
Experiences with RoboNewbie up to now

First tests with parts of the program:
• Anna-Seghers High School Berlin May 2012
• 2 Lectures in Novi Sad in June 2012

Test with full program:
• DAAD INTENSIVE COURSE “Robotics and Mathematics”
  12-18 August, 2012, Ohrid, Macedonia
Intensive course

Robotics and Mathematics

12-18 August, 2012

Lecturers

Hans-Dieter Burkhard, Institute of Computer Science, Faculty of Mathematics and Natural Sciences, Humboldt University of Berlin, Germany

Nevena Ackovska, Institute of Intelligent Systems, Faculty of Computer Science and Engineering, University St. Cyril and Methodius, Macedonia

Program

6 lecture days, maximum 4 classes per day including robotic exercises, sun and lake in the afternoons

Themes

- Engineering aspects of Robotics (N. Ackovska)
- Motion control, cinematics (H.D. Burkhard)
- Sensors, perception (H.D. Burkhard)
- Behavior and control (H.D. Burkhard)
- Image processing, world model (H.D. Burkhard)
- Bio-inspired Robotics, Emotions and Robotics (N. Ackovska)
The Participants

1. Montenegro 3
2. Bosnia and Hercegovina 1
3. Serbia 6
4. Macedonia 5
5. Romania 1
6. Croatia 3
7. Bulgaria 3
8. Kosovo 1
The Preparation

Participants were supposed to have their own laptops.

Prerequisites for the exercises:

1. Java Netbeans 7.1.1
2. SimSpark (Soccerserver) for Windows XP or 7.
3. RoboNewbie010.
4. Java 3D.
5. Motion Editor

Introductory materials for:

a) Installation
b) Simspark
c) RoboNewbie
d) Motion Editor
RoboNewbie

Programs and materials could be downloaded from a website before the workshop.

Please note that the framework is still under development. There should be no links from this page so far (so please do not make any external link to the page).

The RoboNewbie Agent is a basic framework for the development of simulated robots.

It is implemented to serve as an inspiration for beginners and it provides room for many challenges. It runs in the simulation environment of the official RoboCup 3D simulator, wher
Lectures

ca. 20 hours

Computer engineering aspects of Robotics (Nevena Ackovska)
Motion control, kinematics (Hans-Dieter Burkhard)
Sensors, perception (Hans-Dieter Burkhard)
Image processing, world model (H.-D. Burkhard)
Bio-inspired Robotics, Emotions and Robotics
(Nevena Ackovska)
+ exercise on emotional aspects of speech
(Vesna Kirandziska)

“Behavior and control” (H.D. Burkhard)
was omitted to have more time for exercises.
Practical Exercises with RoboNewbie

held by Monika Domanska ("Nika")

ca. 10 hours + individual work for up to 20 hours more
Practical Exercises with RoboNewbie
Java package structure:

project RoboNewbie

- agentIO
- util
- keyframeMotion
- localFieldView
- examples

„hardware access“ - connection to the simulation server

special abilities for the agent

Runnable is always the „Agent_“-class

Create your own programs here inside the RoboNewbie project, because of data and library dependencies.
Debugging agent code

Problem:
Using debug messages printed on System.out need too much time, and the agent can not synchronize with the 20ms-cycle of the simulation server. This causes different strange behaviours of the controled robot, e.g. it does not execute motor commands as expected.

Solution:
1. Use the class util.Logger (syntax is shown in the examples) and print the debug output after the agent program has finished.
2. Use the „Agent synchronized mode“ (Sync-mode) of the simulation server and print the output during the runtime of your agent program.
Practical Exercises with RoboNewbie

Exercises
for understanding the usage of RoboNewbie:

Exercise 1: Try out changing Agent_BasicStructure
Exercise 2: Recognize another agent (raise arms)
Exercise 3: Walk avoiding an obstacle
Exercise 4: Design a motion for kicking the ball
Exercise 2: Show, where the other agent is.

Implement an agent, which lifts the robots arm, when it senses another robot and moves the arm down, when it does not sense any robot. If the other robot is on the left side of your own one, lift the left arm, and the right arm for the right side. (Limits for lifting and dropping the arms are not important, just set the effectors to move into the correct direction.)

Instructions:
Change a copy of Agent_TestLocalFieldView. Define:
\[ id = \text{"0"} \]
\[ team = \text{"simpleSoccer"} \]
Beam coordinates: X=-1, Y=-1, Rot=90.

Use Agent_SimpleSoccer as the target. Start it at different initial positions.
Workshop Competition (Exercise 5)

Become the Soccer Champion of the Fast Scoring Competition of Ohrid!

The example agent SimpleSoccer pushes the ball towards the goal. During 10 minutes it almost reaches the goal with the ball. You can use this program as an inspiration for your task.

You can modify and extend it with new motions, better perception and more intelligent behavior. You can even program a team of up to 4 robots which cooperatively perform the task.

The winner is the team with shortest time to score.
Or: Closest distance to opponent goal after 3 (!) minutes
Teams at Workshop Competition

Become the Soccer Champion of the Fast Scoring Competition of Ohrid!

6 Teams with up to 4 members.

Comparable qualification levels for all teams. (Skills in JAVA, Robotics, Mathematics by self judgements)

Internationally mixed teams were required.

<table>
<thead>
<tr>
<th>Milica Adzic</th>
<th>Podgorica</th>
</tr>
</thead>
<tbody>
<tr>
<td>Petre Lameski</td>
<td>Skopje</td>
</tr>
<tr>
<td>Desislava Stoyanova</td>
<td>Plovdiv</td>
</tr>
<tr>
<td>Antonia Grbic</td>
<td>Zagreb</td>
</tr>
</tbody>
</table>
Team Work
The Competition
Final result: No team could score, but one team came close to the goal.
Evaluation

Did you program in Java before the course?

1 - "few or any experience"
5 - "much experience"
Evaluation

Did you implement robot controls before the course?

1 - "few or any experience"
5 - "much experience"
Evaluation

Where the exercises motivating?

1 - "boring"
5 - "motivating"
Evaluation

How was the level of the exercises?

1 - "too easy"
5 - "too difficult"
Evaluation

Did the “Quick start”-lessons help to understand the framework?

1 - "not at all"
4 - "moderately helpful"
5 - "very helpful"
Evaluation

How do you consider the structure of the framework?

1 - "hard to understand"
5 - "intuitive"
Evaluation

How is the usage of the classes?

1 - "not comfortable"
5 - "intuitive"
Evaluation

Did you use the documentation inside the source code?

1 - "not at all"
5 - "very often"
Evaluation

Is the documentation helpful?

- 1 - "not at all"
- 5 - "very helpful"
Evaluation

Does simulation help to understand real robots?

1 - "not at all"
5 - "very helpful"
Evaluation

Should we spent more or less time on the following parts of the course?

![Bar chart showing the distribution of responses for different course components. The categories include Theoretical lectures, Advised practical exercises, Own experiments, and Discussion with the group. The scale ranges from -2 to 2, with -2 indicating 'less' and 2 indicating 'more'.]
Evaluation

Which scenarios are interesting as a task for learning robots?

![Bar chart showing preferences for different scenarios: soccer playing (16), rescue (10), household robots (8), other (4).]
Next Steps with project RoboNewbie

- “Stabilization”: Program, Documentation, Website
- Extensions:
  - More motions, methods, etc.
  - More complex exercises
  - Machine Learning
  - Other scenarios besides soccer

- Test with High Schools
- Course “Cognitive Robotics” at Humboldt University
- One week course in Novi Sad in 2013
I would only add one more slide that states about the connections between the people. This really amazes me because we are talking about Balkans. Namely it seems that the students become really friendly to each other. Now they plan new schools, conferences and courses together. I follow them in Facebook and I'm quite amazed by the cooperation, even friendship that the school triggered. As Balkan born I find that very optimistic.
Thanks to all!