



BIOLOGICALLY INSPIRED
ROBOTICS GROUP (BIRG)

Logic Systems Laboratory (LSL)
School of Computer and Communication Sciences
Swiss Federal Institute of Technology Lausanne

Summer Semester Project 2004

Aibo Simulation in Webots and Controller Transfer to Aibo Robot

Lukas Hohl, semester 8
June 21, 2004



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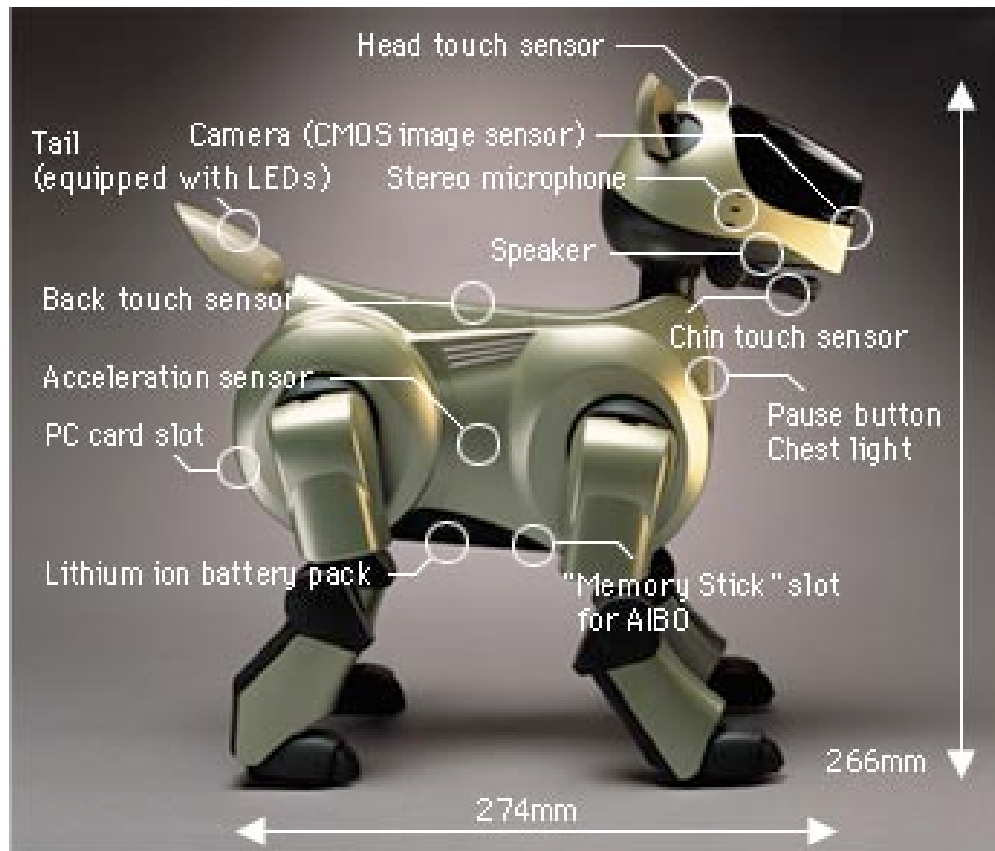


Introduction

Sony Aibo ERS-210(A)
Remote Control System
Webots 4



Sony Aibo ERS-210(A)







Remote Control System



← Wireless TCP/IP →

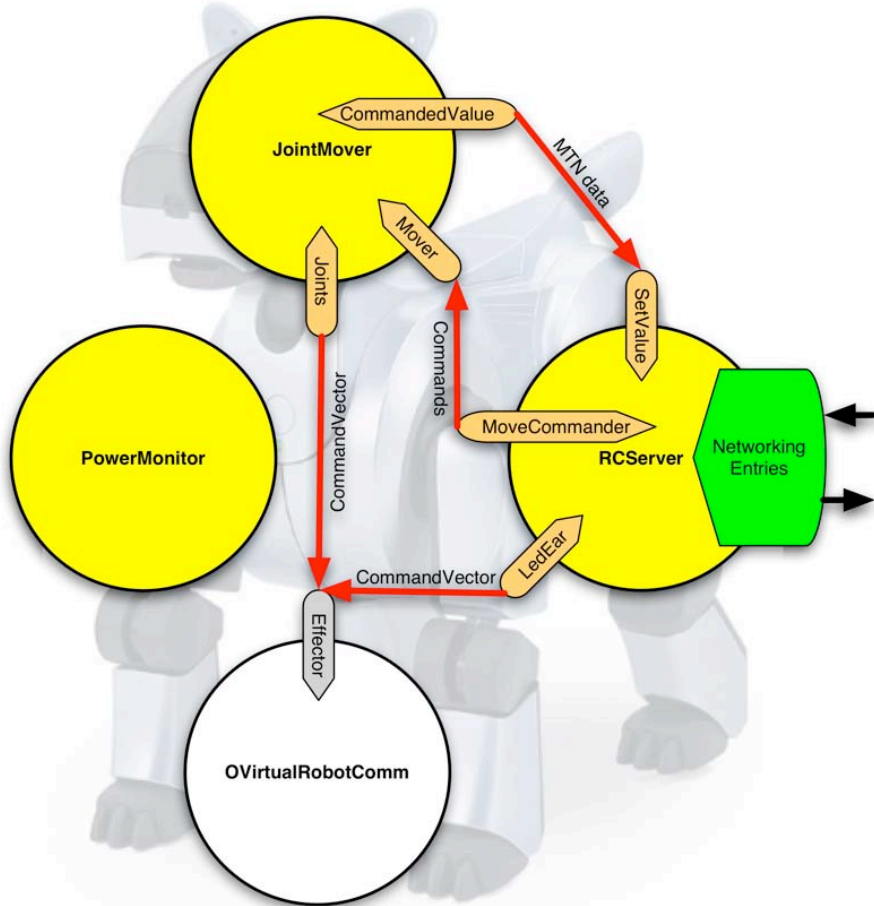


Aibo

Communication Protocol

Aibo Remote Control

BIRG – LSL – I&C – Swiss Federal Institute of Technology Lausanne
 Summer Semester Project 2004, Lukas Hohl
 Aibo Simulation in Webots and Controller Transfer to Aibo Robot



Aibo Remote Control

Network Connection
 IP / URL : 10.0.1.100 Reboot Shutdown Disconnect R

Manual Control

Head Control

	Tilt	Pan	Roll
	-82	43	-29
	-56.25	-90	0.00
	-56.29	0.00	90
			-1.29
	-47	-3	
	-26.47		
	-26.32		

Distance: 0.25 m
 Front: 0.18 N
 Back: 0.98 N

Status
 Accel. X: 0.34 m/s² Thermo: 28.05 C
 Accel. Y: -0.76 m/s² Batt. temp: 28.60 C
 Accel. Z: -9.98 m/s² Capacity: 18.00 %

Leg Control

	J1	J2	J3
	117	-11	89
	7.58	-1.84	23.94
	7.94	-1.99	23.88
	117	-11	89
	-34.73	-2.92	98.34
	-35.99	-2.66	98.17
	117	-11	89
	-12.70	17.44	29.44
	-12.33	18.28	29.67
	117	-11	89
	-57.36	27.36	98.06
	-57.80	27.76	98.66

Tail Control

	Pan	Tilt
	22	-22
	0.00	0.00
	-1.64	-3.28

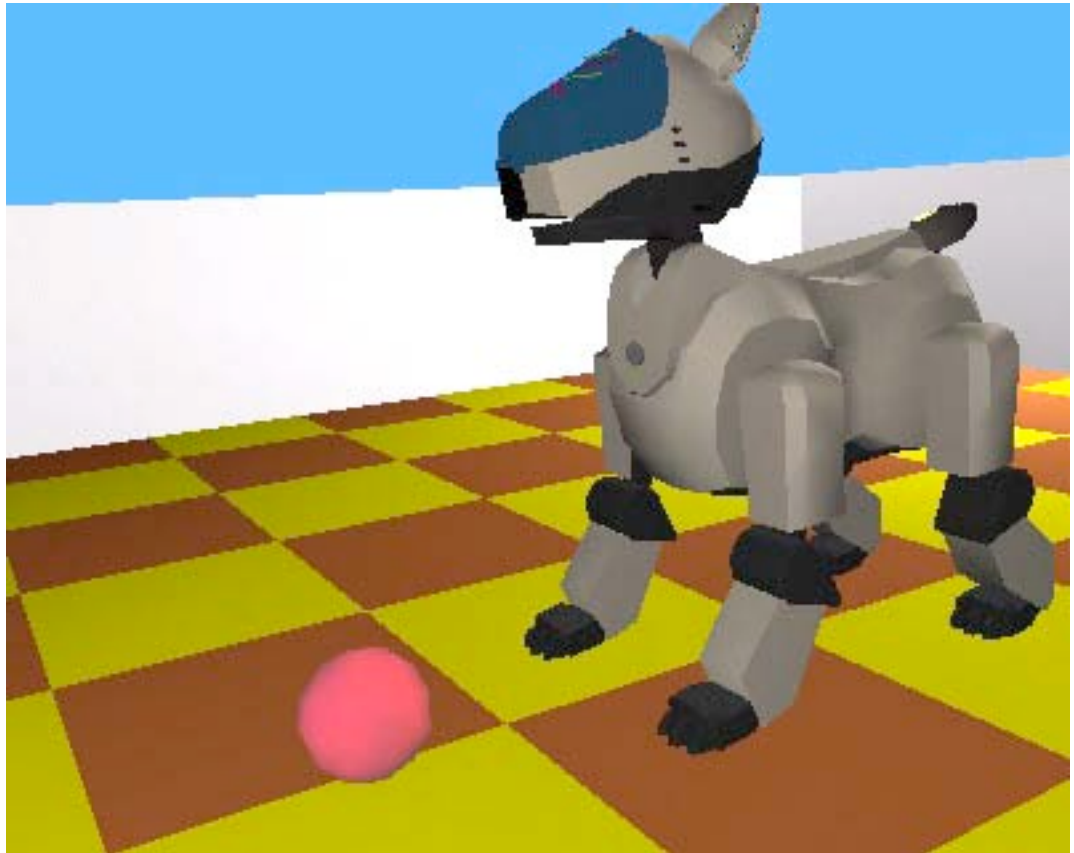
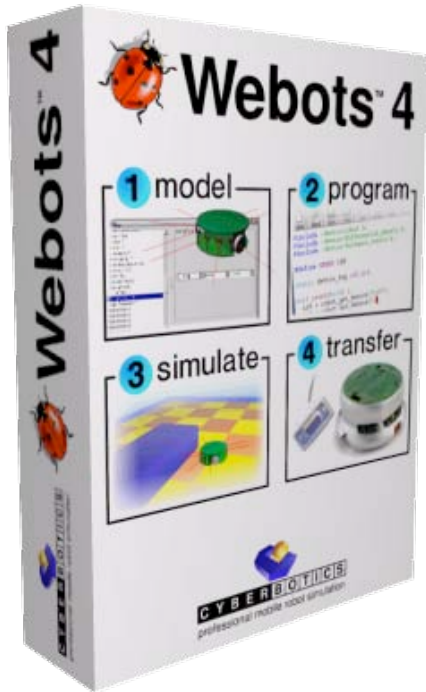
Maximum for:
 (global maximum)

	Velocity (degrees/s)	Acceleration (degrees/s ²)
	12.50	138.67
	256.25	15.63
		267.77
		312.50

MTN Upload and Playback
 File : WWFWD.MTN Choose... Upload Delete Playback Loops: 3 Log



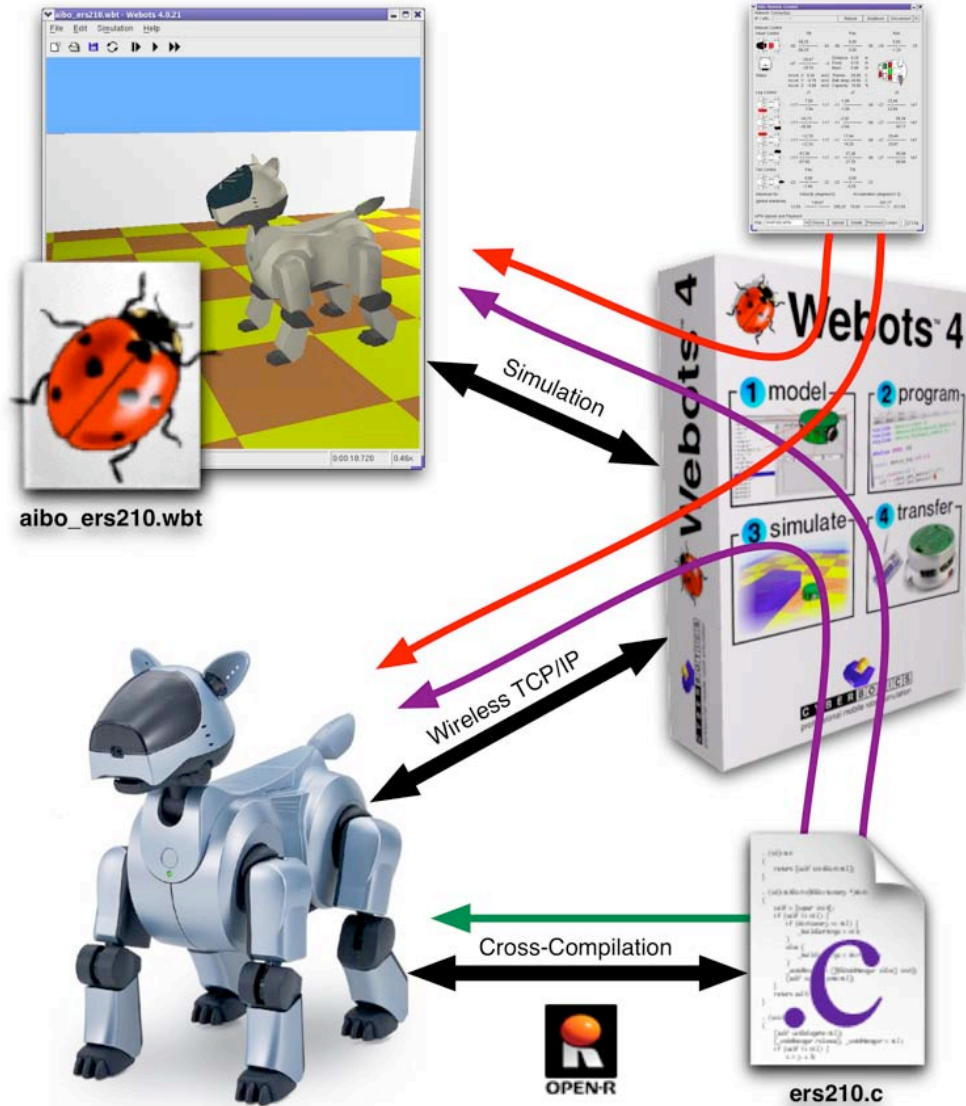
Webots 4





System Overview

Integration of Remote Control System into Webots
Simulation controlled by GUI and Controller
Real Aibo controlled by GUI and Controller
Controller Cross-Compilation



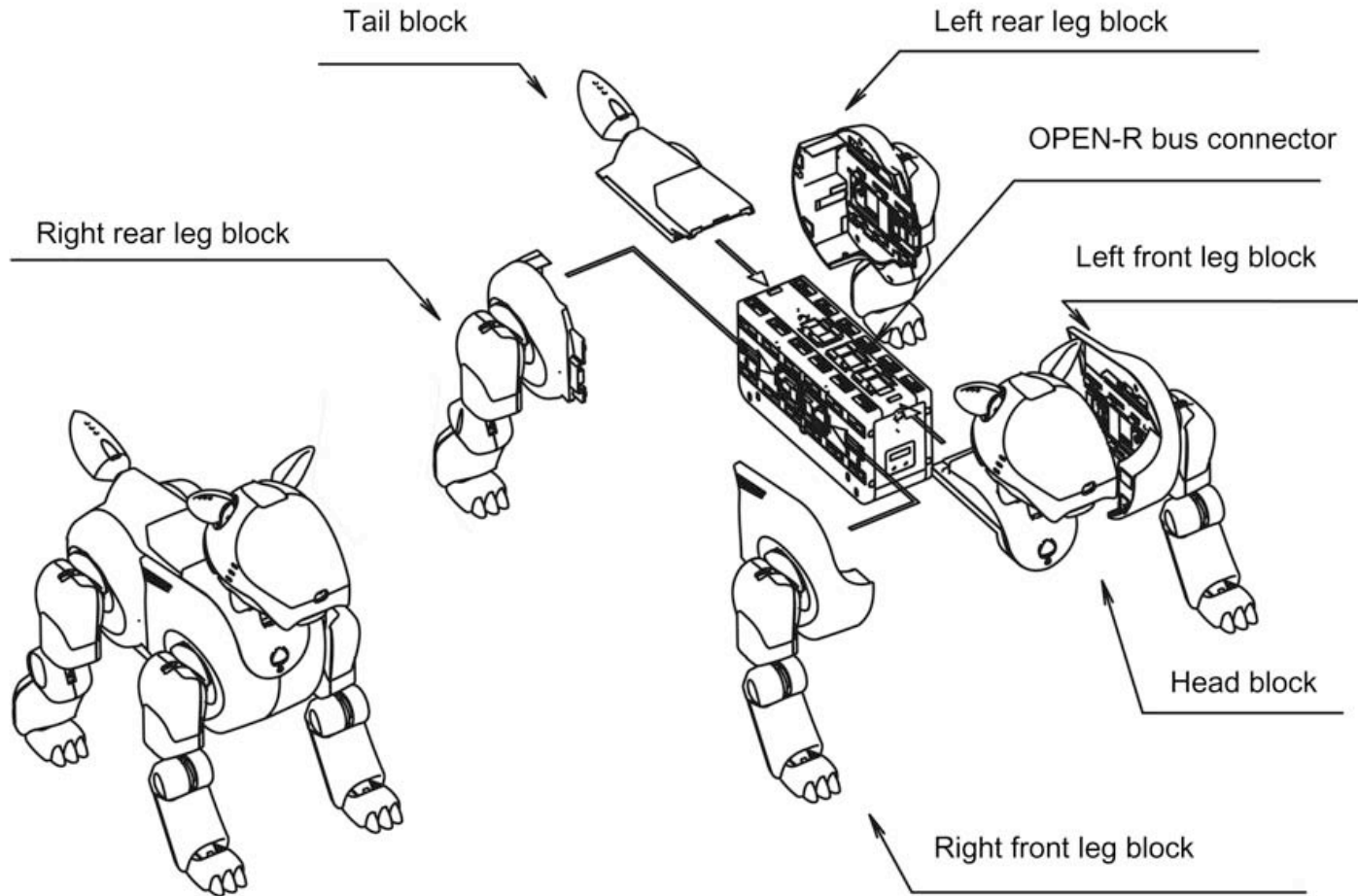


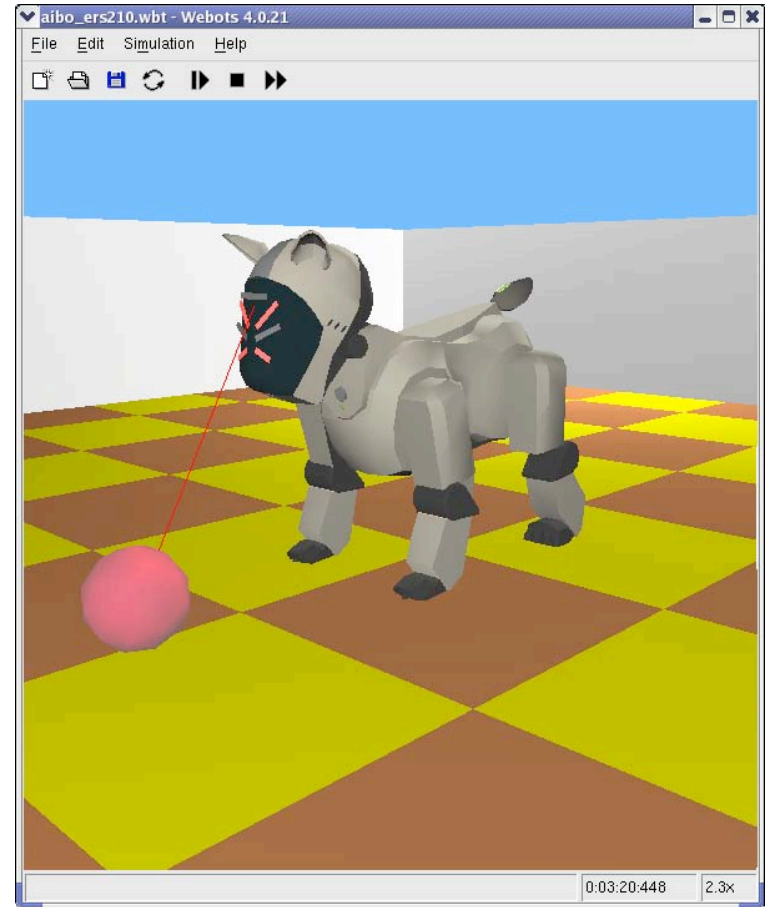
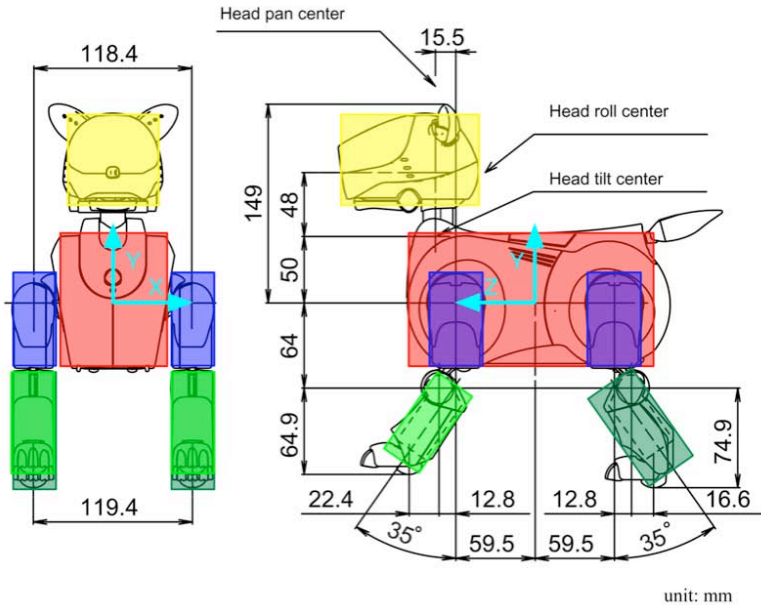
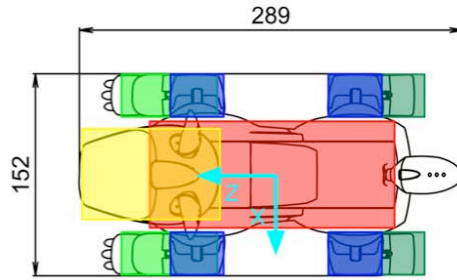
Simulation

Webots Model
Graphical User Interface
Controller Program



Webots Model







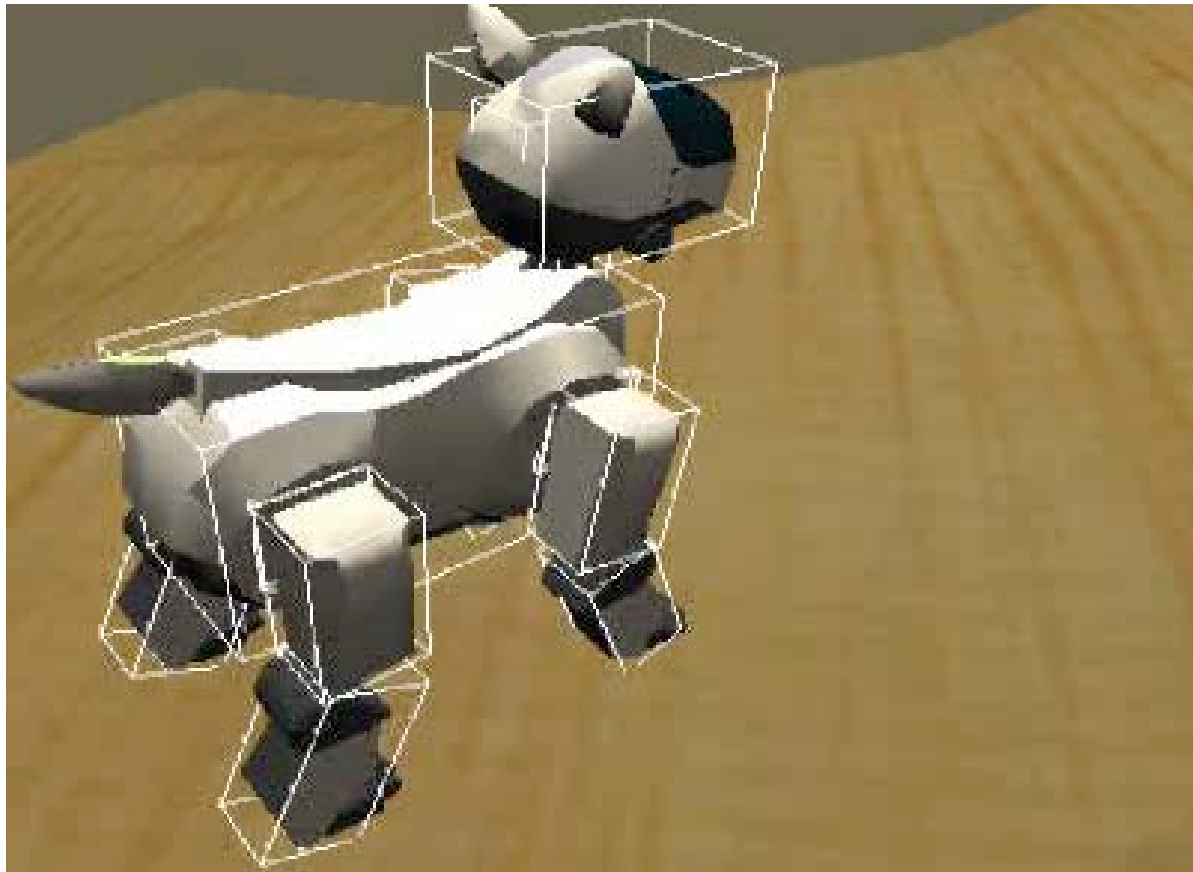
Graphical User Interface

The screenshot displays the Webots graphical user interface for the Aibo robot simulation. The main window shows a 3D rendering of the Aibo robot on a checkered floor, with a pink ball in front of it. The right-hand side of the interface contains a control panel with several sections:

- Simulation and Working:** Includes a 'Connect' button and an IP address field set to '0.0.1.100'.
- Head Control:** Features sliders for Tilt, Pan, and Roll, with numerical values and a small diagram of the robot's head.
- Status:** Displays sensor data including Acceleration (Accel. X, Y, Z) and Temperature (Thermo, Batt. temp, Capacity).
- Leg Control:** Shows sliders for joint angles (J1, J2, J3) and their corresponding velocity and acceleration values.
- Tail Control:** Includes sliders for Pan and Tilt.
- Maximum for:** A section for setting global maximums for Velocity and Acceleration in degrees/s and degrees/s².
- MTN Upload and Playback:** A section for loading and playing back motion files, with a 'File' dropdown set to 'WWFWD.MTN' and a 'Play' button.



Controller Program





Controller Program





Remote Control

Graphical User Interface
Controller Program



Graphical User Interface

The screenshot shows the Webots 4.0.21 interface. The main window displays a 3D simulation of an Aibo robot on a yellow and brown checkered floor, with a pink ball nearby. The right-hand panel contains control and status data for the robot, titled 'ERS210'. Several UI elements are circled in blue:

- The 'Simulation and Working' section at the top right, containing a checked 'Simulation' box and a 'Disconnect' button.
- The 'Head Control' section, which includes a small diagram of the robot's head and numerical values for Tilt, Pan, and Roll.
- The 'Status' section, which displays acceleration (Accel X, Y, Z) and battery information (Thermo, Batt temp, Capacity).
- The 'Leg Control' section, which shows joint angles and velocities for legs J1, J2, and J3.
- The 'Tail Control' section, which shows Pan and Tilt values.

At the bottom of the right panel, there is a table for 'Maximum for:' (global maximum) with columns for Velocity (degrees/s) and Acceleration (degrees/s²).

	Velocity (degrees/s)		Acceleration (degrees/s ²)	
(global maximum)	12.50	62.50	256.25	48.83
			15.63	312.50

The bottom of the window shows 'MTN Upload and Playback' controls, including a file name 'WWFWD.MTN', an 'Upload' button, and a 'Loops: 1' field.



Controller Program

- Callback mechanism for simulated devices
- Under construction
- Sensor reading:
Simulated value set to last measurement received
- Commands:
Message sent to Aibo if difference in target value
- Limited by Communication Protocol



Cross-Compilation

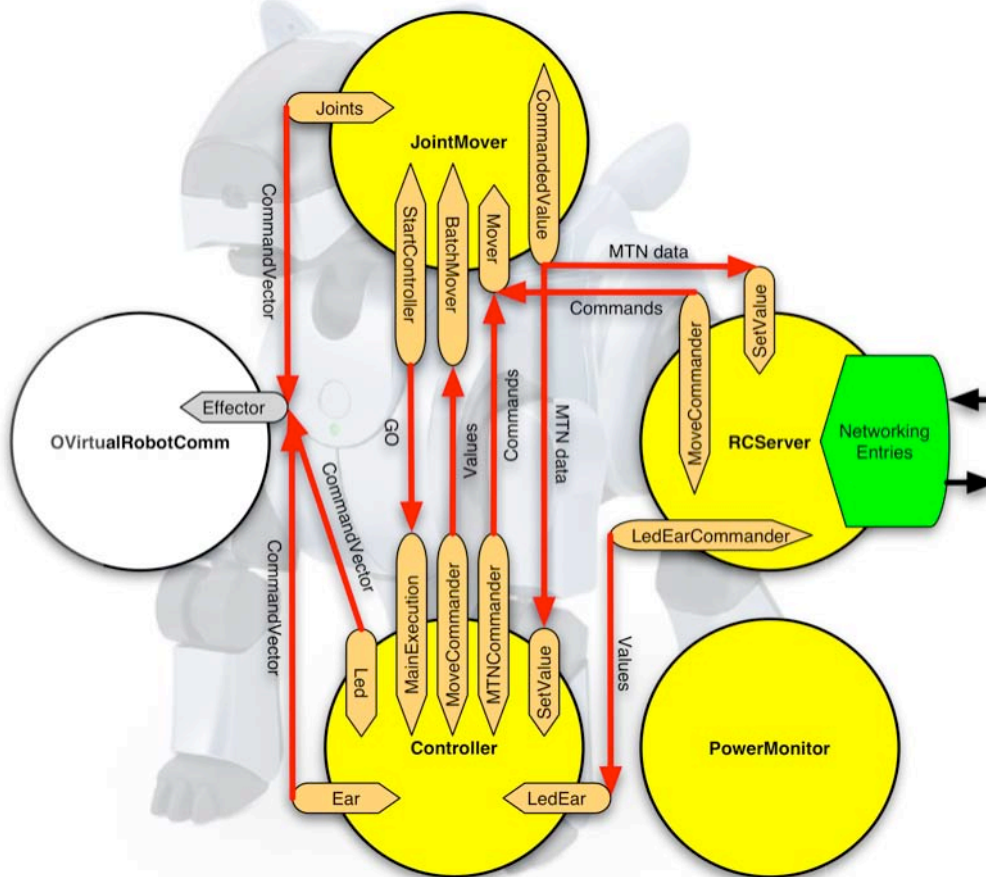
OPEN-R Objects

Cross-Compilation

Webots Controller Program vs. Aibo Programming Scheme



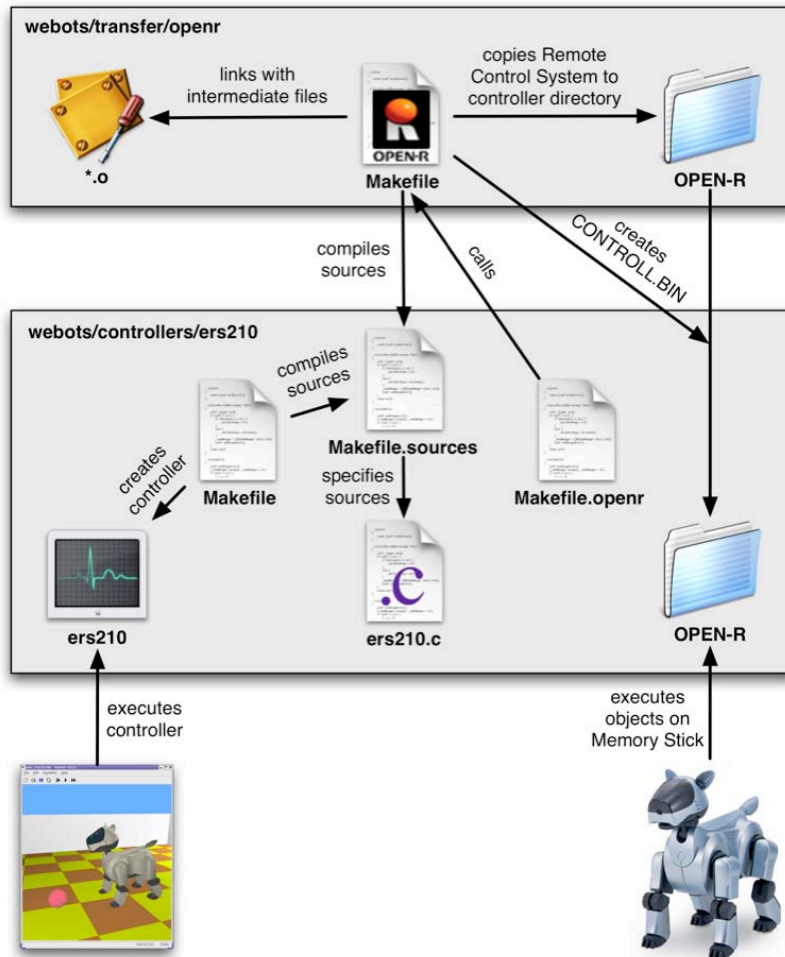
OPEN-R Objects



- main():
Controller
- API Translation:
Controller
- LEDs & Plungers:
Controller
- Joints & MTN:
JointMover
- Remote Control:
RCServer



Cross-Compilation



- Sony's OPEN-R Cross-Compiler
- Links intermediate files and compiled sources
- Creates binary to be put on Memory Stick
- Upload in Webots via GUI possible



```
DeviceTag led_1 = robot_get_device("PRM:/r1/c1/c2/c3/l1-LED2:l1");  
// ...  
  
led_set(led_1, touch_sensor_get_value(touch_sensor));  
led_set(led_2, (distance_sensor_get_value(distance_sensor)<200));  
// ...  
  
MTN* mtn = mtn_new("WWFWD.MTN");  
mtn_play(mtn);  
// ...  
  
if (mtn_is_over(mtn)) servo_motor_off(leg_left);  
// ...  
  
servo_set_position(leg_right, servo_get_position(leg_left));  
// ...
```



Webots vs. Aibo

```
int main() {  
    robot_live(reset);  
    robot_die(die);  
    for(;;) {  
        // instructions  
        robot_step(64);  
    }  
    return 0;  
}
```

Infinite loop contrary to
Aibo Programming
Scheme

```
int run(int k) {  
    // instructions  
    return 64;  
}
```

```
int main() {  
    robot_live(reset);  
    robot_die(die);  
    robot_run(run);  
    return 0;  
}
```

Run function allows
selective execution



- Webots executes `run` in infinite loop
- Aibo uses LED period for timing
- Aibo executes `run` in method handling ready notification after LED command execution
- Aibo sends new LED command vector message to robot immediately after `run`
- Implicit infinite loop on Aibo by continuous reception and sending of messages



Outlook

Other Aibo Models



Other Aibo Models



Aibo ERS-220

Aibo ERS-7



- ERS-220 almost identical to ERS-210
- Remote Control System ported to ERS-7



Modifications...

- Webots Model
- Webots Model Nodes
- Webots Controller Programming Interface
- Graphical User Interface
- Communication Protocol
- OPEN-R Objects on Aibo



How to learn more?

- Project Page @ BIRG (<http://birg.epfl.ch/>)
 - Report
 - ScreenShots
 - Presentation
- <http://www.cyberbotics.com/>
 - Webots
 - Movies



Thank you for your attention!