Austrian-Kangaroos 2009
Team Description Paper (TDP)

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Abstract. The *Austrian-Kangaroos* are a joint *Standard Platform League* team of the University of Applied Sciences Technikum Wien and the Vienna University of Technology, participating in the 2009 RoboCup World Championship for the first time. This paper is a position paper that provides an overview of the *Austrian-Kangaroo's* software architecture as much as current research topics within the team's context.

1 Introduction

As the *Austrian-Kangaroos* are a newcomer team that participates in the RoboCup 2009 for the first time, this year's main focus lays on developing a reliable and dependable software architecture. However, the team's first steps were simplified by utilizing previous experiences in team building made by the University of Applied Sciences Technikum Wien within other RoboCup leagues like the *Small Size League* [1].

The Vienna University of Technology provides extensive know-how in the fields of computer vision and complex dynamical systems at the *Automation and Control Institute (ACIN)*, and foundations on Embedded-Systems Development, and Concurrent- and Real-Time Programming, as much as on robotic software architectures at the *Institute of Computer Languages Compilers and Languages Group (COMPLANG)*.

Based on the theoretical background, this year's main goal is the development of a reliable and dependable software platform that provides a reusable testbed for research activities over the years. In the following sections we will first summarize the team's research interests (Section 2), and then describe the currently developed system architecture (Section 3).

[1] e.g., The Austrian Cubes - former *Vienna Cubes* - is now a joint team of the University of Applied Sciences Technikum Wien and the University of Technology Graz.

2 Research

Robotic soccer players in general provide an excellent platform for research on a wide field of topics. Consequently all institutions participating in he *Austrian-Kangaroos* apply their specific research questions to this standardized platform.

2.1 Vision for Robotics

The workgroup *Vision for Robotics (V4R)*[2] uses the Kangaroos[3] for their research towards robots that see and interact with the world. The humanoids allow us to detect objects and structures in the environment and they enable a natural and almost human-like interaction. The current research covers object detection with little prior knowledge [1, 2], and as much as to grasp such objects [3–5]. Research was also done on home robotics applications [6–9] with localisation [10]. Where the Vienna University of Technology has also a team called the *MetaMechanics*[4]

2.2 Nonlinear Controls

Knowledge on nonlinear control systems is gathered on the *Complex Dynamical Systems Group (CDS)*[5] [11–14] involving bipedal walking algorithms. Ongoing research of the CDS group aims at combining traditional control systems with classical learning algorithms.

2.3 Concurrent and Embedded Real-Time Systems

One of the emphases of the *Compilers and Languages Group (COMPLANG)*[6] are robust embedded systems. Within this context research is conducted for analyses and certification of dependable software, as much as for the development of new programming methodologies and languages that simplify the development of mission-critical embedded systems applications.

Our analyses are mainly based on static analysis at source-code level, and typically aim at the calculation of code properties like worst-case execution times (WCET) [15, 16], heap structure, or stack usage. Research targeting at software architectures covers the design and synthesis of middleware for distributed real-time embedded systems (DRE), as much as model driven development methodologies [17–19].

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[2] V4R website: `http://v4r.acin.tuwien.ac.at`
[3] Kangaroos is the teams nickname.
[4] MetaMechanics: `http://www.meta-mechanics.org/`
[5] CDS website: `http://cds.acin.tuwien.ac.at`
[6] COMPLANG website: `http://www.complang.tuwien.ac.at`

3 System Architecture

The chosen architecture is based on Aldebaran's framework Nao SDK 1.2[7]. Figure 1 provides an outline of the structure: The chosen design is mainly motivated by the idea of separation of concerns. Three independent modules, located at different address spaces at the robot, are connected via explicit shared memory. In addition, external computers may also subscribe to this common data source to monitor ongoing processes on the robot. Beside the shared memory connection, functional coupling is achieved via SOAP wrapped function calls. As a consequence, modules are easily replaceable and hence allow continuous evolution of the modules.

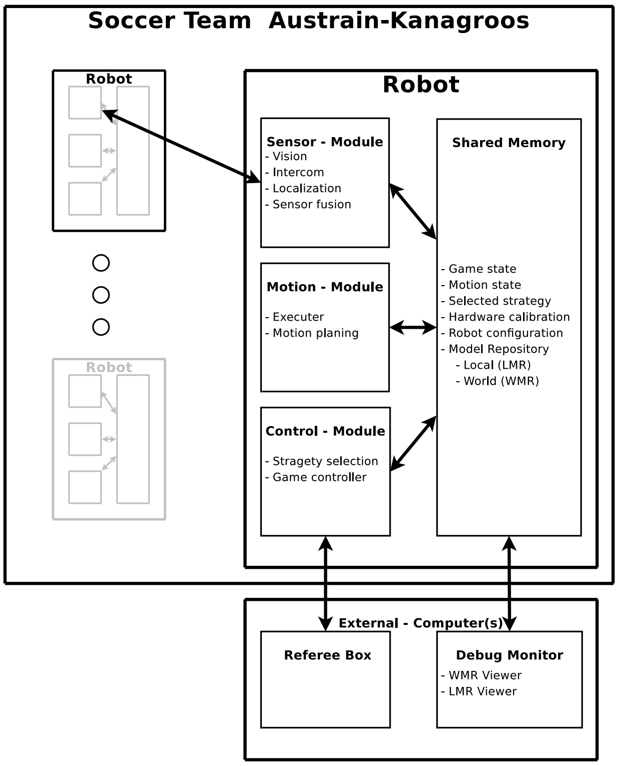

Fig. 1. Our system architecture

- **Sensor-Module**: The sensor module gathers all sensor inputs except the referee commands. It also processes sensor information from other robots and stores all data in a World Model Repository (WMR) [20]. The Local Model

[7] Nao SDK: `http://www.aldebran.com`

Repository (LMR) represents a robot centric view of the environment and stores local sensory information only. Having a LMR allows a more efficient control of local behaviours. The WMR also provides the base for strategic decisions, and for the execution of local actions, if the sensor information in the LMR is not sufficient.
The vision system is founded on two cameras, but the given hardware does not allow simultaneous access. Therefore only the camera in the robots mouth is used during the game. Figure 2 shows an image taken where we can see some detested objects and the estimated playground projected back into the image.

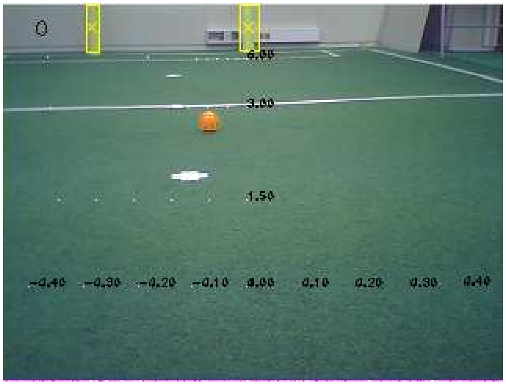

Fig. 2. Detected objects on the playground

- **Motion-Module**: The motion module provides an interface to *primitive* and *composite actions*. It also ensures non-concurrent calls to body resources.
  - Primitive actions are basic motion commands (e.g. kick, stand-up).
  - Composite actions are more complex motion commands like walking to the ball, and are usually composed of several primitive actions and maybe again composite actions. In addition, feedback from the sensor system is used to evaluate proper execution.

  These actions are scheduled by the control module described next.

- **Control-Module**: The control module uses the WMR and the signals received from the referee to reason on a feasible winning strategy. It is responsible for play-selection, role assignment and can create role specific, scheduled action calls that are submitted to the motion module.

- **Shared Memory**: Besides the physical realization of shared memory, this module provides a full-fledged publish-subscribe infrastructure. Hence, it triggers signals in all connected modules if a subscribed memory location is altered. This design allows an IRQ-like implementation of service calls at a high system level.

4 Conclusion

The ongoing work on the software infrastructure of the Austrian-Kangaroos aims at the construction of a reliable and reusable platform for research and education within the RoboCup context. For this year, first results on the vision and the motion module demonstrate the capabilities of our design decisions. However, additional effort within the next month will be required to reach our predefined goals.

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