The IUB 2002 Smallsize League Team

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1 Introduction

The IUB Smallsize Team builds on top of expertise and hardware from a previous smallsize team at the AI-lab of the Vrije Universiteit Brussel (VUB), Belgium [BWBK99,BWB+98], which reached the quarterfinals in RoboCup 1998 in Paris, a second place at the WDR-Cup 1999 in Paderborn, and a 3rd place at the European Championship 2000 in Amsterdam. Unlike the VUB team, which suffered from a significant lack in manpower, the team at the International University Bremen (IUB) can not only rely upon successful hardware, but also on significant efforts related to different educational and research activities that form the core of the team. In respect to research, the smallsize team is the basis for work on onboard vision for mobile systems, coordination of larger heterogeneous teams aiming for 11 against 11 soccer, and hardware software co-design for autonomous systems. In respect to education, the team is used as a regular part of the undergraduate program in Electrical Engineering and Computer Science (EECS) at IUB.

On the hardware side, the IUB Smallsize Team is based on a kind of robot construction kit, the so-called CubeSystem, which allows to implement a wide range of players with on-board control [BWBK99,BWB+98,BB98,Bir98]. The software side centers around the so-called CubeOS [Ken00], a special operating system designed to support behavior-oriented programming [BK00].

2 The hardware side

The RoboCube as dedicated embedded controller of the CubeSystem is meanwhile in its release V2.2. It features a 32-bit processor, the MC68332, substantial I/O-interfaces, and an open bus-architecture allowing flexible extensions of the computing hardware. The RoboCube is described in more detail in [BKW00,BKW98].

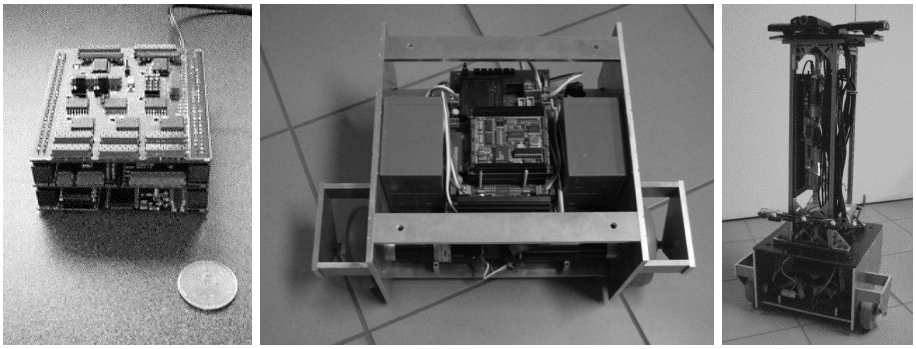

Fig. 1. Left: The RoboCube, an extremely compact embedded computer for robot control. Center: A midsized mobile base completely constructed from CubeSystem components. Right: The RoboGuard, an industrial application of the CubeSystem, which substantially profits from the technological developments for our RoboCup smallsize team.

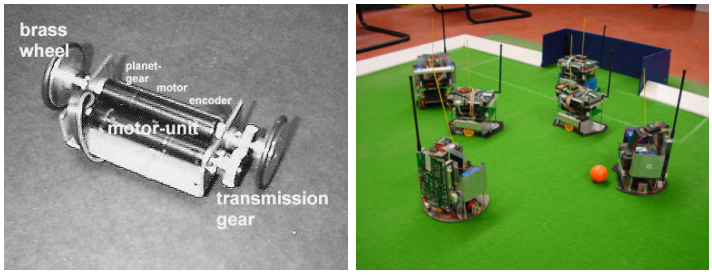

Fig. 2. The drive unit (left) as a mechanical building-block, which can be integrated into several different robots like e.g. the ones shown on the right.

In addition to its central component, the RoboCube as controller hardware, the CubeSystem provides additional hardware, including electronics and mechanics, and software components. The drive components range for example from a small drive unit (figure 2) to a dedicated midsized base used in the industry-project of the so-called RoboGuard (figure 1).

The RoboGuard [BK01b] is of interest in this context as it is an industrial application which - at least to a substantial extent - is directly derived from technology developed for RoboCup. The RoboGuard is a mobile security device which is tightly integrated into the existing surveillance framework developed and marketed by Quadrox, a Belgian SME. RoboGuards are semi-autonomous mobile robots providing video streams via wireless Intranet-connections to existing watchguard systems, supplemented by various basic and optional behaviors. RoboGuards fill several market-niches. Especially, they are a serious alterna-

tive to the standard approach of using Closed Circuit Television (CCTV) for surveillance.

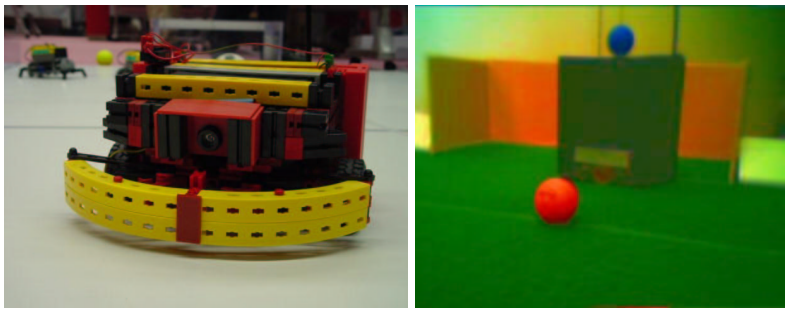

Fig. 3. The new C-MOS based color camera allows high-resoltion images and on-board vision processing with the CubeSystem.

Last but not least, the CubeSystem was recently extended by the development of a high-resolution C-MOS color camera and on-board vision (figure 3). The camera provides images with 356 x 292 pixels in true color and there is on-board vision processing by the CubeSystem.

3 The software architecture

The control software of each robot of the IUB team relies on the RoboCube controller platform, which was shortly described above, and on it's CubeOS operating system to implement the control application. The CubeOS nanokernel contains real-time multi-threading, abstract communication interfaces and thread control primitives. On top of the nanocore, a set of software drivers provides an application programming interface to the RoboCube's hardware.

So, CubeOS supports a wide range of devices employed in the CubeSystem through libraries and it facilitates the development of new drivers to incoporate further devices, let it be sensors, actuators, or computational hardware. Last but not least, it features a novel scheduling scheme designed for behavioral processes. This so-called B-scheduling [BK01a] can handle behaviors running on different time-scales represented through so-called exponential effect priorities.

The on-board run-time system for control and strategies has following architecture. A hierarchical scheduling structure is used. On the highest layer, there are only three threads T0, T1, T2 running in time-slots in a fixed frequency master cycle. T0 is run to completion and its subthreads T0.x establish a hard realtime control. The thread T1, which can be preempted, invokes a further soft-realtime scheduler for behaviors. The behaviors establish close, dynamic couplings between sensors and motors computed in pseudo-parallel.

This includes for example higher level motion skills and all strategic decisions. The third thread T2 allows optional non-uniform processing, e.g., for operator changes of mission parameters.

4 Conclusion

The paper gave a short introduction to the IUB 2002 Smallsize Team. The IUB smallsize team is based on work by senior researchers as well as undergraduate students. The research aspects focus on onboard vision for mobile systems, coordination of larger heterogeneous teams aiming for 11 against 11 soccer, and hardware software co-design for autonomous systems based on the so-called CubeSystem. In respect to education, the team is used as a regular part of the undergraduate program in Electrical Engineering and Computer Science (EECS) at IUB.

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