UQ RoboRoos 2003: The Complete Rewrite

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Abstract. The University of Queensland's RoboRoos team has been developed to play robot soccer in the small size league of the RoboCup competitions. The RoboRoos have been competing since 1998. The 2002 RoboCup competition saw a drop in the relative performance of the RoboRoos system due to software problems. This prompted a rewrite of most of the code for 2003. Optimization of the motion control system is also a priority for 2003 to ensure that the robots are achieving the maximum possible performance from the mechanical design. However in 2002 two systems were upgraded with good results; upgrading to a digital video camera and wireless spread spectrum RF modules.

1 Introduction

The University of Queensland's RoboRoos team is one of the longest standing teams in the small-size league of RoboCup [1] having competed annually since 1998. During these years the performance of the team has been successful, and many research areas explored especially in the areas of multi-robot coordination and navigation in highly dynamic environments.

The 2002 RoboCup competition saw the first time that the RoboRoos team did not make it through the round robin section. This was deemed to be because of a tough round robin table combined with 'hacked at' software and a poorly optimized control system. This has prompted a complete rewrite of all code. Currently the intelligence modules have been rewritten with encouraging initial results.

In 2002 with RoboRoos upgraded their vision and wireless communication systems. Overhead images are now provided by a digital FireWire camera capable of high frame rates at decent resolution. The new RF modules are spread spectrum and are able to transmit at a high data rate (compared to the Radiometrix modules). 2002 also saw the introduction of a ball control mechanism to the mechanical design.

System Architecture

The RoboRoos system architecture at RoboCup 2002 was the same as in previous years. See [2-5] for details of this system architecture.

To prepare for the 2003 competition the RoboRoos system is to be completely rewritten. Currently on the intelligence system has been rewritten. The new system already has the following features (that the 2002 system did not have):

- Navigation and behavior selection on a central PC (instead of on each robot),
- fast OpenGL rendering engine,
- improved latency calculation,
- a playback system that can recreate all multi-agent and navigation decisions,
- ability to easily add new software modules to the project,
- multi-threading (split between the vision system and the intelligence system),
- software ported to C++.

Figure 1 shows the current system architecture. Note that the major difference between this system and other successful small size league systems is that the RoboRoo robots are sent lengths (translation and rotation) instead of velocities (over the RF communication link).

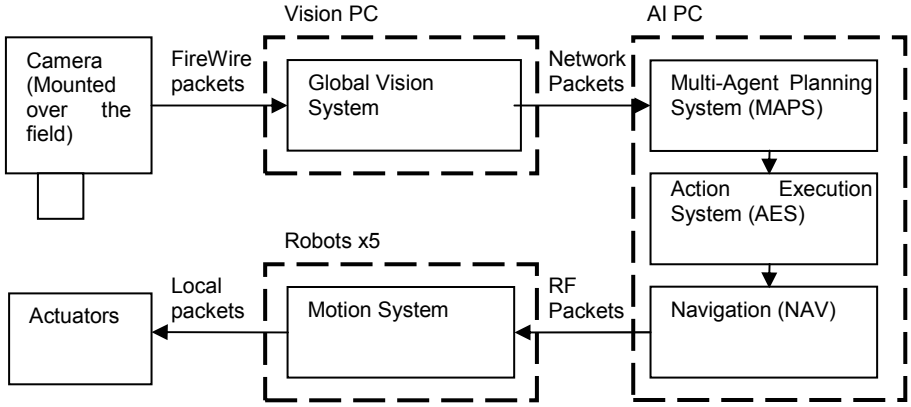

Figure 1. RoboRoo 2003 System Architecture.

Vision System

In 2002 the RoboRoo team switched from an analogue based camera solution to a digital one. This has allowed the possibility of using higher frame rates and higher resolution images. Compared to an analogue camera solution (camera plus frame grabber) the digital solution worked out to be a similar cost.

The RoboRoos selected the Basler A301fc FireWire camera as it is capable of 640x480 at 80Hhz in the Bayer2G format. Note that the 'frame grabber' is located inside the actual camera.

It is intended that by RoboCup 2003 a twin camera solution will be implemented so as to reduce the amount of ball occlusion.

Wireless Communication

In 2002 the RoboRoo's wireless communication system was upgraded from the Radiometrix 418/433 modules to the Innomedia OEM spread spectrum modules. Table 1 summaries the differences between the two modules. Clearly the Innomedia modules are better with a much higher data rate coupled with a lower error rate. A PIC microcontroller is used to convert from the Innomedia's complex custom communication interface to similar to UART. The transmitter board is connected to our USB port (through a PIC microcontroller) for fast communication.

	Radiometrix RX2/TX2	Innomedia OEM SS
Data Rate	19.2kbs	250kbs
Channels	2	4
Error Rate (at RoboCup)	8%	<5%
Interface	UART	Complex, Custom

Table 1. Table showing a summary of the differences between the Radiometrix and Innomedia modules. It clearly shows the benefit of using the Innomedia OEM SS modules.

Mechanical and Electrical

The major mechanical change to the RoboRoos in 2002/2003 is to implement a ball control mechanism (commonly called a "dribbler"). For RoboCup 2002 the RoboRoos featured an innovative ball control mechanism that enabled the ball to be drawn towards the centre of the robot and 'held'. One feature is a 15mm gap cut in the centre of the bar. When the ball is located in this gap the RoboRoo has some control over the sideways motion of the ball. The second feature is the screw shape cut into the rubber. This gives the ball a component of force towards the centre of the dribbler. The ball then becomes trapped in the centre gap.

Unfortunately due to the light weight construction of the RoboRoo robots the ball exerts too much force back onto the robot. This has resulted in a simpler ball control mechanism design with a larger gap but no screw shape cut into the rubber. Teflon/plastic pads are used to ensure that the robot cannot drive up onto the ball.

Motion Control

It was determined that some of the problems that the RoboRoo robots experienced in 2002 was as a result of a poorly tuned motion control system. This has lead to an emphasis in 2003 on optimizing the motion control system. Optimization will ensure that the RoboRoos get maximum performance from the mechanical design. Some important changes include:

- Increase general control of motion – Set the acceleration to be dependent on the current velocity. It was noted that while the robots can achieve quite high accelerations at low speeds, they can only achieve low accelerations at high

speeds. The acceleration is therefore ramped off as the robot approaches its maximum velocity. This gives better performance at higher speeds while still allowing high initial accelerations.

- Increase the accuracy of kicking – It was found that due to vision updates the robot was sometimes unable to reach its desired facing with zero final velocity. The robot may now increase the rate at which is decelerates in order to ensure that it reaches its final facing with zero final velocity.
- Increase dribbling performance - Dribbling performance was increased by varying the voltage to the DC motor (that controls the ball control mechanism) dependent on the type of motion the robot is attempting. For example when accelerating forwards it is better to leave the dribbler off.

Initial Results of the Complete Rewrite

In February 2003 the RoboRoos competed in a friendly game against the RooBots who were placed fourth in the world at the 2002 RoboCup competition. The RoboRoos won the game 6-0. This win is credited to the rewrite of the intelligence system and the optimization of the motion control system.

Conclusion

To address the lack of performance in 2002 the RoboRoos system is to be rewritten for the 2003 competition. Currently the intelligence software has been rewritten. The motion control system is also being optimized to ensure that the RoboRoos are achieving the maximum possible performance from the mechanical design. The friendly game against the RooBots is an encouraging indication of the success of the rewrite and the motion control system optimizations.

References

1. Kitano, H., et al. *RoboCup: The Robot World Cup Initiative*. in *IJCAI-95 Workshop on Entertainment and AI/ALife*. 1995.
2. Ball, D., G. Wyeth, and D. Cusack. *Design of a Team of Soccer Playing Robots*. in *AMIRE*. 2003.
3. Wyeth, G., et al. *UQ RoboRoos: Achieving Power and Agility in a Small Size Robot*. in *RoboCup 2001*. 2002: Springer-Verlag.
4. Wyeth, G., B. Browning, and A.D. Tews, *UQ RoboRoos: Preliminary Design of a Robot Soccer Team.* Lecture Notes in AI: RoboCup '98, 1604, 1999.
5. Wyeth, G., A.D. Tews, and B. Browning. *UQ RoboRoos: Kicking on to 2000*. in *RoboCup-2000: Robot Soccer World Cup IV*. 2001: Springer-Verlag.