# UQ RoboRoos: Kicking on to 2000

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**Abstract.** The UQ RoboRoos have been developed to participate in the RoboCup robot soccer small size league. This paper overviews the history of the team, and provides details of some key factors to the teams success in 2000: a new goalkeeper design, robust communications and smooth, fast navigation. The paper concludes with some thoughts on the future of the RoboRoos.

## Overview

The RoboRoos are one of the longest serving teams in the RoboCup Small Size league. The robots competed at RoboCup '98 [7] where they were runner-up, and in RoboCup '99 [8] where they were eliminated in the quarter finals, despite a 56-1 goal difference during the round robin stage. In RoboCup 2000, the team was eliminated in the semi-finals after a 36 - 2 goal difference in the round robin stage. The field robots have remained mechanically and electronically the same through the years of competition, with significant improvements being made through software revision. The goalkeeper has been re-designed several times over this period with the latest revision detailed in this description.

Figure 1 shows the architecture of the RoboRoos system, which has remained constant since its inception. The vision system was extensively revised in 1999 with excellent results [9]. The team planning system, MAPS, has been the focus of ongoing development [4,5,6], and represents one of the most significant research results of the RoboRoos development. MAPS forms cooperative strategies by observing team agents at the current point in time and choosing appropriate actions to increase the likelihood of cooperation in the near future. These actions are transmitted to the robots, along with the current state of the field, over the RF communications link. The RF communications link has received significant attention to ensure reliability under adverse conditions. The robots use the information from the communications link to set the current goal for navigation, and to build representations of obstacle maps for path planning. The navigation module for the robots has been another area of significant research effort [2], and provides the smooth controlled motion that is the signature feature of the RoboRoos.

P. Stone, T. Balch, and G. Kraetzschmar (Eds.): RoboCup 2000, LNAI 2019, pp. 555-558, 2001.

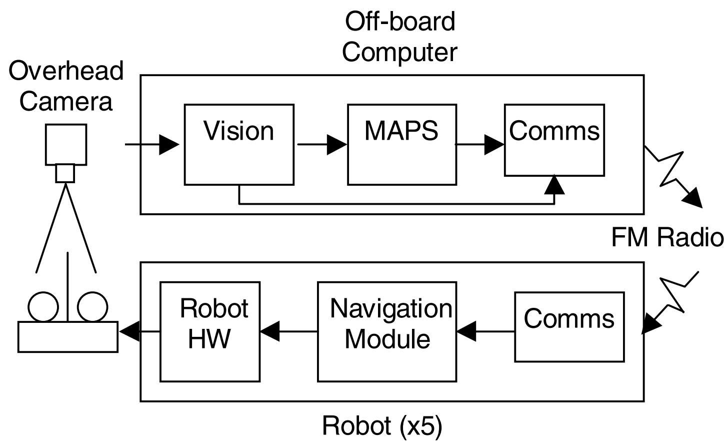


**Fig. 1.** The RoboRoos system in overview.

This team description will focus on the parts of the system that are not described elsewhere, and that have contributed significantly the team's success in RoboCup 2000 - the new goal keeper design, the communications link and the navigation system. The conclusion focuses on the future of the RoboRoos.

## Goalkeeper Design

Past goalkeeper designs for the RoboRoos attempted to achieve maximum performance by having a four wheel drive design with slip steering. The justification for this approach was that the robot would mostly function on a single linear axis, with minor corrections for slip. In practice, this assumption was invalid. As we developed algorithms for our goalkeeper, it became clear that good rotational control was also important. The slip steering method was found to be very hard to control, and extremely hard on battery consumption.

In 2000, we adopted the approach that manoeuvrability was the key, and reverted to a simple wheelchair design. By keeping the centre of mass of the robot low, we were able to minimise "lost" down force on the casters, thus achieving greater grip on the driving wheels. The heaviest components were kept close to the turning centre of the robot, minimising the moment of inertia, leading to vastly improved angular acceleration over the previous slip steer design. The improvement in achievable turning acceleration lead to vastly improved control of the goalkeeper. The nett effect was that usable linear acceleration lifted from 0.3g in the old design, to 0.5g. The time to cover the goal mouth went from 0.9 seconds to 0.7 seconds with the new design, but most importantly the goal keeper remained under control at all times.

The adoption of this simple design for a goalkeeper also allowed us to have a second robot with a large side-on profile. In 2000, we employed this robot as a sweeper which operated in a similar fashion to the goal keeper immediately in front of the goal area. During game play this robot was able to stop a number of long range shots, but was most effective as a tackling defender with its fast sideways motion making it very difficult to pass while dribbling.

## Communications Link

The communication link is a one way design giving the controlling computer the ability to transmit field state and strategic commands to the robots. The hardware design of the link is centred around the use of a RadioMetrix TX2 radio transmitter and RX2 radio receivers. These modules offer a serial data rate of 40 kbps, a useful indoor transmission range of 30m and are able to be directly interfaced to a TTL level signal. One of the weaknesses with this product is that the data slicer is optimised for signals with a 50:50 mark to space ratio. Our investigations found that the error rates quickly rose to over 20% for a 60:40 or 40:60 mark to space ratio, with a massive 80% error rate at the specified outer limit of 30:70 and a slightly lesser 50% for 70:30. The key factor for the use of these modules is clearly a protocol that maintains a 50:50 mark to space ratio.

The simple protocol we adopted for obtaining a 50:50 mark to space ratio is to transmit every byte twice, once in the usual fashion and once inverted. Upon reception, each byte is checked for parity error and for a match between the two copies of the transmitted byte. Any errors cause the entire 48 byte packet for that visual frame to be discarded. Under this protocol, detected error rates were kept below 2% in playing conditions - even when other teams using the same communication modules were having total communication loss. In testing in the lab, we were unable to generate any errors that were not detected by the error detection protocol.

## Navigation

The RoboRoos navigation system has been re-developed from those reported in [2] and [7]. The new module is based on the RanaC model of frog prey catching behaviour [1], which we have dubbed RanaR. The module is based on three radial potential field maps of the environment - Goal Direction (GD), Obstacle Map (OM) and Motor Heading Map (MHM). The GD representation is formed by the goal location received from the MAPS module. It takes the form of a Gaussian field centred on the goal direction. The OM representation is built from the robot position information received from the vision system, with each obstacle contributing to the field based on the heading and distance to the obstacle. The MHM is then built by subtracting the OM from the GD, and applying competitive attractor dynamics to smoothly select a distinct winner in the resulting potential field.

The distinguishing features of the RanaR model from the RanaC model are use of path integration to account for delay in sensory information, the use of pragmatic models of competitive attractor dynamics to achieve real time computation, and the inclusion of a speed module to determine the average speed of navigation for the given situation. The latter is essential for any wheeled system as the robot must slow to approach goals without overshooting, and should travel slowly in crowded regoins to allow faster response to potential collisions.

## RoboRoos 2001

If the RoboRoos are to become champions of the Small Size league, it is clear that serious revision of the mechanical design is required. The addition of a mechanical kicking mechanism adds several benefits to a robot soccer team. Not only is there potential for more powerful kicks, as demonstrated by the FU-Fighters, there is the possibility of one-touch passing and deflections as employed by Cornell Big Red in 1999, and Lucky Star II in 2000. It is far simpler to move to a point where the ball may be intercepted and wait to employ the kicking mechanism, than it is to attempt to navigate the robot through the moving ball. For this reason, the RoboRoos have great difficulty with any opponent who can keep the ball moving. In 2001, the RoboRoos will investigate kicking and dribbling mechanisms.

It is likely also that the RoboRoos will take advantage of new offerings in communication modules to improve communications bandwidth, use a faster off-board computer to improve vision resolution and explore new playing strategies using MAPS. While much of our research focus is now centred around our new ViperRoos [3] team, the RoboRoos will continue to offer technical and personal challenges to the undergraduates at the University of Queensland.

## References

1. Arbib, M.A. and Lee, H.B. (1993) Anuran visuomotor coordination for detour behaviour: From retina to motor schemas. From Animals to Animats 2: Proc of SAB, MIT Press.
2. Browning B., Wyeth G.F. and Tews A. (1999) A Navigation System for Robot Soccer. Proceedings of the Australian Conference on Robotics and Automation (ACRA '99), March 30 - April 1, Brisbane, pp. 96-101.
3. Chang M., Browning B. and Wyeth G.F. (2001) ViperRoos 2000, RoboCup 2000: Robot Soccer World Cup IV. LNAI, Springer Verlag, in this volume.
4. Tews A. and Wyeth G.F. (2001) MAPS: A System for Multi-Agent Coordination. Advanced Robotics, VSP / Robotics Society of Japan, accepted for publication.
5. Tews A. and Wyeth G.F. (2000) Thinking as One: Coordination of Multiple Mobile Robots by Shared Representations, Proceedings IROS 2000.
6. Tews A. and Wyeth G.F. (1999) Multi-Robot Coordination in the Robot Soccer Environment. Proceedings of the Australian Conference on Robotics and Automation (ACRA '99), March 30 - April 1, Brisbane, pp. 90-95.
7. Wyeth G.F., Browning B. and Tews A. (1999) UQ RoboRoos: Preliminary Design of a Robot Soccer Team. Lecture Notes in AI: RoboCup '98, 1604.
8. Wyeth G.F., Browning B. and Tews A. (1999) UQ RoboRoos: Ongoing Design of a Robot Soccer Team. Team Descriptions: RoboCup '99.
9. Wyeth G.F. and Brown B. (2000) Robust Adaptive Vision for Robot Soccer, Mechatronics and Machine Vision, Research Studies Press, pp. 41 - 48.