Knowledge Based Role Allocation

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Introduction

Robot soccer robots perform different roles to collectively make up a team. For the best performance it is vital that the robots be able to dynamically change roles so that they can perform the best actions possible while the team still collectively fulfills every role. There are many possible ways to perform this dynamic role allocation, however the nature of the problem is well suited to a knowledge-based system where each robot's suitability for each role can be described as a series of facts. The same knowledge-based system that performs this role allocation can be utilised to make strategic decisions for the entire team.

KOBRA

KOBRA is implemented in CLIPS and has been tested with the Java^{TM} based Teambots simulator using the JClips interface. During each iteration of the simulation, KOBRA is loaded with the positions of the ball, team robots and opposition. From this information the CLIPS system will determine whether to apply an offensive or defensive strategy and then allocates the optimum roles to the robots for the selected strategy. CLIPS determines which strategy and robot roles to use based on the knowledge-base or set of rules about the system. This set of rules is the actual body of KOBRA. KOBRA implements two strategies (offensive/defensive) that utilise the following roles:

- Goalie: Wait at goalie position and keep ball out of goal.
- Defender: Keep ball out of home half or wait at defensive position.
- Centre: Wait at the centre of the field.
- Attacker: Drive ball towards opponent goal.
- Supporter: Drive behind the Attacker.

The offensive strategy organises the team as: one Goalie, one Attacker, one Supporter and two Defenders while the defensive strategy has: one Goalie, one Attacker, two Defenders and a Centre.

Abstract

Robot soccer teams consist of a number of robots each performing a different role within the team. The roles discussed in this paper are: goalie, defender, attacker, supporter and centre. These roles are too often statically assigned to the robots at the start of the game. Knowledge-based techniques can be used to assign these roles dynamically to allow the team to adopt the optimal behaviour for each situation. Dynamic strategy choice can also be implemented within the same knowledge-based system. A strategy (defend or attack) can be chosen based on robot and ball location which in turn determines which roles should be used in play. Once the roles are defined, they will be assigned to the best robot for each role in turn based on role importance. Testing within the Teambot simulator shows a significant performance increase in score and ball control dominance over the same team with static role allocation. This poster presents the knowledge-based role assignment approach employed and the favourable results obtained.

The actual allocation of roles is performed in a priority structure. The role with the highest priority is assigned first to the most eligible robot for the job and works its way through the list. The allocation list for the offensive strategy is as follows:

- Assign the Goalie to a fixed robot.
- Assign the Attacker to the robot in the best position to drive the ball towards the opponents goal.
- Assign the Supporter to the closest robot to the ball.
- Assign the Defenders as the robots closest to the two defensive positions.

The defensive allocation list is very similar to this list with the exception that the Supporter role is replaced by the Centre role.

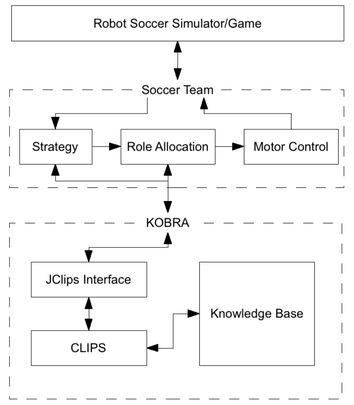

Figure 1: **A diagram showing the architecture of the KOBRA system.**

Figure: 1 shows the architecture of the KOBRA system and how it fits within a robot soccer team program. KOBRA is accessed by the soccer team system when making decisions about strategy and role allocation. The KOBRA system does not influence the actual behaviour of each role or the motor control of each robot. It simply allocates a previously defined role to the robot in the best situation to play that role.

Results

The KOBRA system has been tested by playing it against the previously implemented Massey University Team (MUT) and an updated Massey University Team (MUTU) both using static role allocation. These two teams were played against the KOBRA team with fixed offensive strategy (KOBRA O), fixed defensive strategy (KOBRA D) and the KOBRA team with strategy decisions (KOBRA S). The roles and behaviour of the robots are the same between the two teams, one simply uses the KOBRA system to make strategic and role allocation decisions. Table: 1 shows the results where the KOBRA and Massey columns show the score of each team and the Ball Control shows the percentage of time the KOBRA team has the ball in the Massey half.

TABLE I
PERFORMANCE COMPARISON OF ROLE ALLOCATION TECHNIQUES.

Teams	KOBRA	Massey	Ball Control
KOBRA S vs MUT	1	0	88.24%
KOBRA O vs MUT	2	0	75.19%
KOBRA D vs MUT	0	0	87.37%
KOBRA S vs MUTU	1	0	88.89%
KOBRA O vs MUTU	0	0	80.14%
KOBRA D vs MUTU	1	0	89.25%

Summary & Conclusions

During testing it was noted that the MUT and MUTU robots in defensive roles would drive the ball over the half way mark and attack until the ball was pushed away out of their control area, they would then turn around and return to their defensive position. Only the specified attackers would actually continue to chase the ball and try and score a goal. However, when the KOBRA defending robots were in the same situation, they would be allocated the role of attacker and would drive the ball towards the goal and continue to chase it even if the ball was stolen.

The KOBRA team can outperform the original MUT and MUTU robots in terms of ball control and score. The KOBRA system was observed to solve the problem of robots not taking full advantage of opportunities arising in the game. The KOBRA system is an improvement on the previous team and this research shows that knowledge-based systems are both viable and applicable to robot team coordination.

More information is available in "Knowledge-Based Role Allocation in Robot Soccer" published in the Proceedings of ICARCV 2008.