rUNSWift II:
The University of New South Wales RoboCup Simulation team

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Abstract. rUNSWift II is the soccer team for the Simulation League from the University of New South Wales. This team of autonomous agents attempt to collaborate in the soccer domain by using anticipation. As each team member has the same behaviour encoded in them, they should be able to anticipate its teammates next behaviour. When in defence, the team of agents will mark attacking players. Again they use anticipation to determine who they are going to mark, so that only one defensive player will mark each attacking player. rUNSWift II is based on CMUnited-99. rUNSWift, rUNSWift II's predecessor, competed in RoboCup2001 in Seattle. They came 4th in what was later acknowledged as a strong group.

1 Introduction

rUNSWift was developed by one undergraduate student for his honours project. Since an undergraduate student has limited time on an honours project, the team used by Carnegie Mellon University [1] was used as a basis for this team, so that high level functions could be concentrated on. Using the rUNSWift team that competed at as RoboCup2001 a basis, rUNSWift II was developed, using the techniques and strategies learnt at the competition. As well as the normal strategies and techniques of soccer play, rUNSWift II implements behaviours that are of research interest. A short description into these research areas follows.

2 Anticipation

To best cooperate with one's teammates, an agent must know exactly what its teammates are doing. If the intentions of the teammates are known, the agent can act accordingly to supplement the teammates actions. One method of knowing the intentions of one's teammates is by using communication. Another method is to predict or *anticipate* the intentions of the teammate.

All agents contain the same architecture, thus they have learnt and have the ability to perform the same behaviours. If two agents have the same world state, then they will both behave exactly the same. More importantly, if an agent has knowledge on the world state of a teammate, it can accurately anticipate the teammate's behaviour. So, for anticipation to be successful, a paradigm must be devised so that agents in a team are aware of each other's world states.

Sharing an agent's knowledge of the world state to its teammates is achieved through communication. An agent's belief of the position and velocity of all the moving objects is communicated to its teammates. The teammates could then couple their own behaviour definitions with the knowledge of the agent's world state, to accurately predict the agent's next action.

This paradigm of team coordination is much better than coordination through communicating an agent's intentions. In the Soccer Server domain team communication is unreliable [2]. Since the messages communicated are critical to coordination when communicating intentions, if any were lost, it would be devastating to the agents trying to coordinate their combined efforts. However, if a message was lost during coordination through anticipation, though not ideal, it is hardly critical.

This has been a main research focus for this team. However, due to the recent changes to the simulation used in competition, in particular, the changes to communication in the simulation, the agents will find it extremely difficult to relay its world state. This will mean that an agent will find it more difficult to accurately anticipate a teammate's behaviour. The focus will now be on how to share world states despite the restrictive communication model. If no solution is found by the time of competition, then the anticipation model will most likely be put aside. Despite this, research into anticipation is still intriguing, and has many useful applications in multi-agent systems, and will be developed out of competition.

3 Counter-Adversarial Behaviour

In the past, the winners of the games at RoboCup have won by very large margins. This can be attributed to techniques such as the *break-away* [1] and the like. This team was developed to smother the attacking opportunities of its opponents. The principle behind this behaviour is to restrict the opposition from scoring, and if the opponents cannot score, then the team cannot lose.

3.1 Adaptive Marking Assignments

One way to deny opponents scoring opportunities is to mark them. However, marking one attacking opponent with two defenders is useless and inefficient, as only one defender is needed per opponent. Also, this situation usually leaves another attacking opponent unmarked, and thus free to take advantage of any scoring opportunities. To make sure that only one defender assigned to one particular attacking opponent, communication may be used [1]. However, if the assignment on who to mark is lost due to the unreliable communication model, multiple defenders may still mark one opponent, or not mark any opponent at all.

The defenders of rUNSWift use their knowledge of the world states of the other defenders to determine which attacking opponent it should mark. This method of adaptive self assignment allows the agents to use the limited communication resource for other uses, such as communicating world states.

By assigning who to mark adaptively, defenders can also contend with teams that implement a Dynamic Positioning and Role Exchange behaviour [4]. Even when the opposing team uses different players as their forwards at different stages of the game, the defenders of rUNSWift II will be able adapt and mark the correct players.

However, this method of adaptive marking assignments is flawed. If a defender has an incorrect world state of a teammate, or even a incorrect world state for itself, then it can easily assign itself to mark an already marked opponent.

3.2 Counter-Break-Away Behaviour

Offensive strategies from recent teams have used the *break-away* [1] to great effect. Attacking players who get into *one-on-ones* with the goalkeeper usually score. To counter this, rUNSWift defenders try to identify when a break-away is in progress. When a break-away is apparent, the defenders will endeavour to move into the break-away path as quickly as possible. As the attacking player must often use kicks to control the ball, the defender has a very good chance to overtake the break-away player.

4 Optimal Attacking Behaviour

The method of anticipation described above is particularly useful when the team has the opportunity to attack. A tactic used by this team is to pass the ball deep into the corners of the field in the opponents half. The forwards would then chase the ball, hopefully ending up behind the opponent's defense. If a forward can correctly anticipate a teammate's intention to pass the ball deep into the opponents half, then it can get in a position to get a head start to make the chase for the ball, and so increase the chance of getting to the ball before any opponents do.

As well as using anticipation, this tactic is greatly enhanced by using heterogenous players [3]. Although these type of players run out of stamina more rapidly than the default, homogenous players, the extra speed that they may possess allows them to chase the ball down much more quickly. A utility function that uses the different variables of the heterogenous players as parameters determines the most suitable player type to be a forward.

5 Comments and Future Work

Other than normal soccer strategies, rUNSWift II's success relies on how the agents are able to anticipate each other. But due to the current move to make the simulation more like human soccer, the anticipation method that was based on the old communication model is now unworkable. Further research must be made into how the agents can share their world states if rUNSWift II is to use anticipation in competition. Despite this limitation in competition, anticipation has many applications in multi-agent systems, and so continuing research can be made in this field using the full state option in the simulation.

6 Performance

The current version of rUNSWift II was tested against two teams for the purpose of qualification: Karlsruhe Brainstormers 2001 and Robolog Koblenz 2001. The table below summarises the results of those two games.

Table 1. The results of the games for qualification

Game Against	My Score - Their Score
Brainstormers	0-1
Robolog	8-0

References

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