Individual Tactical Play and Action Decision Based on a Short-Term Goal ~ Team Descriptions of Team Miya and Team Niken ~

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Abstract. In this paper we present descriptions of our two teams that participated in the simulator league of RoboCup 97. One of the teams is characterized by soccer agents that make individual tactical plays without communicating with each other. The other team is characterized by the use of an action-decision algorithm based on a short-term goal and current information. The two teams were among the best of 8 and 16 teams at the competition.

1 Introduction

A chess champion was recently defeated by a computer. What is the next challenging problem to be solved by a computer? Robot soccer is one of the relevant candidates for the standard challenging problems in Artificial Intelligence.

At the Faculty of Engineering at Kinki University, we constructed two teams of synthetic soccer agents and then participated in the simulator league of RoboCup 97(The World Cup Robot Soccer 97). In this short paper, we present technical descriptions of our two teams, Team *Miya* and Team *Niken*. Team Miya and Team Niken are characterized by *individual tactical play* and action decision based on short-term goals and current information. Many researchers often emphasize the communication between multiple agents. In a dynamically changing environment like a soccer game, however, there is not enough time for agents to communicate with each other and confirm their teammate's explicit intention. Furthermore, hostile agents interfere with the communication by "jamming" the other team's agents. Thus, we tried to invent agent-control algorithms which do not require the communication or any exhausting calculations.

2 Team Miya

2.1 Team Miya Objective

The main objective of our research with Team Miya is developing an agent model that satisfies the following two requirements. The first requirement is that the cooperative actions of the agents should be expressed in a simple form that can be modified easily. The second requirement is that the actions of the agents are quick and smooth under a real-time environment.

2.2 Architecture

In Fig. 1, we show the architecture of a soccer client program controlling an agent on Team Miya. A client program receives visual and auditory information, decides on an action, and *compiles* the action into a series of basic commands prescribed by RoboCup 97 regulations.

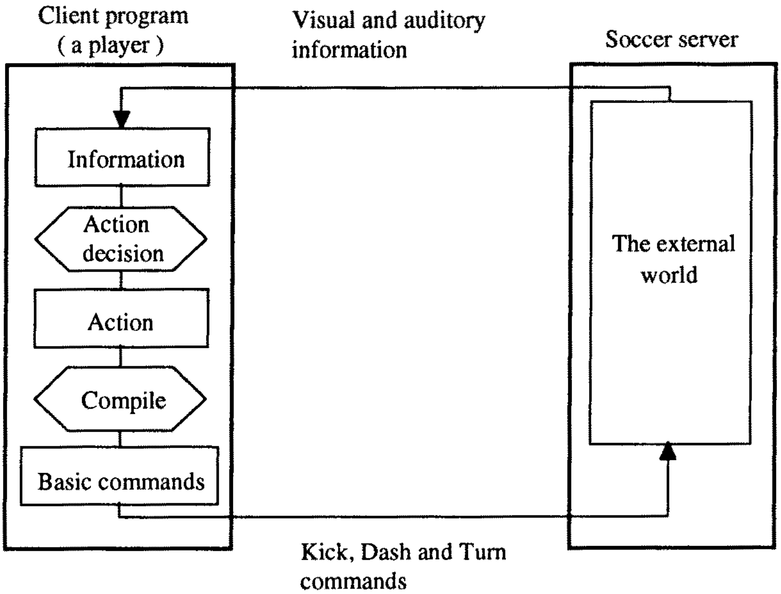

Fig. 1 The architecture of a client program controlling a soccer agent on Team Miya.

2.3 Hierarchy of Actions

The second feature of Team Miya is a hierarchy of actions. Actions are generally classified into four levels: strategy, tactics, individual play and basic commands (as shown in Table 1). A higher-level action includes more players and requires information in a wider range of time and space than a lower-level action. Coradeschi et al.[CK1] and Tambe[T1] expressed the relationship between actions as a decision tree. We call such a decision tree an *action tree*. A soccer agent selects an action from the action tree at each action cycle by analyzing visual and auditory information and by considering the agent's current state. The action is *compiled* into a series of basic commands: kick, turn and dash.

Table 1. A hierarchy of actions.

	Action	Definition	Examples
Level 4	Strategy	Cooperative team action.	Rapid attack, Zone defense
Level 3	Tactics	Cooperative action by a few players for a specific local situation.	Centering pass, Post play, Triangle pass
Level 2	Individual play	Individual player skill.	Pass, Shoot, Dribble, Clear
Level 1	Basic command	Basic commands directly controlling soccer agents.	Kick, Turn, Dash

2.4 Individual Tactical Play

The action tree contains information on compiling. Tactic actions, however, require communication between players and often slow the reactions of players in a real-time environment like a soccer game. Therefore we decided to remove tactics and introduce *individual tactical plays* into the action tree. The hierarchy of the modified action tree is shown in Table 2.

Table 2. The modified hierarchy of actions.

	Action	Definition	Examples
Level 4	Strategy	Cooperative team action.	Rapid attack, Zone defense
Level 2	Individual tactical play	Action of an individual player for a specific local situation without communication, but expecting cooperation from a teammate.	Safety pass, Post play, Centering pass
	Individual play	Individual player skill.	Pass, Shoot, Dribble, Clear
Level 1	Basic command	Basic commands directly controlling soccer agents.	Kick, Turn, Dash

Individual tactical play is introduced to reduce the delay time between decisions and actions. The individual tactical play is defined as an action that an individual plays in a specific local situation without communication from a teammate. But an agent expects some cooperation from a teammate in an individual tactical play. For Team Miya, we implemented three actions as individual tactical plays: the safety pass, the centering pass and the post play. The three plays speed up the tactical actions of the safety pass between two players, the centering pass from a wing player, and the post play of a forward player.

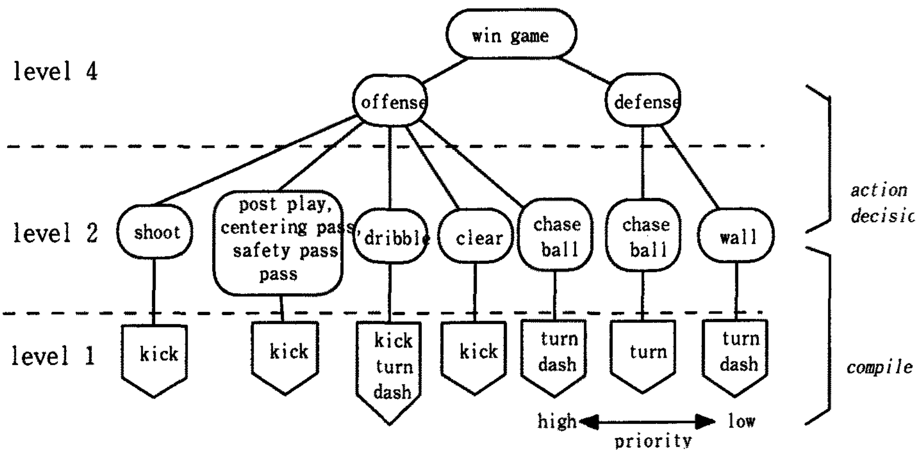

Fig. 2 An action tree used by Team Miya.

2.5 Action Tree

According to the role given to the agent, each agent will have its own action tree based on a modified hierarchy shown in Table 2. An agent's next action is specified by prioritized rules organized into its own action tree. An example of an action tree is shown in Fig. 2. In Fig. 2, if the node offense is selected, the firing conditions of action nodes at level 2 are checked from the left side to the right side. The more to the left, the higher the priority is. The action is compiled into a series of basic commands at level 1. The process of deciding an action at level 2, and the compiling procedure, were described as *action decision* and *compile* in Fig. 1.

2.6 Safety Pass and Safety Kick

The actions of level 2 are not unrelated to one another. The actions: shoot, centering pass, post play and dribble, consist of two basic skills, the *safety pass* and the *safety kick*. The *safety pass* is a skillful pass to a receiver so that it is not easily intercepted by the opponents. Pass direction determined by machine learning techniques is quite laborious[SV96]. But the effectiveness of a learning system may depend on its learning data, in this case, the opponents' behavior. For this reason, we use the following rules to determine which teammate to pass to. First, the distance between passer and receiver should be larger than 8 and smaller than 25. Second, a receiver should be forward of the passer and in the visual field of the passer. Third, the angle D, which is an angle between a receiver and the nearest opponent, should be more than five degrees. These three conditions are illustrated in Fig. 3.

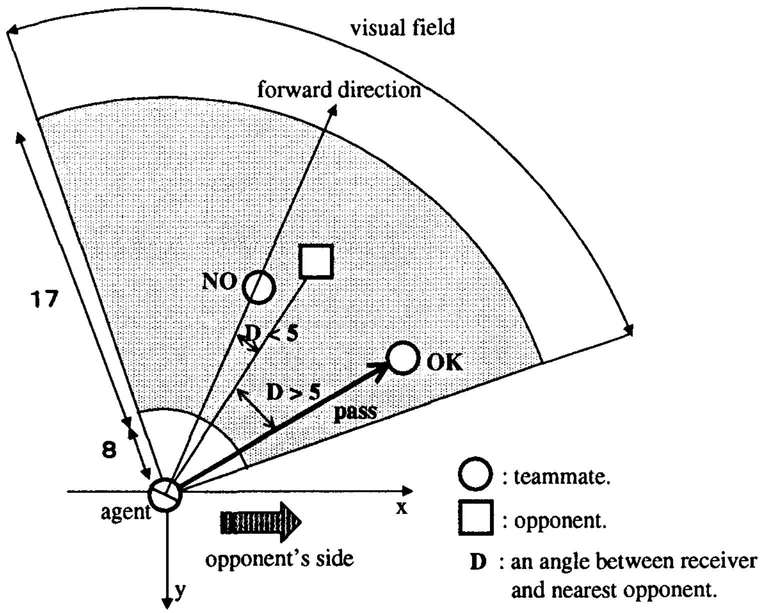

Fig. 3 *Safety pass* used by Team Miya.

The *safety kick* is a skillful kick, without being intercepted by the opponents, in the direction of the objective. In Fig. 4, an agent has a visual field with an angle of 90 degrees in its forward direction. An agent will kick a ball in the forward direction. As illustrated in Fig. 4, we divide a region with an angle of –35 degrees to +35 degrees in the forward direction into seven equal fans. An agent searches the seven fan regions for opponents and selects the fan that has no opponents and is closest in the forward direction. The agent kicks the ball into the center of the selected fan region.

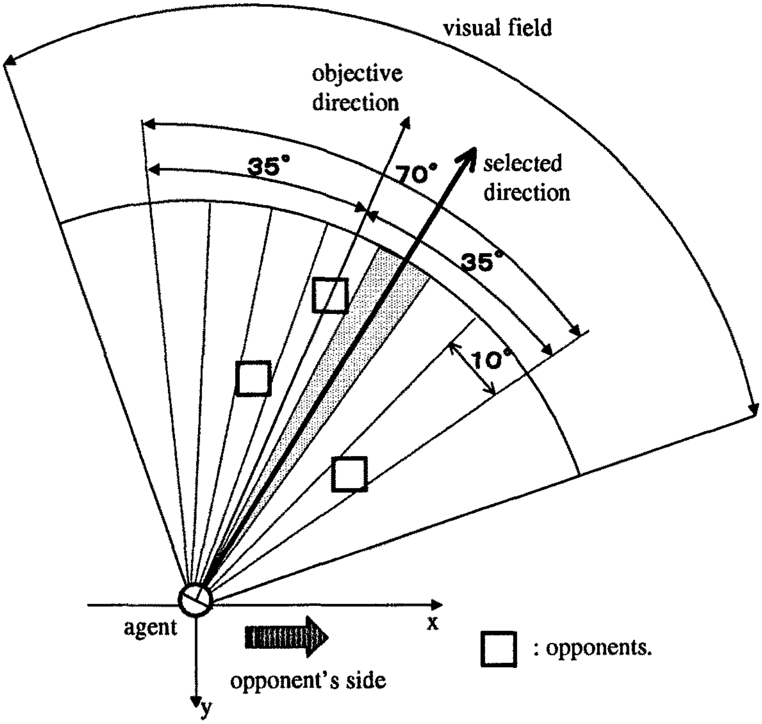

Fig. 4 *Safety kick* used by Team Miya.

2.7 Team Miya Results at RoboCup 97

In an algorithm used by Team Miya, information for controlling soccer agents is expressed in an action tree. It is easier to change an agent's control due to the action tree expression. In addition, individual tactical plays do not require communication between players, so the speed of passing was rapidly increased in RoboCup 97 games, and the team sometimes behaved as if it had been taught some tactical plays. Team Miya proceeded to the quarterfinal match and was one of the best 8 teams in the simulator league.

3 Team Niken

3.1 Technical features of Team Niken

Team Niken has the following three technical features in order to speed up reactions and increase flexibility in action decision. First, an agent decides on an action on the basis of a short-term goal and current information. Second, the agent's short-term goal is determined by a hierarchical decision tree called a *goal tree*. Third, Team Niken adopts only simple individual skills for quick reactions. In some cases, an agent passes a ball in a fixed direction specified by the role of the agent.

3.2 Overview of an agent system in Team Niken

An agent's behavior on Team Niken is shown in Fig. 5. Each soccer agent receives visual and auditory information from a soccer server. A short-term goal in the lowest level of the *goal tree*, defined in the next section, is determined by the current information received from the soccer server. When an agent receives a set of new information, it decides the next action from the current short-term goal and the new information. In Team Niken, information in the past is used to symbolize a current short-term goal and is used to decide an agent's next action.

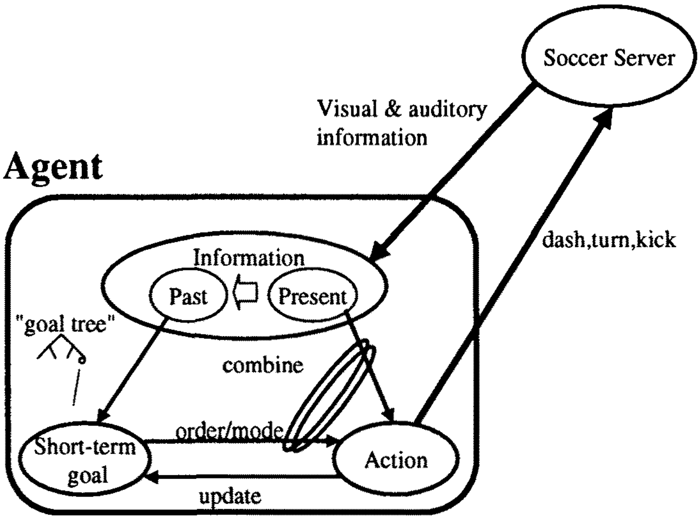

Fig. 5 Overview of an agent system used by Team Niken.

3.3 Goal tree

For Team Niken, we use a *goal tree* (Fig. 6). However, a goal tree is not the action tree used by Team Miya. For the goal tree in Fig. 6, nodes in the lowest level represent short-term goals the agent has to try to achieve. An agent selects a short-term goal from a goal tree by using the current information received from the soccer server agent.

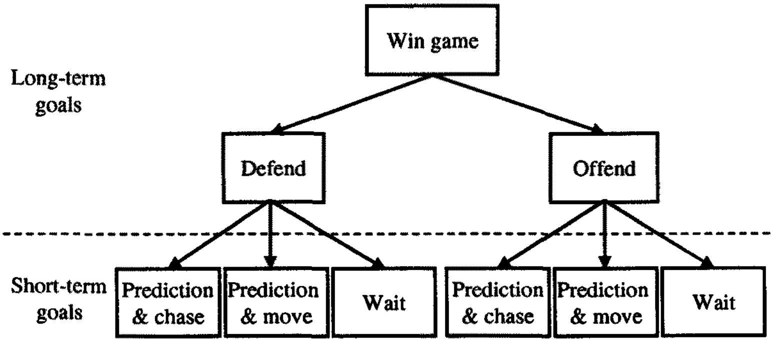

Fig. 6 A *goal tree* used by Team Niken.

3.4 Short-term Goals

The short-term goals used by Team Niken are summarized with definition and objective in Table 3.

Table 3. Short-term goals used by Team Niken.

Goal	Definition	Objective
Prediction and chase	A player predicts a position where the ball will stop and moves there.	Increasing the probability of getting the ball.
Prediction and move	A player predicts a ball's motion, decides on a profitable position, and moves there.	Better positioning for offense or defense.
Wait	A player does not move until the current short-term goal is updated.	Retaining stamina and avoiding an unnecessary chase for a moving ball.

3.5 Team Niken Results at RoboCup 97

Agents on Team Niken showed very quick responses to dynamically changing situations. Team Niken passed the preliminary round and proceeded to the final tournament. As Team Niken lost the 1st round game of the tournament, it resulted in one of the best 16 teams in the simulator league of RoboCup 97. We used only simple individual actions in Team Niken to speed up agent reactions, but we soon realized that more systematic team play is necessary to win games against the high-level teams at RoboCup 97.

4 Summary

Team Miya and Team Niken were designed to quicken reactions in a dynamically changing environment. Therefore, all of the client programs for the 11 agents ran and worked well even on a single workstation at RoboCup 97. However, we believe that our next goal should be the creation of a team of client programs equipped with Artificial Intelligence techniques such as machine learning, inference and coordination in a multi-agent system.

References

[CK1] Coradeschi, S., Karlsson, L.: A decision-mechanism for reactive and cooperating soccer-playing agents. Workshop Notes of RoboCup Workshop, ICMAS 1996.

[T1] Tambe, M.: Towards Flexible Teamwork in RoboCup. Workshop Notes of RoboCup Workshop, ICMAS 1996.

[SV96] Stone, P., Veloso, M.: Using machine learning in the soccer server. Proc. IROS-96 Workshop on RoboCup(1996)19-27.