The Reactive Motion Planning in the Passive Situation

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Abstract. The HAARLEM[1] is a team of the agents which is designed to play soccer. It is put emphasis on decision of behavior in the passive situation and it is set importance on the defense. The tactics of soccer are classified into three levels, individual tactics, group tactics and team tactics. The feature of the defense is embodied in the level of group tactics. The effectiveness of the tactics were demonstrated in the RoboCup-97, because the goal against was relatively low.

1 Introduction

In the world in which multiple agents behave, the agents are distinguished to two types. One is active agent which has initiative action. The other is passive agent which doesn't have initiative action. This distinction of two types varies dynamically in each situation and the degree of initiative also varies dynamically in each situation. The passive agents need to select reactive motion to the behavior of other agents.

The tactics of soccer are classified into three levels.

1. Individual tactics:
   The action of single player in each situation
   Free-running, pass, shoot and dribble, etc.
2. Group tactics:
   Effective combination and application of individual tactics as a group in the situation of both offense and defense
   Combination play, one-two pass, etc.
3. Team tactics:
   How to attack and defend as a team
   Fast attack, man-to-man defense, zone defense, etc.

This paper describes how the behavior of the passive agent is decided in each level.

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[1] The team name HAARLEM is originated from the team name to which the famous Dutch player "Ruud Gullit" belonged.
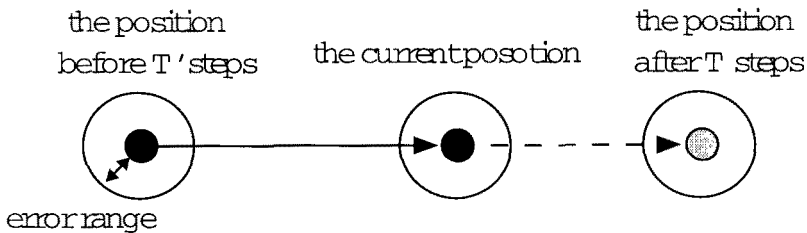
2 Individual tactics

2.1 Free-running to capture the ball

In the situation when an agent must touch an object, for example, the rescue at a fire or an capture of an animal, the agent needs to predict the motion of the object and to get ahead to the predicted position. In the soccer this situation corresponds to the case when the player chases the ball.

When the player is going to kick the ball, the distance between the player and the ball needs to be short. The ball seldom approaches to the player from itself. Usually the player has to approach close to the ball. The player can capture the ball more effectively by predicting the motion of the ball and by getting ahead to the predicted position than by chasing the ball directly.

In the designed system, the client corresponding to the player decide how many steps does it take for the player to catch up the ball according to the distance between the player and the ball. The client also predicts the position of the ball after T, where T is simulation step in Soccer Server, steps by the use of the absolute velocity calculated by the two past position of the ball (Fig.1). The client approaches the ball while modifying the predicted position with every time that the client recognizes the visual information.

the position
before T ' steps   the current posotion   the position
                                                                 after T steps

error range

Fig. 1. The predicted position of the ball

2.2 Pass

Like to dribble, to pass is one of the fundamental play to move the ball in the soccer. The client needs to find the straight line to the pass course to avoid colliding the obstacles,that is, other players. To find the course,first, the client will prepare the circles as other players' sphere of influence. The center of the circle is located at the position of each player and the size of radius of the circle is proportional to the distance between each player and the ball. Second, the client draw the tangent lines to the circle. Because there exist two tangent lines to a circle in general, there emerges a region surrounded by two lines and

the circumference. If the center of the circle corresponds to the position of the opponent, the region means where the client must not pass the ball. Conversely,if the center corresponds to the position of the mate, the region means where the client may pass the ball. Third, when there exist more than one region where the client may pass, the client choose one out of them according to the distance between the mate and the goal, the distance between the mate and client itself and the size of the region (Fig.2). Finally, as soon as the client finds the pass course to the mate, the client tell the position to the mate with the *say command* and actually pass the ball by *kick command*.
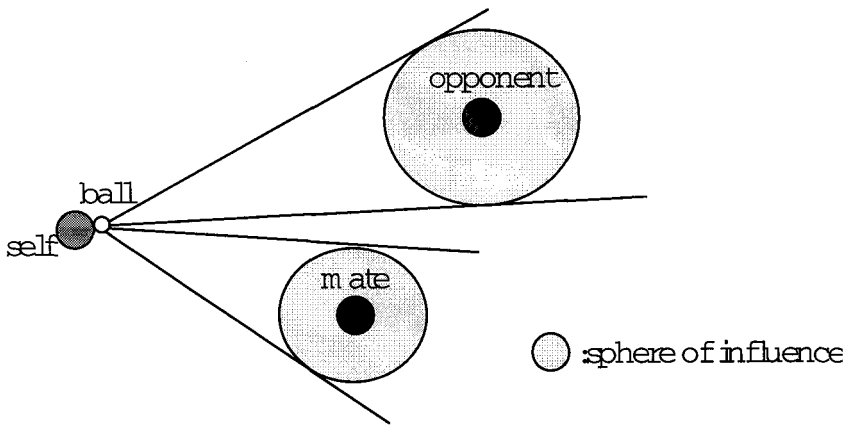

Fig. 2. The passable region and unpassable region

3 Group tactics

It is important that the multiple agents should have the purpose in common and should make appropriate actions in the multi agent system. In soccer game, the case in which the multiple agents have the purpose in common in the passive situation is often found when the team have to defend the goal, that is, in the defensive mode. It is required that the defense have to react properly against the actions which the opponent made in real time. The defense has a major purpose to defend the goal and at the same time it has several sub purposes, for example to recapture the ball, to close the shoot course of the opponent and so on. The agents have the major purpose in common, but they may change the sub-purpose according to the situation. The skill of the defense can be so easily evaluated whether they have points lost or not.

This system concentrated on the defense in front of the goal. The designed system prepared several patterns of formations concentrated to the center in

order to keep more players of the mate than those of the opponent just before the goal. The system selects the pattern of formations in Fig.3 according to the position of the ball, that is, whether the ball comes to the side or to the center. Fig.3 (a) shows the case when the ball is, at the left side near the center, (b) show the case at the right side near the center, (c) show the case at the left side near the touch line and (d) show the case at the right side near touch line. The formation enables to close the shoot course of the opponent or the pass course into the penalty area.
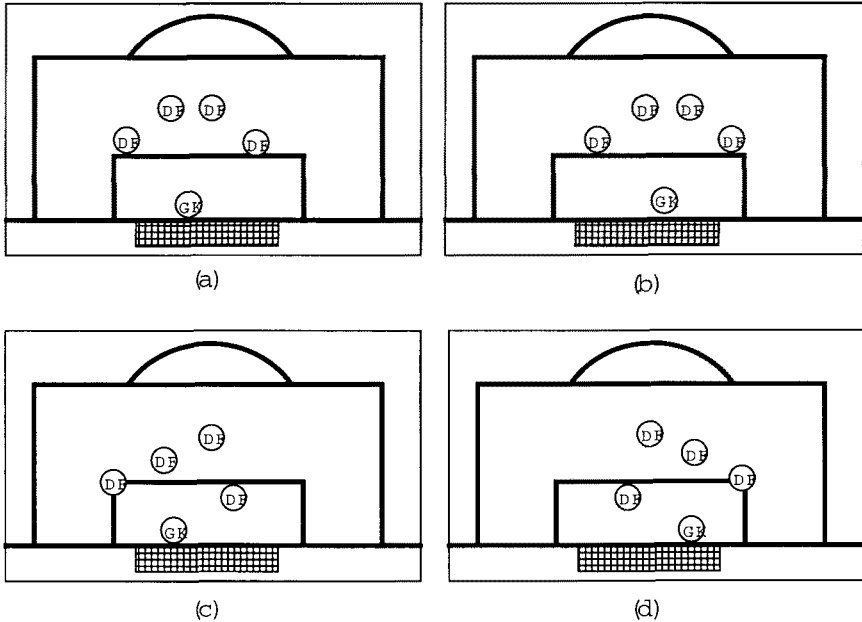
Fig. 3. Defense formation

4 Team tactics

It is important that the roll of each agent can be changed dynamically in the multi-agent system. The designed system can change the roll of the agent in the play by having many elements in common other than the basic position of the player and the priority of the decision of action. In the system, the strength of the opponent might be estimated by the difference of the points obtained and the points lost. The system can change the formation the number of the defense in the middle of the play according to the strength(Fig.4). Because the

system prepared two basic positions each corresponding to the offense and the defense, the players can keep from spreading from the forward to the defender and the distance from the backmost player and the frontmost player can be kept relatively short,thus the more players can be present.
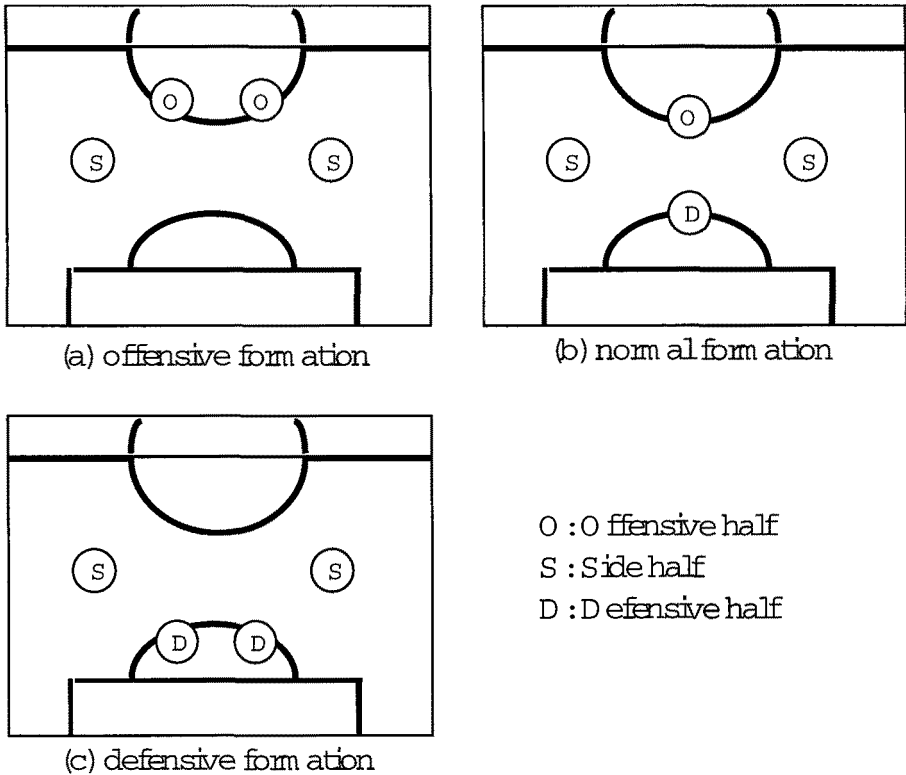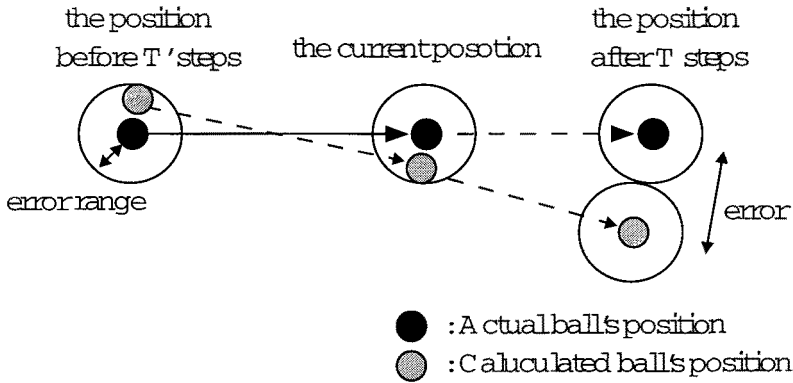

(a) offensive formation

(b) normal formation

(c) defensive formation

O : Offensive half
S : Side half
D : Defensive half

Fig. 4. The formation in the middle of the play

5 Results

5.1 Individual tactics

The designed system calculated the absolute velocity with the use of only two past positions obtained by the visual information. But visual information contains some error, there emerged the difference of the predicted position and the actual position. Then, the designed system often predicted wrong positions(Fig.5).

the position
before T' steps   the current posotion   the position
afterT steps

error range

error

● : Actual balls position
◉ : Caluculated balls position

Fig. 5. Error in the predicted position of the ball

5.2 Group tactics

The system selects the prepared patterns of formations. While the selection was made only based on the numerical information, the formation tends to collapse when the ball comes near to the border.

5.3 Team tactics

To keep the distance from the backmost player to the frontmost player shorter, it is often required that the players run back and forth on the field. As a result, the stamina of the player tend to be exhausted. In RoboCup-97, the system gave the players a few seconds' break in out of play mode to recover the stamina.

6 Conclusion

As a whole, the system was successful in reducing the points lost. But the prediction in the free-running in the individual tactics was slightly wrong, then the points lost were much more than expected as a result.

References

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