TOWARDS TO AUTOMATIC TACTICS' ANALYSIS IN SOCCER*

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Abstract

One of the main problems in soccer is to coordinate in real time scale collective behavior of team members, who solve a common task by solving individual tasks. The specificity of the problem consists in the fact that soccer players with their collective and individual skills, individual behavior and incomplete knowledge of the environment and limited resources should succeed in reaching the common goal in dynamically changing game.

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Keywords: spatial reasoning, formal spatial situation description, intelligent soccer tactics' analysis

1 Introduction

Soccer players act in time and space inside an unpredictable environment that often complicates team work. When organizing a team play, the main task is to provide coordinated actions of players, all trying to realize their individual actions. Thus, behavior of soccer players as a team is a more complex phenomenon than coordinated individual actions of separate athletes.

At present we are building a digitized soccer match analysis tool and implementing situation patterns in a real soccer match. Our research started from interviewing soccer coaches in order to understand their interpretation of detailed spatial situation description. So we determined fuzzy linguistic variables set and defined formal description of a spatial situation.

The objective of this study was to create an Intelligent System of Tactics' Analysis (ISTA) in a group of interacting players in game situations and during tactical training exercises

2 Methods

To create ISTA, we used multi-agent technologies and fuzzy semiotic models to control individual agent. According to the adopted terminology we use the word "agent" instead of "soccer player". Three layers were distinguished in a cognitive agent: physical actions, individual behavior and coordinated behavior.

When analyzing team work of a multi-agent system, one should take into account that it is organized with the help of the group (team) plan of actions of the agents. This plan has the following peculiarities.

1. The group plan requires the consent of the group of agents to follow some instructions in the group actions.

2. The agents should take responsibilities in respect of their individual actions and the activity of the group as a whole (individual intentions about how to act).

3. At the same time, the agent should take responsibility in respect of the actions of the other agents (coordinated intention).

4. The plan of the group activity may include plans of individual agents for the assigned actions and plans of the subgroups.

Spatial situation on a soccer field is described by determination of spatial relations between players, ball and goal. We might not calculate dimensions of these objects, but accept that a soccer player is <middle-sized>, the goal is <big> and the ball is <small>. Determination of static spatial relations (e. g. relations of directions and distance) is shown on picture below (Figure 1; the same approach as used in [1], [2]).

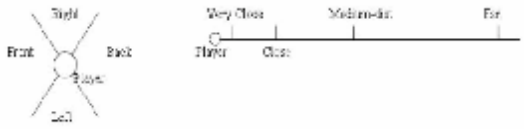

Figure 1: Spatial relations (distance, directions).

Then we've added the speed of each player and the ball. Possible speeds are <standing> (0 m/s), <walking> (<2 m/s),<jogging> (from 2 to 4 m/s),<running>

(from 4 to 5,8 m/s),<high speed running> (from 5,8 to 7 m/s) and <sprinting> (>7 m/s). This information is taken from previous time step (while building a spatial situation description we need current and previous coordinates of the players and the ball).

There are many typical spatial situations on a soccer field. Formal Spatial situation description defines a "pattern" abstracted from objects coordinates using qualitative spatial data. We are trying to recognize 'local' situation double-pass etc., and predict movements of each player during realization of this game pattern. Two players can play together having determined the same spatial situation pattern, without sending any messages (as players in real soccer). So if a player "knows" that his role is "assistance" in double-pass pattern, he will pass back to first player after catching the ball. In other case he will do something ignoring his partner

We are building formal situation description for each 0.1 second of a soccer match (digitized record of a real human match). Then we are using qualitative spatial reasoning to determine the game pattern, which exists on the field at the moment.

Hierarchy of tactical group actions in soccer consists of tactical variant, tactical scheme, and tactical combination.

In our work we recognized the following combinations: in attack - wall pass, pass to a third player, scissor movement; in defense – counteraction to wall pass, counteraction to the combination "pass to a third player", covering. Tactical schemes consisting of several tactical combinations were registered: in attack – run and center, run through the center, flank run with pass to the other flank; in defense – man-to-man marking, zonal marking, horizontal and vertical displacement.

The system ISTA was adapted in order to work with Qualisys motion capture camera with high-speed video "Oqus" (Qualisys AB, Sweden), that permitted to create a database of game combinations for the learning sample of the artificial neural network. To complete computer training support tool, which deals with digitized match record database and automatically recognizes pre-defined situation pattern, now we use fully-defined spatial situation description, while human players do their spatial reasoning using some dominant objects. We are to provide an algorithm to cut unnecessary spatial relations and objects from agent spatial situation description.

3 Results

Using this approach for processing video records of matches played by teams of different qualification permitted to identify some patterns in tactical actions of the teams used in a match. We have analyzed 4 games of the leading European club teams (group A), 5 games of the Russian national youth team (16 yrs) in the European championship of 2006 (group B), 5 games of Second Division teams participating in the regular Russian championship (group C).

Our study permitted to reveal some specific features of tactics organization in teams of different qualification during official games. Data presented in Table 1 and Table2 demonstrates that teams of the group A used less diverse tactical schemes ($P < 0.05$), but repeated the same scheme more often ($P < 0.01$) in a game, than teams of the groups B and C. Team-work in defense was more often used in the group A, than in the other two groups ($P < 0.05$). It should be noted that reliability of team actions in defense was considerably lower in the groups B and C, than in the group A.

Table 1: Group tactical attacking actions with % success rate for different qualification teams

	Number of schemes	**Number of repetitions**	**%**
Group A	6±1,1	31±3,5	20
Group B	9±2,1	18±2,1	40
Group C	8±3,1	12±1,3	50

Table 2: Group tactical actions in defence with % success rate for different qualification teams

	Number of schemes	**Number of repetitions**	**%**
Group A	4±0,2	20±3,1	80
Group B	3±0,2	15±4,3	60
Group C	3±0,7	12±2,4	50

Data displayed in Table 3 revealed formation of tactical schemes in attack and distribution of tactical combinations by 4 zones of the field.

Table 3: Number of group combinations in a single scheme of attack and their distribution by field zones

	Number	**Zone**			
	of	**1**	**2**	**3**	**4**

	combi-nations				
Group A	4±0,2	5	25	30	40
Group B	3±0,2	10	40	35	15
Group C	3±0,7	30	50	20	10

Zone 1 – one quarter of the field around the penalty area of attacking team, zone 4 - one quarter of the field around the penalty area of defending team, zones 2 and 3 – in the center of the soccer field on the sides of attacking and defending teams correspondingly. Players of the group A used more combinations during the realization of a single scheme ($P < 0.05$), than players of lower qualification (groups B and C). It was found out that teams of higher qualification improved interaction in immediate proximity of the opposing goal (group A - 40% in the zone 4), while less qualified teams organized most of collective actions on their own half of the field (group B - 40% in the zone 2; group C – 50% in the zone 2). The lack of sufficient technique preparedness of players of the groups B and C must have prevented them from reliable performance on the opposing half of the field in case of active defense of the opponent.

4 Conclusions

Digitized data (e.g. coordinates of players and ball) can easily be used for automatic tactics' review of match or training process. Usage of ISTA coach assistant is the way to raise effectiveness of training.

Given results was highly commended by real soccer coaches, since ISTA is the way to reduce time spend for match review and it is the way to equitably analyze tactics of both teams. Furthermore we have revealed the following tendencies in organization of team and group actions in soccer. Less qualified teams improvise more during the game that interferes the use of collective actions. To organize team work effectively, tactics of a team must be determined by the chosen style of playing, based on minimal number of tactical variants and schemes. Nowadays we see perspectives in greater universality of players from the point of view of organization of group actions when tackling on the whole field.

Acknowledgement

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References

[1] Kandrashina E., Spatial and temporal knowledge representation in artificial intelligence, Radio I Svjaz, Moscow, Russia, 1989.

[2] Musto, A., On Spatial Reference Frames in Qualitative Motion Representation, FKI-Bericht Nr. FKI-230-99, Technische Universitat Munchen, Germany, 1999.