YuShan2021 Team Description Paper for RoboCup2021

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Abstract. This team description document introduces the research framework (the Simulation 2D Digital Twin Framework)of Team YuShan2021 and the work carried out based on the framework in the recent period. We build team portraits for different teams and compare the differences between different teams to find where we are weaker than strong teams. We analyzed the kick data by frequency statistics, and found out the key areas of different teams' offenses to re-divide the football field area . we also analyzed the pass data through a clustering algorithm to describe the offensive strategies of different teams.

1 Introduction

YuShan Soccer 2D Simulation Team was established in 2009, affiliated with AnHui University of Technology in China. Having participated in RoboCup for six times since 2012, YuShan was ranked 4th in the RoboCup2019 in Sydney, Australia and won three consecutive championships in RoboCup China Open Tournaments from 2016 to 2018. In recent years, YuShan has been employing data mining in the analyses of different team characteristics and further proposed the Digital Twin Framework in 2019. Some results have been achieved until now in formation, player movement, passing analysis, shooting strategy, offense and defense judgment, etc. The development of YuShan2020 is dependent on YuShan-Base drawing upon the reconstruction project of Agent-2D 3.1.0 [1], mainly including attack module and defense module.

2 Three-Layer Architecture of the S2DDTF

YuShan put forward the Simulation 2D Digital Twin Framework (S2DDTF) in 2019 and builds portraits for each team with it and YuShan2020 is further optimized by it. As shown in Fig. 1, the S2DDTF has three layers: the physical layer, information layer and digital twin layer. The physical layer is responsible for generating and managing the binary, with the information layer processing and analyzing log files, whereas the digital twin layer establishes team portraits and feeds back the differences between the portraits to the physical layer to find a new direction of R&D [2]. With the S2DDTF, YuShan analyzes the gap between itself and other strong teams in shooting, passing, formation and physical strength so as to adjust the tactical strategy of the team in time and improve the performance of the team’s attack, defense and stability of passing and receiving the ball.

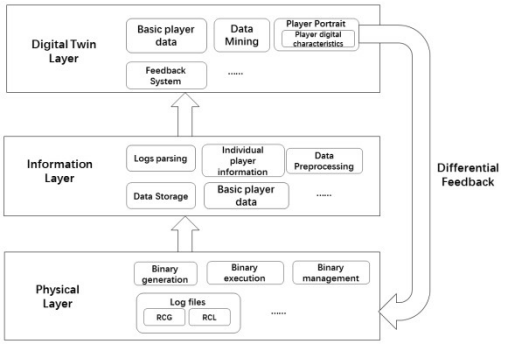

Fig. 2.1 YuShan2020' three-layer architecture of the S2DDTF

3 Analysis of Key Areas of Offense

Helios2019 extracted kick data by processing log files, and analyzed the similarities of kick data from different teams to find the commonness between teams[3]. There are some similarities and differences between different teams in offense and defense, which is the key to the victory over opponents in a game. Therefore, some strengthened defense in key attacking areas may lead a team to prevent more goals from being scored by the opposition. YuShan used to find weak defense areas and key offense regions by watching a lot of videos, which is strenuous and time-consuming. It would be more scientific and reasonable to apply data mining to the analyses of weak defense and key offense areas according to the characteristics of each team. Based on this, YuShan has conducted in-depth research on the problem of targeted defense in key areas of attack for different teams.

In the process of researching teams' key attacking areas, there are steps as follows:

Step1: map the players' offense path and their passing relations through log files.

Step2: fit the ball position distribution on the attacking paths and divide the field.

Step3: obtain the teams' key offense areas by self-adaptive density-based clustering algorithm for ball positions in different areas.

Step4: attain defense strategies via comparing the diagrams of key players' passing sequences and the mappings of key offense areas.

YuShan first parses log files of the games and extracts information from the RCG and RCL files about where the ball is when our players issue the kick commands, and then YuShan links the coordinates of the ball positions in all offense action chains to get a team's chain of offense moves (see Fig. 3.1(a) for a team on the left side).

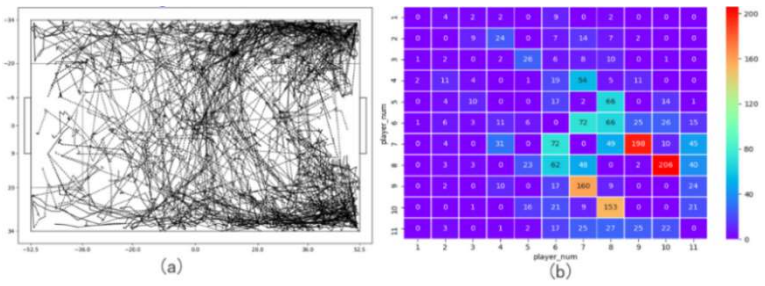

Fig. 3.1 The team's offense action chain and passing thermodynamic diagram

Fig.3.1(a) shows that the team's action chains cross more in the side areas of its opponent's half, indicating that driving down the opponent's side-lines and centering the ball obviously in front of the penalty area is the team's main attacking strategy. Seen from Fig.3.1(b), players 7 and 9, 8 and 10 have the highest passing

frequencies, so players 7, 8, 9 and 10 should be payed closer attention in the game.

3.1 Field Division

The traditional way of field division (see Fig.3.2(a)) is not by the distribution of ball positions; however, the action chains of the teams suggest that the teams' offense paths have different focuses, that is, the positions of the ball are not evenly distributed in the whole field, and there is a big gap between different areas. In light of this, YuShan calculates the teams' key areas of offense by a dynamic field-partition algorithm.

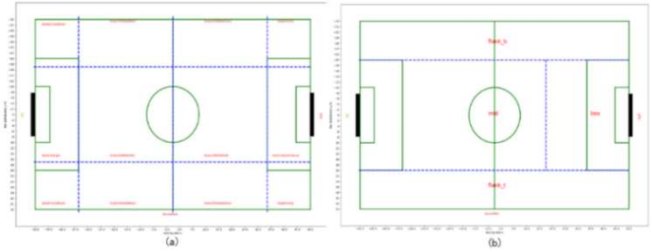

Fig.3.2 Field division diagram

Here the ball position coordinates projected onto the X-axis and Y-axis separately are first collected from the attacking action chains. Then data distributions of vectors X and Y are fitted by Gaussian kernel function, the results of which are shown in Fig.3.3. The field is divided with reference to Fig.3.3. (see Fig.3.2(b)).

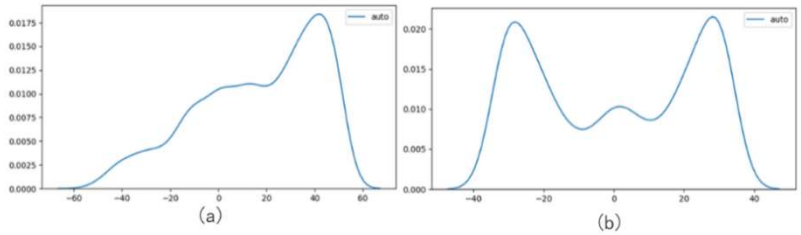

Fig.3.3 Data distribution of X-axis and Y-axis

3.2 Key Offensive Area Analyses

With the dynamic field division method, the whole field is divided into four regions, i.e. flank_t, flank_b, mid and box (see Fig.3.4) through data distribution with each part clustering the teams' key offense areas by parameter adaptive DBSCAN algorithm. Triangles, triangles, circles and squares respectively represent the clustering points in each region.

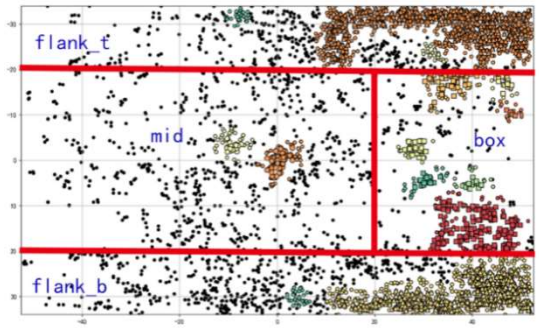

Fig. 3.4 Region-division result by parameter adaptive clustering DBSCAN

3.3 Defensive Strategy Analyses

At the physical layer, YuShan selects Hfut2019 (National Competition) as the benchmark to compete (ten games per team) with Alice, MT2019, YuShan_NB and YuShan2019 respectively.

At the digital twin layer, the fitting results of ball positions on the offense action chains by Gaussian kernel function are presented in Fig.3.5. The data distribution of different test teams and the calculation results of adaptive Eps and Minpts in different regions are shown in table 3.6.

Table 3.6 Adaptive Eps and Minpts values

Team A – Team B	Area(x, y)	Eps	MiniPts
Hfut2019-Alice	mid(x<30,|y|<20)	3.4	19.18
	box(x>30,|y|<20)	5.1	39
	flank_t(y<-20)	2.15	26.03
	flank_b(y>20)	2.79	27.35
Hfut2019-MT2019	mid(x<20,|y|<20)	3.07	30.59
	box(x>20,|y|<20)	2.33	18.85
	flank_t(y<-20)	3.2	25.28
	flank_b(y>20)	2.43	21.36
Hfut2019-YuShan_NB	mid(x<30,|y|<10)	2.94	28.97
	box(x>30,|y|<10)	2.5	18.89
	flank_t(y<-10)	4.38	34.56
	flank_b(y>10)	2.72	15.14
Hfut2019-YuShan2019	mid(x<30,|y|<20)	4.14	36.97
	box(x>30,|y|<20)	3.59	10.08
	flank_t(y<-20)	1.74	18.28
	flank_b(y>20)	3.28	27.91

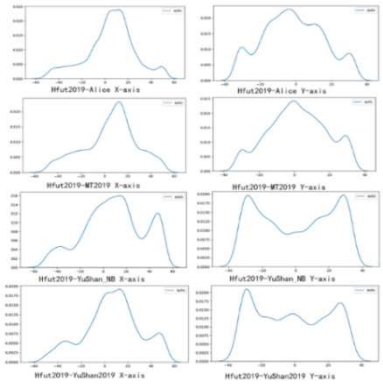

Fig.3.5 Data distribution of different teams

YuShan first divides fields of each pair of test teams by data distribution and conducts adaptive DBSCAN clustering within each sub-field to obtain their crucial attacking areas, and then YuShan maps the passing sequences of some key players (over 70 passes to each other) via the passing thermodynamic diagrams (see Fig.3.7 where Hfut2019-YuShan_NB is the analytic object.).

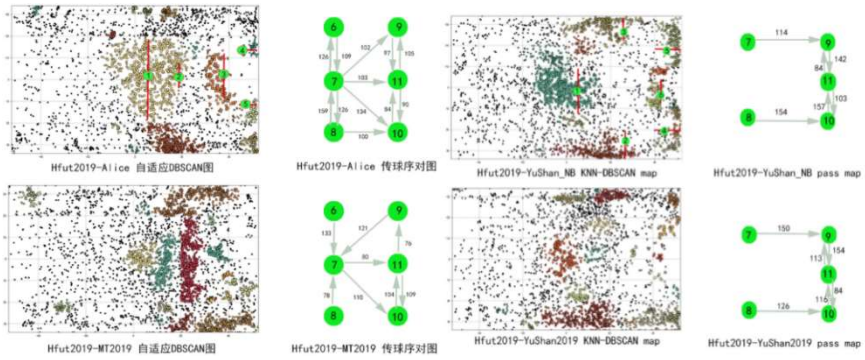

Fig.3.7 Adaptive DBSCAN and passing sequence diagrams

Hfut2019 employed similar strategies when competing with YuShan_NB and YuShan2019, and Hfut2019's offense characteristics can be captured as follows according to Fig.3.7:

(1) Players 7 and 8 pass the ball to the forwards 9 and 10, dribbling along the side to the penalty area.

(2) Players 9, 10 and 11 cooperate relatively more closely in the attacking.

According to the offense portraits, it is proper to adjust the players' base points for a three-tier defense by us (see hfut2019-yushan2019 KNN-DBSCAN map in Fig.3.7):

(1) The strikers might be appropriately withdrew to the "1" zone for engagement in midfield defense; (2) Some midfielders might be placed in the "2" and "3" areas to prevent opponents from dribbling along the sides to the penalty area; (3) Near the penalty area, the remaining midfielders and some defenders might be put in the "4" and "5" zones to block passes, and the rest in the "6" zone to stop shootings.

4 Summary and Prospect

On the basis of S2DDTF, YuShan2020 initially builds the teams' overall portraits and also the portraits of players' interception, attention and offense paths with the employment of HFO open-source tools, and then analyzes the portraits' differences, which guides the R & D of the base codes and effectively improves the overall performance of the teams. Besides, YuShan will further build more comprehensive team portraits, combine human football game [5] with soccer simulation 2D and discover their common patterns. Finally, we would like to express our sincere thanks to Hidehisa Akiyama, Mikhail Prokopenko and others who promote the 2D Alliance over the years.

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