

# YuShan2018 Team Description Paper for RoboCup2018

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## 1 Introduction

YuShan Soccer 2D Simulation Team was established in 2009, affiliated to Anhui University of Technology in China. Since 2012, we have taken part in WorldRoboCup four times and RoboCup China Open eight times. Among them, we have got the seventh place in Mexico World RoboCup2012, the third place in WorldRoboCup2013, the sixth place in both WorldRoboCup2014 and WorldRoboCup2015, the second place in RoboCup China Open2016 and the third place in WorldRoboCup China Open2017. YuShan is unique and distinctive, with its cutting-edge technology to make it more powerful.

The development of YuShan2018 is based on the Agent2D-Base in version3.1.0. (Further information can be accessed via the downloading address[1].).

## 2 Overall Framework

In the overall framework of YuShan2018, we determined the strategy according to the player's position. There are two types of players: With balls and without balls, as shown in Fig.1 and Fig.2[2]. On the one hand, offense module has increased the number of executions of back and dribble and improved action balance of Pass and Dribble effectively. On the other hand, attack module has optimized forward's position by expanding the condition of the original player's position. Defense module has optimized the action decision by inference engine.

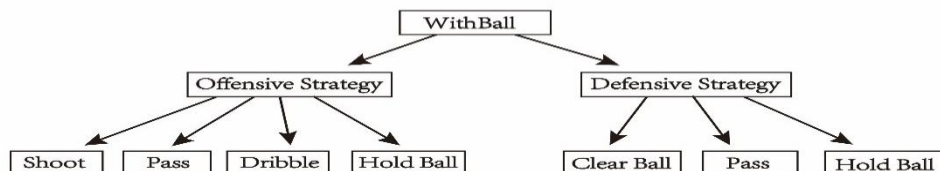


Fig.1. WithBall Strategy

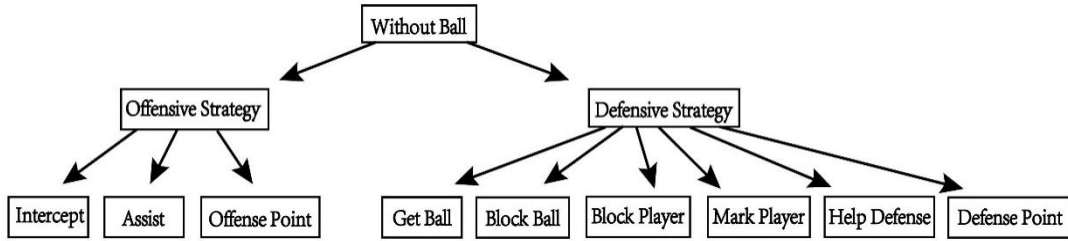


Fig.2. WithoutBall Strategy

In view of the fact that Python is now widely used in data mining, YuShan has generated the action chain diagram of each team by using data mining based on Python. For example, the action chain for Helios2017 is shown in Fig.3. The characteristics of each team can be analyzed and optimized by the action chain diagram. The results of analysis and optimization are discussed in detail below.

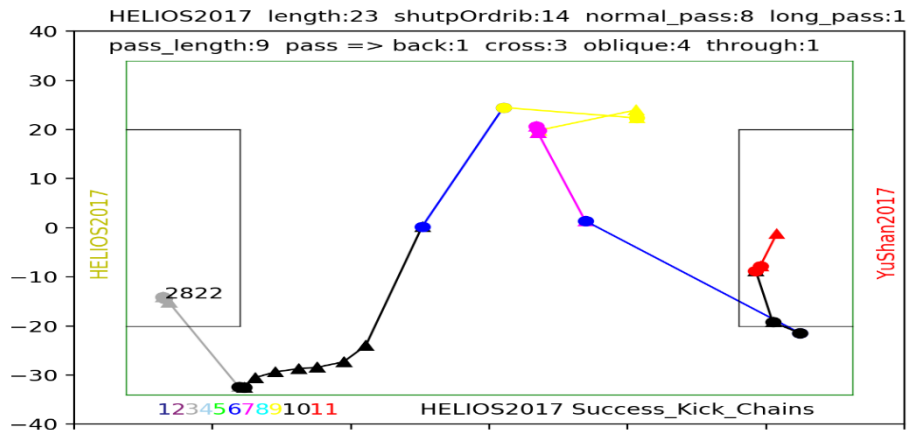


Fig.3. HELIOS2017 Success Kick Chains

### 3 Offensive Module

In the Offensive Module, YuShan2018 has done the optimization work in three aspects including forward's position, back, dribble and action balance of pass and dribble.

#### 3.1 Optimization of Forward's Position

The selection of forward's position directly affects the offensive quality. YuShan found that the high quality of the offensive also lies in holding the defensive line and maintaining a defensive position by analyzing. Agent-2D is modeled by using the Delaunay Triangulation Principle and it determines the position of the player according to the attributes of the ball. As shown in Formula.1, Position refers to the basic position of players. However, in actual games, it is necessary to consider various factors. So, YuShan2018 has chosen four main factors and we changed the formula.1 to formula.2. Ball\_attribute has these parameters: *ball\_vel* attribute, *ball\_pos* attribute, *ball\_posCount* attribute and *ball\_velCount* attribute.

$$\left\{ \begin{array}{l} \text{Position} = f(\text{ball\_attribute}) \\ \text{ball\_attribute} = \{ \text{ball\_vel}, \text{ball\_pos}, \text{ball\_posCount}, \text{ball\_velCount} \} \end{array} \right. \text{(Formula.1)}$$

$$\text{Position}=f(\text{ball\_attribute},\text{mate\_attribute},\text{opp\_attribute},\text{area},\text{role}) \quad (\text{Formula.2})$$

### 3.2 Reinforcement of Pass the Ball Behind and Dribble

According to the analysis of Helios and WrightEagle, both of them have more dribbles and longer action chains than other teams, so, they have higher quality of offense. YuShan2018 has reinforced these two actions and it has generated longer action chains by modifying evaluation function. So, it has improved the quality of offense.

### 3.3 Action Balance of Pass and Dribble

Pass and Dribble action frequencies have a great influence on the attack success rate. In general, at the bottom of agent, the execution of pass action is preferred. We found in some areas, like the midfield and off-limits. However, the appropriate increase of dribble movement can greatly improve the quality of attack. So, in offensive module of YuShan2018, the success rate of offense has been further improved by adjusting the pass actions.

## 4 Defense Module

The basic defense module of YuShan contains the following modules: *Block* Module, *Intercept* Module, *Get-Ball* Module, *Mark-Opp* Module, *Go-Home-Position* Module, etc. In a traditional defense module, the use of decision tree for candidate defense makes the code large and difficult to maintain. On the basis of this, YuShan2018 has introduced the inference machine to the defense module, and a new formation research method is proposed. This section elaborates on these two parts.

### 4.1 Introduce the Inference Engine into the Defense Module

The Inference Engine is used in the offense module at the bottom of the Agent-2D and good results have been achieved. Therefore, YuShan2018 tries to introduce the inference machine, similar to Chain-Action, into the defense module. The candidate for basic defensive action has been generated by the evaluation function[4]. Such function is manifested by the Formula.2 in section3.1. WrightEagle used the Hidden Markov Model Inference Engine, and it has also achieved good effects in games[5]. Because of the large target reasoning space, it is very difficult to make the best choice in a limited time. Fortunately, the kind of Inference Engine solves the problem very well. So, YuShan learns and draws on the solution of this Inference Engine. YuShan expects to be able to promote communication through games and make some contributions to the 2D alliance.

### 4.2 The Research about New Formations Models

The formation is of great significance to the selection of defensive basic points. Different teams have different strategies of formation. The player's stance strategy is the basis and key of formation. More concretely, the position of player is not only related to the attributes of the ball, but also needs to be taken into consideration of other factors and can finally be determined by an

evaluation function. The influence of player's position includes the following factions: *ball-attribute*, *mate-attribute*, *opponent-attribute*, *area* and *roles*. Specific details have been elaborated in section3.1. Based on this, YuShan tries to explore and analyze the information such as the range of activity and area density of each player, through modeling by Delanuary Triangular subdivision method. By using Matlab the simulation of the formation analysis data of each player on the field is realized. Based on the characteristic of Chebyshev Neural Network and BP Network, we put forward the research method of formation strategy learning based on neural network learning. YuShan2018 tries to apply the method to the new defensive strategy[6].

## 5 Data Mining and Analysis in YuShan2018

YuShan tries to find out Hidden Patterns in accordance with game log files. YuShan2018 consults open source analysis software which was uploaded to GitHub (This software is from, the original tool package is offline and we re-upload)[7]. We use this software based on Python to analyze data. Meanwhile, this is the basis of data mining.

### 5.1 Generating Action Trajectories by Data Mining

Through data analysis players' action trajectories are able to find team's weak spots: A defender place in the player's movement which is the most intensive compound of the team defense. Conversely, the players lacking of local defense are weak, and opponents maybe break through the area. Fig.4 is a test version of player's trajectories. Fig.4.b shows that the circled position is a set of points and lines in the most intensive area, where as the circled position in Fig.4.a is the area where points and lines are the sparsest. Furthermore, the area is also the most vulnerable place to defend. YuShan2018 has already made great progress in scoring efficiency than YuShan2017. (YuShan2017 is China Open Binary in 2017)

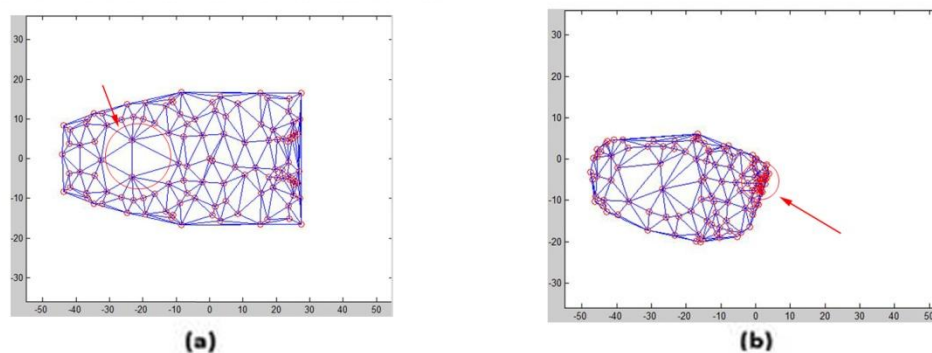


Fig.4.Weaknessof Defense Formation

### 5.2 Kick Model Analysis

Team's offensive strategies can be expressed by different types of action classification. YuShan divides the distance attributes of the pass into three kinds. As shown in Formula.3 and Formula.4:

$$\text{Distance} = \sqrt{(Origin.x - Destination)^2 + (Origin.y - Destination.y)^2} \quad (\text{Formula.3})$$

$$\text{Kick Mode by Distance} \begin{cases} \text{Dribble: } Distance < 6 \\ \text{Normal\_pass: } 6 \leq Distance < 30 \\ \text{Long\_pass: } 30 \leq Distance \end{cases} \quad (\text{Formula.4})$$

YuShan 2017 has tested 50 games with the top eight of the World Cup in each. The data in Fig.5 is the result of these game logs. Data Mining can help greatly in this process. From Fig.5, the average numbers of YuShan are: 13.52 dribble, 3.8 normal\_pass and 0.091 long\_pass. The number of pass in the field is significantly different from that of any top three World Cup team in 2017. Therefore, the balance of pass and dribble has got a correction by optimizing evaluation function to reduce the proportion of dribble. This optimization obtained satisfactory results.

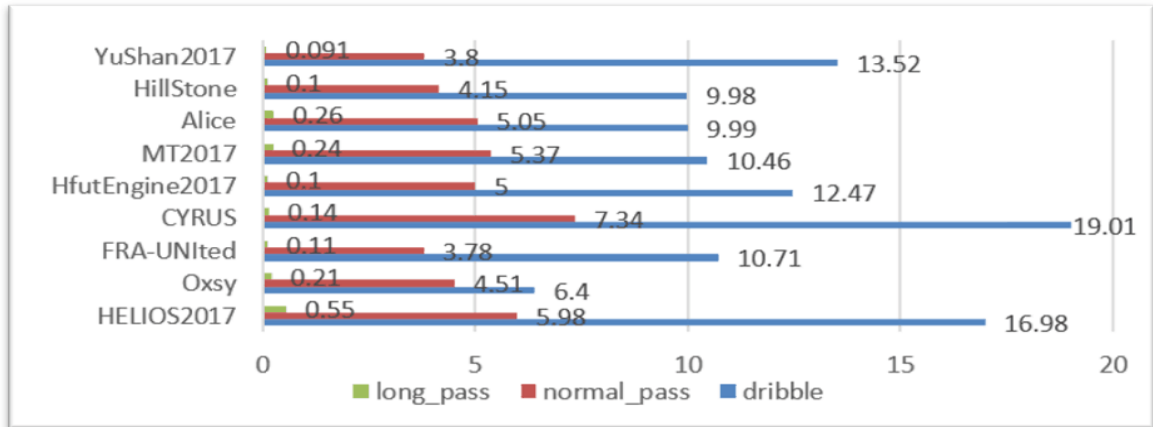


Fig.5.Divide Statistics by Three Kinds of Pass Chain Length

### 5.3 Data Mining by Passing Angle

In the analysis of the pass chain, it has been found that the pass chain had great impact on the team's offense. The length of the pass chain is positively related to the rate of the ball control. As a result, the longer pass chain is, the higher ball control rate will be. Generally, the chain length of a stronger team is longer than other teams. The pass chain can also reflect the fluency of the offense in a team. Meanwhile, the team's discontinuity point somewhere can be used to analyze defensive points or weak points of the offensive side. Based on this, YuShan analyzed the data from pass chain that we collected. We selected the passing angle as the evaluation criterion and subdivided its attributes into following (Formula.5 and Formula.6):

$$\text{Relative angle: } |\theta| = \text{atan}^2(\text{Origin.x} - \text{Destination.x}, \text{Origin.y} - \text{Destination.y})$$

$$\text{if } (|\theta| > 180) |\theta| = |\theta| - 180$$

(Formula.5)

$$\text{Pass Mode without Dribble} \begin{cases} \text{Backpass: } 110 < |\theta| \\ \text{Crosspass: } 70 < |\theta| \leq 110 \\ \text{Obliquepass: } 30 < |\theta| \leq 70 \\ \text{Throughpass: } |\theta| \leq 30 \end{cases} \quad (\text{Formula.6})$$

Data Mining results are shown in Table.1, which suggests that the number of back pass and through pass is almost less than that of all the teams that we tested in YuShan2017. Because of the large proportion of dribble, the number of pass reduces. It is found in the analysis that the appropriate back pass can increase the team's offensive quality. However, YuShan2017's pass times affects the quality of offense to a certain extent. In current evaluation function, the closer a player is to the goal position, the higher the evaluation value leads to the reduction of the back pass. The current evaluation model is largely based on the Formula.5, YuShan2018 hopes to change the evaluation function. This function can be evaluated comprehensively to realize the balance between dribble and pass when the players offense and increase the back pass appropriately. YuShan has carried out further research[8].

**Table.1.**Data Statistics table

Team	back pass	cross pass	oblique pass	through pass
HELIOS2017	1.31	1.57	1.97	1.69
Oxy	0.52	0.86	1.69	1.66
FRA-UNited	0.78	0.82	1.16	1.12
CYRUS	1.48	2.54	1.87	1.59
HfutEngine2017	0.56	1.35	1.86	1.33
MT2017	0.61	1.68	1.97	1.35
Alice	0.53	1.45	1.87	1.46
HillStone	0.42	0.93	1.56	1.34
YuShan2017	0.26	0.97	1.57	1.09

## 6 Conclusion and Future Works

YuShan has made some positive progress in using the data analysis system based on Python. YuShan hopes to discover the hidden patterns in 2D through deeper Data Mining. The big data set, released by Oliver Obst in 2017, has played an important role in the development of the 2D alliance. We would like to express our sincere gratitude to Hidehisa Akiyama and Oliver Obst for their many years' selfless dedication to 2D alliance.

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