GDUT_TɪJɪ 2011 2D Sɪᴍᴜʟᴀᴛɪᴏɴ Tᴇᴀᴍ Dᴇsᴄʀɪᴘᴛɪᴏɴ Pᴀᴘᴇʀ

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Abstract: GDUT_TiJi participated the RoboCup China Open since 2006, in the past several years; we got the second and third prizes in China Open. Before 2011, we used UvA_TriLearn as our base code, this year we are trying to use the agent2d as new base code. In this paper, we will give a briefly introduction of GDUT_TiJi 2011 and our work based on agent2d, including the strategy of goalie, the structure of defensive, and some improvements of offensive. In the end, we will conclude our effort since we use this base code and describe the future research direction.

● 1 Introduction

GDUT_TiJi was established in the early 21st century by Prof. Yang Yi-min, who is the leader of Intelligent Robot Laboratory(IRL) in Guangdong University of Technology, also he is the vice director of the committee in RoboCup China Open. RoboCup Soccer 2D simulation is the first project we founded in IRL, with the rapid development of RoboCup, we also have TiJi_3D, TiJi_rescue, TiJi_Middle Soccer, TiJi_NAO teams now.

GDUT_TiJi 2D simulation team now is mainly directed by Prof. Chen Wei, besides of former graduate students, we imported several undergraduate students after RoboCup China Open 2010. Meanwhile, this year, we use agent2d as our base source. In the past year, our major effort was training new members and up on the agent2d base source, what's more, we have some improvements on low and high level of the whole team, which will be mentioned later.

In the second part we will introduce the construction of GDUT_TiJi 2011; the third part discusses the formation of the team; the fourth part shows some improvements of defensive system; the fifth part comes to offensive improvement, at last, we will conclude our major work and discuss the future research direction.

● 2 Structure of GDUT_TiJi

In the past several years, GDUT_TiJi used UvA base code, while we choose agent2d as new base code for GDUT-TiJi 2011, which generally contains 2 packages:

agent2d-3.1.0 (http://sourceforge.jp/projects/rctools/releases/?package_id=4887)

librcsc-4.1.0 (http://sourceforge.jp/projects/rctools/releases/?package_id=3777)

Librcsc-4.1.0, in fact, it is a base library for RoboCup Soccer 2D simulator, which can be used as a framework for a simulated soccer team. There are many basic defining of the simulation soccer team, including the model of players, the connection of team to server, the calculation and defining of the playground, etc. Whereas the agent2d is a sample team program using librcsc,

new teams of RoboCup 2D simulation can use this package to develop their own soccer team.

Agent2d provides a more comprehensive structure for team building. The field is reached to 10 partitions, and the players in the field is also decided by the role its performs, each player is corresponding to relevant role, that means each player will be activity in its own field, every moment the player will make decision based on its position, its role, its formation position and the outside environment.

The version 3.1.0 of agent2d is different from former version such as 3.0.0, 2.1.0. In version 3.1.0, players make decision mainly use the methods defined in the file of "chain_action", which is particular in version 3.x. So the whole structure of version 3.x is mainly as figure 1:
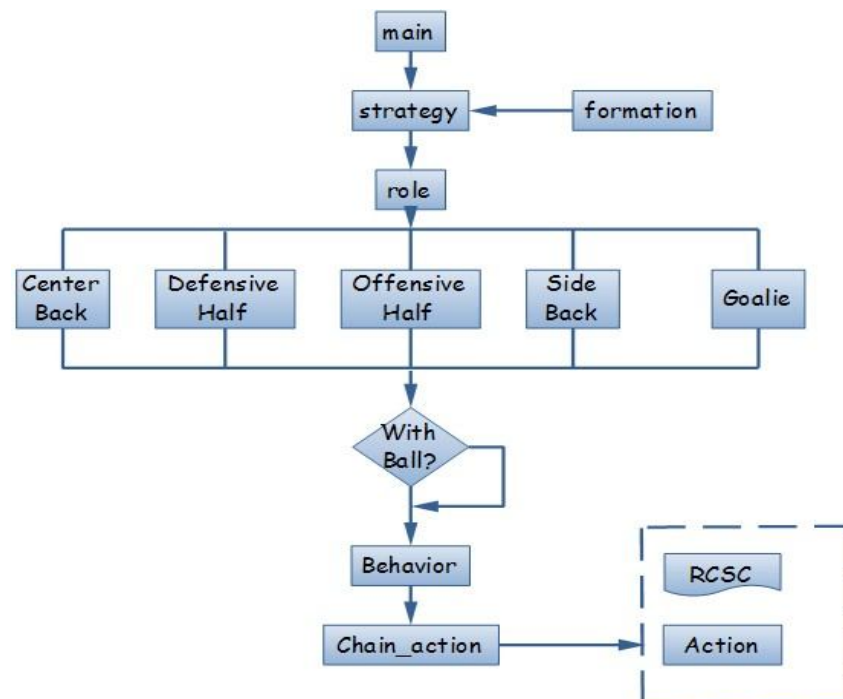

Figure 1 structure of GDUT_TiJi 2011

- **3 Formation**

Every soccer team will have various formations in competition, in agent2d base code, each player have a position mechanism which ensures players to a certain position whether it is in defensive or offensive situation. HELIOS offer a formation editor tool called fedit2-0.0.0 for developer to modify the formation of soccer team, as Figure 2 below.

Fedit2 Download address: http://sourceforge.jp/projects/rctools/releases/?package_id=11389.
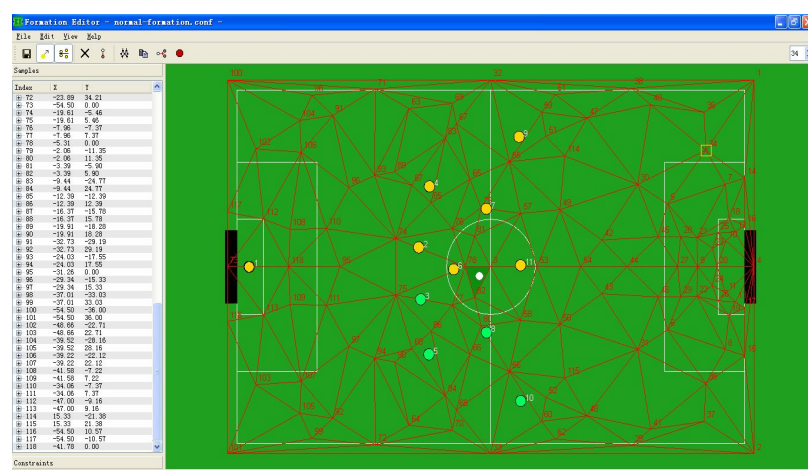
Using this tool, we can easily modify the formation for soccer team. In GDUT_TiJi 2011, first we changed the before-kick-off formation. Agent2d base code designed the formation mainly according to Constrained Delaunay Triangulation (CDT), after our experiment and analysis, we found the normal formation was not precise enough, and sometimes it cannot lead players to a proper position, so we modified the formation, and recruited the positions of players by experience, at the end, the number of the ball's position comes to 118, that means there are 118 groups of positions for players in normal formation. What's more, we tuned some players' positions to make sure they can make decision much swiftly and be closer to ball. By the same time, we also changed defense formation, corner-kick formation by analysis and experience.

- **4   Defensive**

Section 3 we discussed the formation editor tool, it is undeniable that the formation editor tool would be helpful for soccer team, in defensive situation, we tuned the positions of players to make sure players can be more cooperative and make swift decision. In this part, we will show what we done in defensive situations, first we designed the block, mark, tackle actions into our team, then reconstruct 5 roles such as center-back, defensive-half, offensive-half, side-back and side-forward. The defensive decision mainly based on the areas of ball and players besides situation. Due to the importance of goalie, in the end, we optimized the strategy of goalie.

4.1   Defensive strategy

Here we will introduce 3 situations in defensive which mainly used in our team.

✓   *Side defensive*

We enhanced the side defensive, when opponent player with ball come to the back side of ours, defensive players should break the offensive of opponent in due course, and reasonable cooperation will be more important. As Figure 3 shows, red No.10 with ball comes to our back side, yellow No. 4 will execute block action while yellow No. 7 will help its teammate to cut off opponent's path of pass, other yellow player which would be nearer would actively mark opponent players.

Figure 3 side defensive

✓   *Penalty defensive*

It is very important to enhance the penalty defensive of soccer team; a casual mistake would be the best chance for opponent. Our penalty defensive mainly optimized the duty for each role player. First, when opponent does not come to this area, defensive player must prevent

them, especially opponent player who with ball. While, if opponent player comes to penalty area, defensive players must try to cut off the path of pass for opponent, using block, tackle actions, but it is not safe to use tackle action for it might be punished if tackle is not properly executed. So an optimal tackle action here is needed. To help strength the defensive, powerful mark action will be more helpful, which mainly be used to opponent players who are near to their teammates that with ball. If opponent player who with ball just comes to penalty area, defensive player must decide what action to execute by the position of each self and opponent players, sometimes giving up the block action and go back to join new defensive would be more useful.   Figure 4 shows the penalty defensive of GDUT_TiJi 2011.

Figure 4 Penalty defensive

✓ *Corner-kick defensive*

Corner kick is powerful for offensive; accordingly, defensive when corner-kick is quite harder not only related to position of opponents and ball, but the joint of actions of mark, block and tackle. After experiments we found mark will solve this problem more. So in defensive of corner-kick, first we changed the position in normal formation of team, make sure the players get to a more forceful position, and then we used mark action to break the cooperation between opponents. In this case, we can decrease the danger of opponent when their corner-kick. Figure 5 shows corner-kick defensive of GDUT_TiJi 2011.

Figure 5 corner-kick defensive

4.2 Goalie

We refreshed the goalie strategy in GDUT_TiJi 2011, aiming at rectifying the decision of goalie. In soccer field, the goalie is the last defensive line, while, there are quite a lot of chance that the

goalie must make correct and swift decision, especially when opponent player with ball reach the penalty area of ours. For an agent like goalie, it performs huge importance in the whole team. Our goalie strategy referred to HELIOS 2008, meanwhile, we have some improvements.

i. *Clear ball*

When opponent player who with ball attacks and the goalie get the ball, how to deal with the ball will be urgent. Whether passing the ball to teammate or clearing the ball will be more careful, in GDUT_TiJi 2011 we emphases some important areas for goalie to decide what to do, as in Figure 6, when the goalie get ball in area 1, while teammates are in area 3, 4, goalie should clear the ball, whereas teammates are in other areas of the left half field, goalie will pass the ball to teammate who are there; when the goalie get ball in area 2, it is opposite from the situation of area 1.
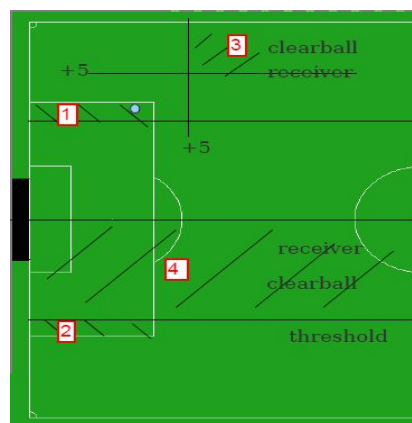

Figure 6 clear ball

ii. *Basic movement*

When opponent holding ball, goalie should move to right position to chase the ball, while when teammate holding ball, goalie will move all the same to wait for rational cooperative choice. However, the stamina of goalie is limited, when it is not the dangerous situation, overfull movement is not good for goalie. We set a proper district where goalie can move properly, otherwise, goalie will just reach the basic position designed by normal formation. As Figure 7 shows, the shadow area will be just the basic movement area, we also called it conservative area. When opponent holding ball reaches this area, goalie must choose a proper position to prevent opponent's offensive.
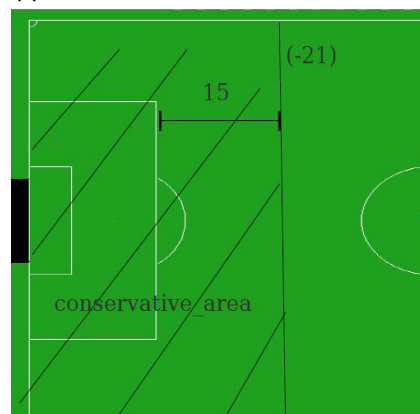

Figure 7 Basic movement area

iii. *Predict ball's track and direction*

Goalie should predict the track of ball if opponent holds ball and it will have chance to shoot. In Figure 8 & 9 shows the basic decision when it comes to the dangerous situation that opponent will shoot. Figure 8 shows the method of predicting ball's track that means which position the ball will reach. Figure 9 give us the idea of which direction the ball will move to.
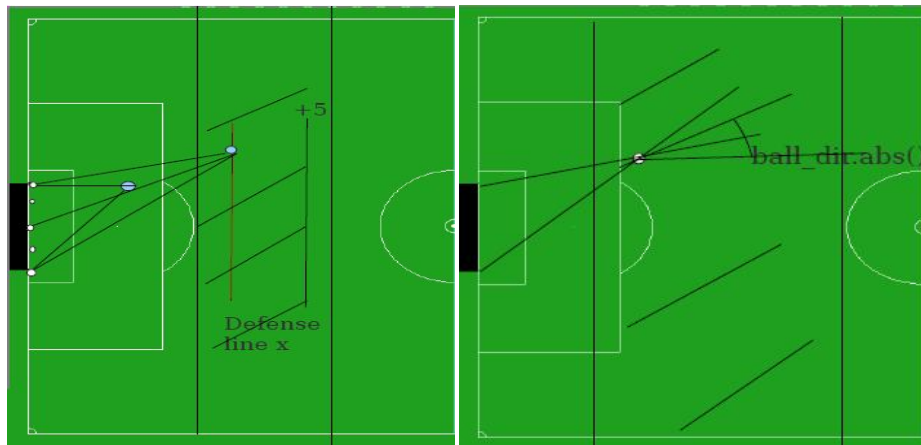

Figure 8 predict ball's trace   *Figure 9 predict ball's direction of movement*

iv. *Active defensive*

When opponent who holding ball get through the last defensive line, facing with goalie alone, it is very dangerous situation for a single mistake would lose. In GDUT_TiJi 2011, we set active defensive method for goalie. There are dangerous chase area and tackle area for goalie. Once opponent get through the last defensive line, if it is just in the dangerous tackle are, goalie will just tackle to break the offensive; while in the dangerous chase area, goalie will just chase the ball as soon as possible; while if the opponent and ball are all in the shadow area in Figure 10, goalie will get out of penalty are to break the offensive of opponent as early as possible. This is the active defensive for goalie. The detail of area distributing will be shown in Figure 10.
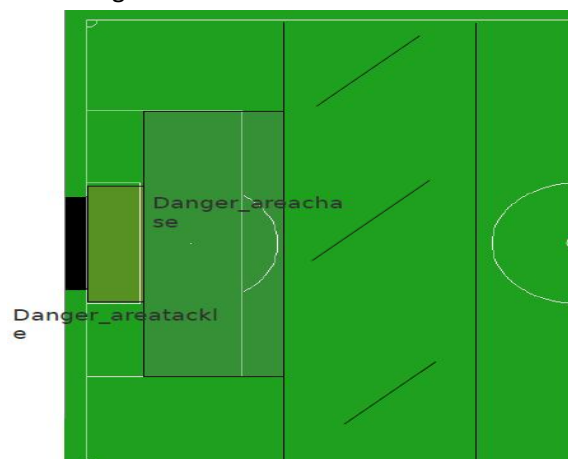

Figure 10 Active defensive area

● **5 Offensive**

Offensive is best defensive. By now, we have not completely finished the offensive decision. So in this part we just describe our idea of offensive which are under experiment but not yet finished. We are trying to finish these parts before the middle of August. As we introduced before, most decision making of agent2d-3.x will be packed up in the file called 'chain_action', where we must do more effort to solve the offensive strategy.

5.1 Shoot & Pass

Shoot is the best criterion to measure a soccer team, for more shoot means more chance to goal. That why every team will spend more effort to enhance the shoot action and the decision of forward player, we also prepared for the improvement of shoot. While it is preponderant for players passing ball correctly to teammates, and pass and shoot have more similar characteristic, so we are trying to use a new grade mechanism to improve both shoot and pass action. Especially when forward player who holding ball alone and only facing with opponent goalie, a more effective and active offensive shoot will be more powerful. That's what we are still trying to solving these days.

5.2 Position

Football is an cooperative game, whether offensive or defensive, it is not finished by single player. When offensive, one forward player holding ball, other teammate nearby should try to get a more advantaged position to attach them into the offensive. So a more effective predict model is under test. We aim at solving the position problem which can not only used in offensive but also anti-mark and anti-block.

5.3 Penalty kick

Penalty kick have already finished. Some basic setting in the base code has been modified. When it comes to penalty kick, the goalie decision and player decision are all reconstructed. By the competition before, we found it is useful and perform well in penalty kick.

- **6   Conclusion**

In this paper, we just described GDUT_TiJi 2011. First give a briefly introduction of our new base code- agent2d, including agent2d-3.1.0 and librcsc-4.1.0; then we introduced the formation editor developed by HELIOS which can be used easily in formation design and what we do for the formation of GDUT_TiJi 2011. In section 4 and 5 we discussed the methods we use for improvement of defensive and offensive respectively. Also there is some work we did not finished yet in offensive, but all these are under test.

- **7   Further research**

Agent2d is a new base code which may be quite comprehensive for developer, but this base have more setting which cannot been understood easily. When using this base code, whether which version it is, what we do first is make sure it is clear of the structure of the whole team. So, later on, we will make more effort on this base code and the code of server, which will lead to clearer frame to understand agent2d.

Due to limited time, we cannot use more models and algorithms for our new team, it is a pity for that, the base code cost too much time, so we just do little improvement for GDUT_TiJi 2011. Some of our modeling is still under test; we did not give a detailed introduction of that before we get better experiments. There are many useful algorithms and models for us to research, what I think more significative for further improvements are:

✓ *POMDP* is a novel model for agent to make decision in partially observable situation. The solving ability has been verified lot. While the performance of this model is merely based on the state space, if it is too huge, the algorithms existent cannot solve it yet. It may be more useful in local decision-making problem in RoboCup, with pretreatment of state space and others.

- ✓ **DEC-POMDP** is also useful for some agent to work together to solve some problems. As POMDP, space will be the most important problem which will be designed properly; useful algorithms are also under research, DEC-POMDP would be a more helpful model for the cooperation and compete between agents.
- ✓ **Online learning** is a typical game theory which can adjust agent's optimal strategy online with new data. This is not just used in math theory but also used in decision making area.

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