RoboCupJunior 2021 Soccer Simulation Challenge

Team Description Paper (TDP) 2021

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1. Header:

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2. Abstract

In this paper, we would like to outline methods that our team Speshari used in preparation for Soccer Simulation Challenge 2021. We will introduce/describe how the team members of Speshari interacted with each other and how we divided our work. We will present our strategy of using the same program for all three robots, thanks to the finite state machine. Then we will provide an explanation for each state of the robot. In the document, we will also present to you how the robots arrange themselves at the right angle for a kick. In the end, we will discuss what we have gained from this competition and how we could improve our work.

3. Introduction

3.1 Team Background

Our team Speshari consists of 4 members: Patrik Sašina, Samuel Vargovčík, Martin Baluďanský and Adam Strelec. We are all students of the secondary technical school of electrical engineering in Prešov, from Slovakia. At the start, we quickly realized that we have to assign work to each other for better time management. That is why we divided the work between each member. Samuel was in charge of the program as the main programmer. Martin was designing and presenting our strategy for the competition. Adam was a tester and programmer. Patrik also helped with testing the program and held responsibility for the team description paper/direction of the video. Of course, there always was team communication between all members. We are glad that our team cooperation was an easy task for us because it strengthened our bond as friends. Thanks to our field of study, we are passionate about robotics and mathematics. That is why we decided to join this honorable competition. Three of us had an amazing opportunity to learn something new from an already experienced Robocup attendee Samuel. He had experienced the beauties of Robocup 4times already. In terms of successes, he ended up 4th on a worldwide round of CoSpace in 2019.

3.2 Team photo

Figure 1. Team Speshari

4. Robots and Results

4.1 Software

We used the same program for each robot. The objective of the robot changes based on its surroundings. They are able to evaluate the situation and switch between the 6 states of the robot. Functions of the states range from defending to supporting the attacker to just attacking.

4.1.1 Finite state machine

States 0 and 1 have the same objective – standing halfway between the ball and the center of the goal – but their transition conditions are different (described in the transition table below).

State 2 also has a defensive function. Its objective is getting between the ball and the goal, but right next to the ball instead of halfway to the goal.

State 3 is the state of an attacking assist robot helping in case the other attacking robot loses the ball. It stays a certain distance from the other robot along the y axis and it will try to score a goal if it gets the chance. If the ball is kicked away from the robot it will try to catch it .

State 4 is the state of the attacking robot that has the ball. It aligns itself with the ball to kick it in the goal.

State 5 just follows the ball, trying to score a goal.

States	Condition	New state
0	the robot is near the ball	1
0	there is another robot closer to the goal	3
1	the robot is far from the ball or the ball is on the other team's side	3
2	the robot is near the goal and there is at most one robot already defending the goal	0
2	the robot is near the ball	1
3	the robot is the closest to its goal	0
3	the ball is on the robot's side	2
3	the robot is the closest to the ball	4
3	it's aligned with the ball so it can score a goal	5
4	the robot is not the closest to the ball	3
4	it's aligned with the ball so it can score a goal	5
5	it's not aligned with the ball so it can score a goal	4

***Table 1**. Transitions of the robots*

***Figure 2.** Robots doing the actions determined by their states*

4.1.2 Getting around the ball

In some states, the robot needs to align with the ball in a specific way. For that, it needs to get around the ball, ideally without touching it. This is done using secondary states. Each state has a position relative to the ball where the robot is going. The state transitions are done based on the robot's position relative to the ball and the destination position, (where it would be aligned), because going directly to that position could kick the ball away. To make the transition conditions simpler, we transform the coordinates by rotating the positions of the robot, the ball, and the destination. We still keep track of the original positions because those would be easier to manipulate.

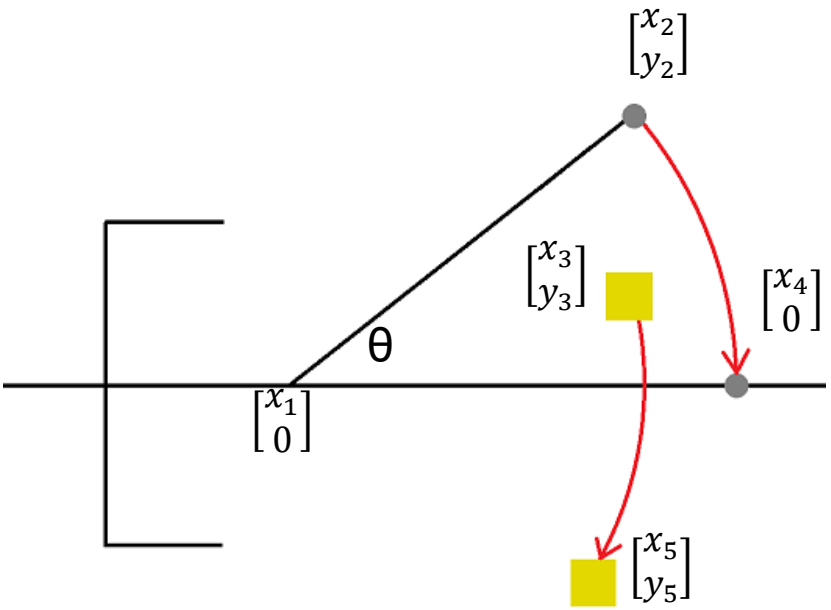

Figure 3. *Visualization of the rotation function*

$$\theta = tan^{-1}(\frac{y_2}{x_2 - x_1})$$

$$x_4 = \sqrt{(x_1 - x_2)^2 + y_2^2}$$

$$\begin{bmatrix} x_5 \\ y_5 \end{bmatrix} = \begin{bmatrix} \cos(\theta) & \sin(\theta) \\ -\sin(\theta) & \cos(\theta) \end{bmatrix} \begin{bmatrix} x_3 \\ y_3 \end{bmatrix}$$

Equation 1*. Equations for the rotation function*

4.2 Results

All robots have the same program and different roles based on how they can be most useful in the situation. The roles are implemented using a finite state machine. Each state has a function for determining its action. Each state transition condition is composed of simpler conditions, which have functions for determining whether they're true. The transitions are handled by a function using a list of transition conditions, and at the end, it calls the action functions and returns the new state of the robot. The main program only calls this function to handle the states, and in some states, it also handles a secondary state which is used to get around the ball.

5. Conclusions and Future work

5.1 Summary

Even though this year Robocup was online, we still learned and expand our knowledge in many fields. While facing many difficulties, our team had to apply advanced critical thinking to solve our challenges. We could solve the difficulties that lied in front of us only, thanks to good team communication. Our time management and work division had to get better if we wanted to achieve effective results.

We had to get familiar with more complex math, so we could improve the performance of our program. We have improved our abilities in using the programming language python in a new application. Lastly, we got familiar with the Webots environment, which will definitely help us in future study or competitions.

5.2 Outline

In our future work, we would like to expand on our idea that all robots have the same program. The fact that they can't communicate between each other is not a problem, because they all get the same information (positions and orientations of all robots and the ball). The program could simply calculate the ideal roles for all 3 robots and each robot would choose its role from that based on its name, so it's possible to prevent their roles interfering with each other. We hope that by expanding our knowledge we will be able to implement this feature as soon as possible.

6. References

6.1 Resources

1. http://uclab.khu.ac.kr/lectures/2005-2-is/guide_webot.pdf
2. https://www.cyberbotics.com/doc/reference/motion-functions
3. https://www.researchgate.net/publication/256474901_Tactics_Analysis_in_Soccer_-_An_Advanced_Approach
4. http://www.knowledge-dojo.com/papers/1930%20Advanced%20Trigonometry%20-%20Durell%20&%20Robson.pdf
5. https://www.cyberbotics.com/#download