RINOBOT-JAGUAR's joint Team Description Paper

Ana Sophia C. A. V. Boas[1], Bernardo A. Lopes[1], Daniel K. Almeida[1], Gabriela de Jesus C. Castro[1], Gabriele Leandro do E. Santo[1], Gabryel Vitor S. Gonçalves[1], Gustavo C. Martins[1], Gustavo Kenji[1], Isabella Q. Lopes[1], Iuri Carlos S. Brighenti[1], Jessica C. Souza[1], João Pedro A. Vigilato[1], Lívia B. A. Costa[1], Lívia F. Guirão[1], Lucas C. V. C. Chaves[1], Lucas B. Esteves[1], Luiz Miguel B. Silva[1], Manuel A. Rendón[1], Marcelle B. F. Facirolli[1], Marcelo R. de Souza Filho[1], Marcos V. P. Delgado[1], Mariana M. F. Ruy[1], Samuel A. Pereira[1], Vinícius S. Almeida Atan de A. Cardoso[2], Bernardo P. R. Dominguez[2], Diego A. Carvalho[2], Helton Rodrigo de S. Sereno[2], Letícia de O. Candido[2], and Matheus Henryck de O. V. Vargas[2]

[1] University Campus, Federal University of Juiz de Fora
(Universidade Federal de Juiz de Fora)
St. José Lourenço Kelmer, Juiz de Fora, MG, 36036-900, Brazil
rinobot@engenharia.ufjf.br
[2] Volta Redonda Campus, Federal Institute of Rio de Janeiro
(Instituto Federal do Rio de Janeiro)
Rua Antônio Barreiros, 212, Nossa Senhora das Graças, Volta Redonda - RJ, 27215-350, Brasil
www.equipejaguar.com.br

Abstract. Team Description Paper of the brazilian joint team Rinobot-Jaguar

Keywords: TDP · Ball Detection· CNN

1 Team Information

Our team is formed by the union of two brazilian teams: the Rinobot Team and the Jaguar. The Rinobot Team was founded in 2016. Its Headquarters stand at the Federal University of Juiz de Fora (UFJF), located in the city of Juiz de Fora MG in Brazil, their the contact information is as follows: rinobot@engenharia.ufjf.br. It is constituted by more than 60 participants including the captain, Iury Brighenti. All of which study Electrical Engineering, Mechanical Engineering, Production Engineering, Computer Science, Computer Engineering, Exact Sciences, Communication, and others, under the guidance of professors from the Electrical Engineering department and a laboratory technician.

The team is divided into 6 areas: Management (responsible for planning, marketing, disclosure, finance, and collection of results), and the other 5 areas are their competition categories. They are: Very Small Size Soccer (VSSS), Line Follower, Lego Sumo, Mini Sumo and Standard Platform League (SPL).

The SPL category is made up of 11 members, including leader Lucas Chaves. These members are distributed among the Exact Sciences, Computer Sciences, Computer Engineering, Electrical Engineering, Information Systems and Production Engineering courses, all of this at undergraduate level.

Jaguar was founded in 2012. It has its headquarters at the Federal Institute of Rio de Janeiro (IFRJ) on the campus located in the city of Volta Redonda RJ in Brazil. Their contact email is: contato@equipejaguar.com.br. It is constituted of 23 participants including the captain, Helton Sereno. Excluding him, who is a professor at the IFRJ, graduated in Mechanical Engineering at the Catholic University of Petrópolis (UCP), the other members are studying Technician in Industrial Automation.

The team presents the SPL category as its main area of activity, with a total of 10 active members, all studying Technician in Industrial Automation at undergraduate level.

2 Code Usage

2.1 Vision

After Robocup23 we started migrating to the codebase of the German HULKs team. Thus, our entire image acquisition system for the robots' cameras is developed by them. Notwithstanding, we are reusing our Tiny-YOLO based Neural Network developed for the last competition, and continuously developing, tuning and training it. By Eindhoven we plan to have a more efficient ball recognition than last year, and an initial step towards robot recognition.

2.2 Motion

Our motion system is the same provided by HULKs in their code release. It contains a plethora of tools, filters and algorithms that guarantees a swift and efficient motion

2.3 Strategy

As the game requires a different behavior from the robot depending of the stage of the game, the game controller software GameController is used. This software gives a interface that can replace a role of a human referee and helps to manage the robot state throughout the game. The GameController Interpreter we'll be using was made by HULKs. Our strategy is based on Hulks behavior tools and coding architecture, besides their game controller. We have a goalkeeper and 4 field players which will be divided in defenders, midfield and attack, keeping the possibility of changing it during the game or between games.

3 Own Contribution

3.1 CNN Ball Detection

Since 2018, the Rinobot and Jaguar teams have been using a haar cascade classifier to detect the black and white ball. While this method is considerably fast, it has been found to be unreliable due to the high number of false positives it produces. In order to improve the accuracy of ball detection, the teams have decided to switch to using Convolutional Neural Networks (CNNs) as their classifier.

The new approach consists of two steps. Firstly, the teams use the haar cascade classifier to identify candidate regions of interest in the image. Then, these candidates are fed into a CNN for further analysis. The current implementation uses the tiny-YOLO object detector, which has shown promising results in terms of accuracy and speed.

The teams' CNN is structured with 24 layers, and takes a 32x32x3 input. This design allows for the network to analyze small regions of the image in detail, which can help to reduce false positives and improve overall accuracy. By combining the strengths of both the haar cascade classifier and CNNs, the teams are able to achieve a high level of accuracy while maintaining real-time performance.

The use of CNNs represents a significant improvement over the previous haar cascade classifier approach, as it allows for more sophisticated image analysis and better discrimination between true and false positives.

3.2 Object Detection

The issue with the robots constantly committing fouls during their performances was due to their lack of obstacle detection capabilities. They would focus solely on pursuing the ball without taking into account any obstacles in their path, which often resulted in collisions and fouls.

To address this issue, we implemented obstacle detection through the use of sonar sensors. Currently, we process the data from the two sonars on the robot and simulate a third based on the codebase from the runSwift team. This allows us to obtain more precise information about the location and proximity

of obstacles, enabling the robot to determine which side it should move towards to avoid colliding with them.

Overall, this solution has helped to significantly reduce the number of fouls committed by the robots during their performances, resulting in a smoother and more efficient gameplay experience.

3.3 Strategy

Using PyO3 Project, we'll be integrating python and rust to get be best of both worlds, the ease of use from python and speed from rust. Our main goal is to implement our strategies using this project, but it can be extended to other parts of our code if it fits.

4 Past History

Last year we had the honor of being accepted for Robocup 2023, however, due to technical problems we were unable to play any matches. Therefore, we only included the results of our previous participation, Robocup 2018

Table 1. Results of Rinobot games in RoboCup 2018

Games	Game Type	Results
Rinobot X MiPal	First Round Robin Pool	0 - 0
Rinobot X NTU RoboPAL	First Round Robin Pool	0 - 0
Rinobot X Camellia Dragons	Challenge Shield	0 - 3
Rinobot X UPennalizers	Challenge Shield	0 - 1
Rinobot X MiPal	Challenge Shield	1 - 0
Rinobot X Aztlan	Challenge Shield	0 - 0
Rinobot X MiPal	Penalty Kick Competition	1 - 0
Rinobot X B-Human	Penalty Kick Competition	0 - 2

Furthermore, in 2017, the Rinobot Team got the first place in the Latin American Robotics Competition (LARC) on SPL category, which occurred in Curitiba, Paraná, Brazil, and, in 2019, the Rinobot Team got the second place in the same competition, which occurred in João Pessoa, Paraíba, Brazil.

As team Jaguar, we have not yet participated in RoboCup, but we have been participating in LARC since 2016. Our results are presented in the following table:

Table 2. Ranking of Jaguar in LARC

Competion	Ranking
LARC 2016	2° (second)
LARC 2017	2° (second)
LARC 2018	3° (third)
LARC 2019	1° (first)
LARC 2022	2° (second)

5 Impact

Robotics is one of the fastest growing areas in the world. New technologies arise at all times and it is undeniable that the future will have the increasingly striking presence of robots in our daily lives. The Rinobot-Jaguar Team, armed with a feeling of growth and innovation, seeks through research and testing, always improve and optimize game strategies.

The Robocup championship, worldwide, has the potential to give more prestige and visibility to the team's efforts, encouraging companies and potential employees to sponsor the team, enabling the continuity of the project.

It will be extremely important for the Brazilian teams that make up the team, because contact with more advanced technologies would contribute greatly to the educational development of the team, in addition to encouraging and strengthening research in this area, in national territory, and being able to put into practice everything we have developed so far.

At Rinobot, the team places a strong emphasis on community outreach. They regularly visit local schools to showcase their robots and introduce children and teenagers to the exciting world of robotics. This is especially important as robotics is still relatively under explored in basic education, and the team believes in inspiring young minds to pursue careers in this field.

The Jaguar team also has a very important impact on its surroundings, using NAOs as tools for education and recreation for the elderly. This activity has been very impactful, mainly with those diagnosed with Alzheimer's and Dementia. This project aims to promote social inclusion and well-being of people with Alzheimer's through the use of the NAO robot.

Overall, both the Rinobot and the Jaguar teams are dedicated to advancing the field of robotics through their passion for innovation and their commitment to community outreach. The team's participation in the Robocup is a key component of their mission, as it provides a platform for showcasing their work and advancing the field as a whole.

6 Other

Rinobot Team and Jaguar Team, who have been collaborating since participating in Robocup 2023, are now working to adapt the Hulks Team codebase.

Through this work, it is expected that the improvements initially designed for the old Rinobot code, used in its NAOs v4, will be developed in the future, such as the anti-fall system and communication between robots.

References

1. Wang, X., Girshick, R., Gupta, A., & He, K. (2020). Non-local neural networks. In Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition (pp. 7794-7803).
2. HULKs 2023 Code Release, https://github.com/HULKs/hulk.