Borregos3D Team Description 2009

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Abstract. This paper shows the description of our team Borregos3D for the RoboCup Simulation 3D league. Last year in China we used a basic set of behaviors like walk, kick, turn and stand up. We achieved a very high speed for the walking gait using coupled oscillators. This year campus MTY and campus CEM of our university are starting to collaborate to improve the agent behaviors and decision making algorithms. We are paying special attention to the turn and kick behaviors as they were among the slowest gaits. Also, we are adjusting the localization and worldmodel modules to handle the new restricted noisy vision. Finally, we are planning to develop high level strategies like path planning and passing, as well as a better goalkeeper behavior.

1 Introduction

This paper shows the overall architecture and characteristics of our soccer agent team. For the first time, campus MTY and campus CEM of our university are going to join efforts for increasing the quality of the current code and developing high level decision making mechanisms. Students from campus MTY have participated in the RoboCup simulation league since 2004, starting in simulation 2D and moving to simulation 3D later. Last year in China, our team, Borregos3D, was among the TOP 8 teams of the tournament. Students from campus CEM are venturing into the 3D league, but have a lot of experience in other RoboCup leagues since 2002 in the four legged league with their well-known team TecRams. More recently, campus CEM also has presence in the humanoid teen-size and kid-size league with the team Bogobots and in the Robot Rescue team TecRams since 2008.

Borregos3D was created back in the year 2004 for the Simulation 2D category [16]. Later, in 2006, the team competed for the first time in the simulation 3D league of RoboCup Germany in the city of Bremen with spherical agents which seemed very unrealistic. However, the platform offered a lot of advantages compared to simulation 2D. A fuzzy bayesian approach for decision making in RoboCup Simulation 3D was presented in the RoboCup Symposium [14]. Later, a comparison between fuzzy bayesian classifiers and gaussian bayes classifiers was published in [13]. and a set of physics models which were used in the goto and dribble behaviors of the agents was published in [10].

A hybrid monte carlo localization with Kalman filter sensor fusion approach was used for diminishing the effect of noise and uncertainty in the agent self localization process, and was published in [11]. With this approach, Borregos3D won the third place in the RoboCup Brazil Open 2006 competitions. For more detail on Borregos3D team architecture and methodologies see [9] and [12].

In 2007, we participated in the first humanoid simulation competition in Atlanta, USA, using humanoid agents for the first time which were based on the Fujitsu HOAP-2 robot. Later in that year, we were the organizers of the 3D simulation league in the 3rd. RoboCup Latin American Open celebrated in Monterrey, Mexico. In 2008, we made it to the TOP 8 in the RoboCup China competitions in the city of Suzhou, using a new agent model inspired in the Nao robot of Aldebaran Robotics (fig. 1), which is the new official robot for the RoboCup Standard Platform League.

We are now focusing on improving low level behaviors, specially turn and kick because they were slow and among the most critical points against other teams. Also, we have to do the corresponding changes to the localization and worldmodel modules to handle the new restricted vision, as well as implementing better algorithms for high level decision making and a better goalkeeper. Finally, we are planning to implement communication protocols among agents to allow definition of roles and strategies.

2 Architecture

The architecture of the agent (fig. 2) is described by three different layers:

External Server Layer Any type of 3D simulation server can interact with the Borregos3D Agent, as long as the classes for interaction are previously defined (the server model and the robot models).

Server Interface Layer This layer is a black box by which a Borregos3D Agent senses the information of the current simulation step from the server and transforms it into a Message Object, and after the thinking process, an Action Object is generated and an action is sent to the server. The Server Model dictates the structure of the percepts and actions of the current server.

Agent Layer This layer provides several modules for the internal working of the agent: the server model, the robot model, the localization model, the world model, the decision module, several behavior implementations and a command list for the current simulation step. The command list is constructed from the actions of the behaviors and from the memory in the World model. This layer is initialized with general information about the current execution of the agent: the server ip, server port, the server model, the robot model, the team name and player number.

Fig. 1. Borregos3D architecture.

3 Walking gait

Developing stable and reliable walking patterns is one of the fundamental problems in humanoid robots. It is said that a statically stable pattern is that in which the Center of Mass (CoM) relies on the supporting area of the robot when walking. A dynamically stable pattern is that in which the Zero Moment Point (ZMP) is within the supporting area. The supporting area is the convex hull of the robot's feet. Developing a dynamically stable gait is harder, but can lead to faster walking behaviors.

We are using a method for walking which consists on coupled oscillators for controlling the joint trajectories during walking. This approach is similar to Central Pattern Generators (CPGs) and it has been applied in the real HOAP-2 robot in [15]. In a near future, we plan to combine the center of mass with the coupled oscillators to get even better results. The coupled oscillators allowed our agents to be among the fastest in RoboCup China 2008 and lead us to the TOP 8 teams of the competition.

In the aforementioned approach, the rhythmic component of the walking gait is described by a system of coupled oscillators modelling the controller phase (ϕ_c) and the robot phase (ϕ_r) with the following equations:

$$\dot{\phi}_c = \omega_c + K_c sin(\phi_r - \phi_c) \tag{1}$$

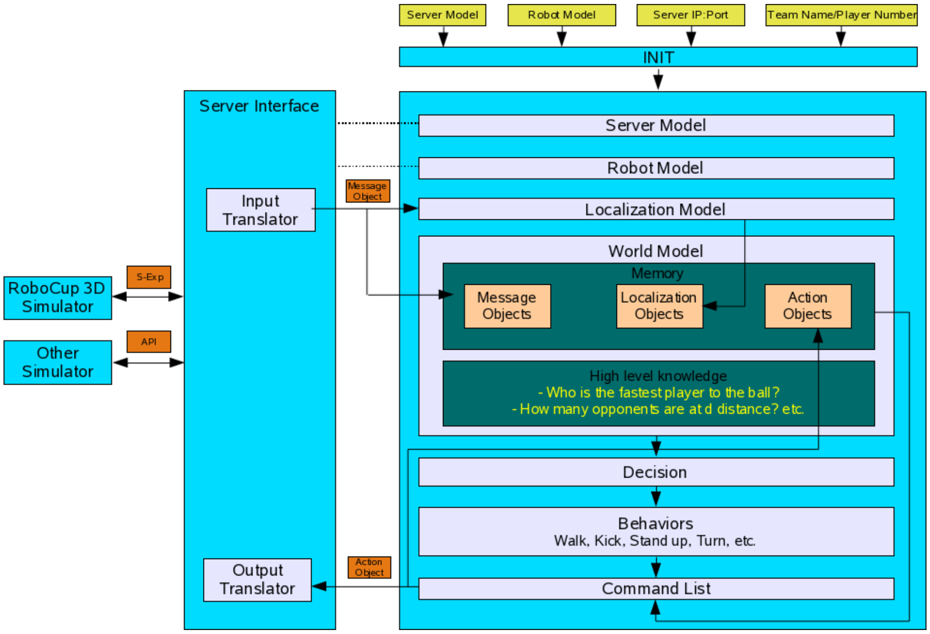

Fig. 2. Borregos3D architecture.

$$\dot{\phi}_r = \omega_r + K_r sin(\phi_c - \phi_r) \tag{2}$$

However, the robot natural phase ω_r and the coupling constant K_r are unknown as they depend on the robot dynamics. The robot phase is detected with the position C and velocity $\dot{C}$ of the center of pressure:

$$\phi_r = atan2(\dot{C}, C) \tag{3}$$

The center of pressure is scaled into the range $[-1, 1]$ where -1 indicates that the robot is standing in its right foot, 1 indicates that the robot is standing in its left foot and the numbers between them indicate a transition from one foot to the other.

The desired trajectory for each joint is a peudo-sinusoidal wave with phase ϕ_c and phase differences depending on the current state of the walking gait. Thus the trajectories are computed with the numerical integration of $\dot{\phi}_c$ and the joints are moved with PID controllers. The amplitudes of the sinusoidal waves are currently hand tuned, but we are planning to use genetic algorithms for searching the parameter space for better amplitudes.

4 Improving from experience in the Four-Legged league

As mentioned before, campus CEM has experience in the Four-Leggen league of RoboCup. Within this context, they have had to develop several algorithms and methods to allow Sony AIBO ERS-7 robots to play.

For the new restricted noisy vision, campus CEM developed a perception system [6, 4, 1, 18] that allows fast color segmentation. Our best method was to use implicit surfaces to adapt to different color regions [3, 2] this gave very good results. We later also experimented with Fuzzy Q-learning [5] trying to adapt to variable light conditions. We finally succeded with good adaptation to variable conditions [17] that allowed to win 2nd place in the Open Challenge of the Four-Legged league in RoboCup 2007.

We have also develop several methods for allowing agents to play using strategies. We first developed communication using KQML and endowed agents with the capability of communicating and interacting with each other by using interaction protocols like Contract-Net[20, 21]. Agents using this method were tested in a simulator and developed emergent behaviors that allowed them to attack the opponent team by moving the ball back and then passing when opponents had moved from their defense positions.

An automatic behavior generation was also developed [19]. This system generates very basic behaviors like find-ball, follow-ball, etc. very efficiently. This might probe useful for our purposes of improving turn and kick behaviors.

Finally, we have developed a notation to develop, describe, test and modify strategies (SSDS). This allowed us to create a team agent architecture (TABA) that based on the current events, can select the best predefined play and instruct agents to execute it [7]. Results in a simulator were very encouraging allowing agents using SSDS and TABA to win more often over agents not using these methods [8].

5 Conclusions

Through this paper, we discussed our current and planned research for our Borregos3D RoboCup 3D Simulation team. We have participated in RoboCup Simulation competitions since 2004 and this year we are joining efforts with campus CEM from our university whose students and academic staff have a lot of experience in the RoboCup four legged league. Joint efforts will prove to be very efficient to adapt previous work and generate new methods for the competition in Austria.

We are focusing on three main tasks: improving low-level behaviors such as turn and kick, adapting the localization module to the new restricted vision perceptor and developing decision making mechanisms for high level cooperation and coordination of agents.

References

1. Raziel Álvarez, Erik Millán, Alejandro Aceves-López, and Ricardo Swain-Oropeza. *Mobile Robots: Perception & Navigation*, chapter 8 Accurate color classification and segmentation for mobile robots, pages 149–164. Robotics & Automation Open Access Platform. Pro Literatur Verlag, Germany, February 2007. Open Access Database www.i-techonline.com (http://s.i-techonline.com/Book/Mobile-Robots-Perception-Navigation/ISBN3-86611-283-1.html).
2. Raziel Álvarez, Erik Millán, and Ricardo Swain Oropeza. Multilevel seed region growth segmentation. In Alexander Gelbukh and Hugo Terashima, editors, *MICAI 2005: Advances in Artificial Intelligence, 4th Mexican International Conference on Artificial Intelligence*, volume 3789 of *Lecture Notes in Computer Science*, pages 359–368. Springer, 2005. Monterrey, Mexico, November 14-18, 2005.
3. Raziel Álvarez, Erik Millán, Ricardo Swain Oropeza, and Alejandro Aceves. Color image classification through fitting of implicit surfaces. In *9th Ibero-American Conference on Artificial Intelligence (IBERAMIA)*, Lecture Notes in Computer Science. Springer-Verlag, 2004.
4. Raziel Álvarez, Erik Millán, Joaquín Vaño, and Ricardo Swain Oropeza. The evolution of a visual perception system in the 4-legged league. In *1st IEEE Latin American Robotics Symposium (LARS)*. IEEE, October 2004.
5. Raziel Álvarez and Jorge Ramírez. Calibrating seed region growing homogeneity criterion with fuzzy Q-learning. *GESTS International Transactions on Computer Science and Engineering*, 31(1):87–98, 2006. ISSN: 1738-6438.
6. Raziel Álvarez Guevara. Creación de sistemas de percepción y localización para robots cuadrúpedos. Master's thesis, Tecnológico de Monterrey, Campus Estado de México, 2005.
7. Myriam Arias Ruiz and Jorge Ramírez Uresti. Team agent behavior architecture in robot soccer. In *IEEE LARS 2008 - 5th IEEE Latin American Robotics Symposium*. IEEE, IEEE, October 2008.
8. Myriam Zoraya Arias Ruiz. Definición de una arquitectura para la generación de estrategias en equipos de fútbol robótico. Master's thesis, Tecnológico de Monterrey, Campus Estado de México, 2008.
9. Carlos Bustamante. Probabilistic agent localization and fuzzy bayesian pass evaluation for the robocup simulation 3d league. Master's thesis, Tecnológico de Monterrey, Monterrey, Mexico, December 2007.
10. Carlos Bustamante, Cesar Flores, and Leonardo Garrido. A physics model for the robocup 3d soccer simulation. In *Proceedings of Agent-Directed Simulation Symposium (ADS 07)*, Norfolk, VA, USA, March 2007.
11. Carlos Bustamante and Leonardo Garrido. Monte-carlo localization with kalman filter sensor fusion. In *Proceedings of the 4th IEEE Latin American Robotic Symposium*, Monterrey, Mexico, November 2007.
12. Carlos Bustamante and Leonardo Garrido. *Robotic Soccer*, chapter Probabilistic and Statistical Layered Approach for High-Level Decision Making in Soccer Simulation Robotics, pages 109–134. I-Tech Education and Publishing, December 2007. ISBN 978-3-902613-21-9.
13. Carlos Bustamante, Leonardo Garrido, and Rogelio Soto. Comparing fuzzy naive bayes and gaussian naive bayes for decision making in robocup 3d. In *Proceedings of the 5th. Mexican International Conference on Artificial Intelligence (MICAI 06)*, pages 237–247, Apizaco, Tlaxcala, Mexico, November 2006. ISBN 3-540-49026-4.

14. Carlos Bustamante, Leonardo Garrido, and Rogelio Soto. Fuzzy naive bayesian classification in robosoccer 3d: A hybrid approach to decision making. In Gerhard Lakemeyer, Elizabeth Sklar, Domenico G. Sorrenti, and Tomoichi Takahashi, editors, *RoboCup 2006: Robot Soccer World Cup X*, volume 4434 of *Lecture Notes in Computer Science*, pages 507–515, Bremen, Germany, September 2007. RoboCup, Springer Berlin / Heidelberg. ISBN 978-3-540-74023-0.
15. Christian Lathion. Biped locomotion on the hoap2 robot. Master's thesis, Ecole Polytechnique Federale de Lausanne, Switzerland, 2007.
16. Emmanuel Martínez and Ramón Brena. Maximizing future options: An on-line real-time planning method. In *Proceedings of the 4th. Mexican International Conference on Artificial Intelligence (MICAI 05)*, Lecture Notes on Artificial Intelligence, Monterrey, NL, Mexico, November 2005. Springer-Verlag.
17. Erik Millán, Alberto Sobrino, Carlos Reyes-Rico, and Jorge Ramírez Uresti. Automatic online calibration for indoor and outdoor environments with variable illumination. In *4th IEEE Latin American Robotics Symposium*. IEEE, 2007.
18. Carlos Reyes Rico, Alberto Alejandro Sobrino Arvizu, Mauricio Guevara Souza, and Jorge Ramírez Uresti. An automatic segmentator for RoboCup Four-Legged robot league using XML files. *GESTS International Transactions on Computer Science and Engineering*, 38(1):51–62, 2007. ISSN:1738-6438.
19. José Juan Tapia, Carlos Reyes Rico, and Jorge Ramírez. Automatic behavior generation in a multi agent system through evolutionary programming. In Javier Ruiz del Solar and Pablo Zegers, editors, *3rd IEEE Latin American Robotics Symposium*, pages 2–9. IEEE, IEEE, October 2006. ISBN: 1-4244-0537-8, IEEE Catalog Number: 06EX1489C.
20. José Luis Vega, Ángeles Junco, and Jorge Ramírez. Major behavior definition of football agents through XML. In Tanio Arai, Rolf Pfeifer, Tucker Balch, and Hiroshi Yokoi, editors, *Intelligent Autonomous Systems 9 (IAS-9)*, pages 668–675, Tokyo, Japan, 2006. IOS Press. ISBN 1-58603-595-9.
21. José Luis Vega Romero. Definición de estrategias de robots jugadores de fútbol a través de XML. Master's thesis, Tecnológico de Monterrey, Campus Estado de México, 2005.