Borregos Salvajes - Tec de Monterrey
Team Description

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Abstract. Tec de Monterrey Campus Estado de Mexico is one of the new teams that have joined RoboCup in 2002. This was the first Mexican team participation in the Sony Four-Legged Robot League. The team main objective was to make the robots able to play football as fast as possible and without re-using code from other universities of the league. The main objective of our team is to build a research platform, which would allow robust an efficient carriage of robots playing soccer.

1. Introduction

The reasons that motivate our participation in the RoboCup 2003 Sony Legged Robot League are:

- Conduct active scientific research in the area of Robotics and Artificial Intelligence.
- Support our Mechatronics, Computer Science and Manufacturing Systems master-degree programs as well as Electronics, Computer Systems, Mechanics and Mechatronics major programs.
- Development of mexican robotics technology for industry's dangerous activities.

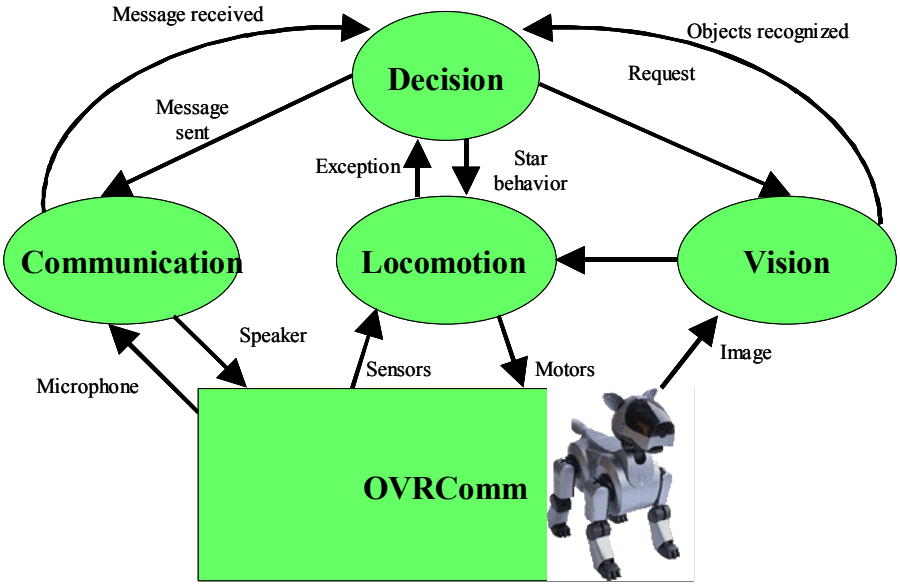
During the last years, the Computer Science and the Mechatronics Departments have been carrying out intensive research work in the areas of Control Systems, Computer Vision, Decision-Making and Learning models, Multi-Agent Systems, Robot Navigation and Mechanic Design.

Participation in RoboCup 2002 has encouraged cooperation between departments to overcome the robotic soccer challenge. From the Fukuoka experience we decided to focus our attention on four main issues:

- **Dynamic equilibrium**. Normally all dynamic walking algorithms consider robot as a dynamic system. We are modeling 3D position of robot's gravity center depending of all torques applied to it. Afterwards, control strategies will be used for control its center of gravity position
- **Localization algorithms without colored beacons**. We have developed a localization algorithm that should work without the use of beacons, field lines will be used to find the points for localization. Invariant light condition for color segmentation. We are researching algorithms for segmenting images regarding of shadows, light conditions and noise.
- **Enhanced virtual reality**. We are planning to develop an enhanced virtual reality field that will allow us to test our four Sony robots in competition against four simulated robots.
- **Team strategies acquisition**. We have developed distributed reinforcement learning algorithms for team strategies acquisition and used a Nash equilibrium model to make rational decisions among the robots. Those algorithms were tested in a simulator and we intend to test them in the AIBOs.

2. Proposed approach to address the RoboCup challenge

We plan to continue following a modular architecture as close as possible. The main system components are: locomotion module, vision module, communication module and decision module.



This structure allows us to decompose de overall problem in layers:

- *Low level robot control*: Using inverse kinematics techniques to move robot´s legs and head as quickly as possible to perform simple tasks such as: standing up, walking, running and blocking.
- *Object tracking and self-localization*: Image processing and pattern recognition algorithms to localize quickly the ball, beacons, goals, teammates, opponents, and reliable algorithms for distance estimation of objects and self localization on the field.
- *Off-line skill learning by individual robot*: Learning to intercept the ball or learning to kick the ball with the appropriate power. We are considering that a good individual player's behavior should be the following sequence (1) find the ball, (2) go close to the ball, (3) get control of the ball, (4) shoot towards the goal or pass the ball to a teammate.
- *On-line skill and collaborative learning*: Learning to play as a team, more precisely, the problem of coordinating agents in offensive and defensive team strategies - in order to take into account the contribution of all of the agents involved in a given play.

3. Background of the principal investigator

Ma. de los Angeles Junco, PhD, Multi-agent systems and artificial intelligence.

Ma. de los Angeles Junco received her B.Sc. degree in Computer Systems in 1989, her M.Sc. degree in Computer Science in 1993 and her Ph.D. degree in Computer Science in 2003. Her Ph. D. research proposed a distributed and rational decision-making model, based on Nash equilibrium and using a distributed Q-learning model, for gathering team strategies in a soccer agent domain.

In 1994 she joined the Department of Computer Science at Tec de Monterrey as a full-time lecturer and researcher. Since then she has participated in projects such as: Speech recognition, Manufacturing cell automation, TecRobocup and Soccer strategies for B2B strategies.

Related publications:

- Junco A., Espinosa E., Ramos F.; "Soccer Strategies that Live in the B2B World of Negotiation and Decision-Making"; (To be published vol 35/3 pp 287 - 310), International Journal on Decision Support Systems, Elsevier.
- Junco A., Ramos F.; "A Distributed Q-learning Model for Rational Team Decision-Making in Soccer Domains"; FIRA Robot World Congress. Seoul, Korea; May, 2002.
- Junco A., Espinosa E., Ramos F.; "Solving Conflictive Situations within a Distributed B2B Decision-Making Framework Based on Soccer Team Strategies"; Advances in Infrastructure for Electronic Business, Science, and Education on the Internet; L'Aquila, Italia; 3 al 12 de Agosto, 2001.
- Junco A., Ramos F.; "Learning Team Strategies for MultiAgent Systems Environments"; YU INFO 2001, International Symposium on Information Technologies; Yugoslavia, Belgrado; 19-23 de Marzo 2001.
- Junco A., Ramos F.; "Improving Multi-Agent Coordination with an Approach Based on a Distributed Rational Decision-Making Model"; International Journal of Knowledge-Based Intelligent Engineering Systems (IJKBIES); October, 2001.

4. Description of the team organization

Our team is composed by four professors, un PhD. student, two master student and seven undergraduate students. We are internally organized in four groups: the locomotion group, the vision group, the decision group and the core-architecture group. Each competition we are testing enhanced versions of vision, motion and decision modules. For example, the locomotion module has corrected the inverse kinematics, the foot path generator and the interpolation algorithm. The vision module has enhanced segmentation by using inductive learning models and heuristic techniques. In the case of the decision module we are testing our collaborative strategies, localization algorithms and world model.

5. Pointers to relevant publications

1. Swain-Oropeza R., Devy M. and Hutchinson S. Sensor-Based Navigation in Cluttered Environments in IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS), Maui, Hawaii, USA, November 2001.
2. Swain-Oropeza R., Burschka D., Kriegman D., Hager G. and Knapek M. Selecting Landmarks for a Visual-Based Navigation Task in the International Symposium on Intelligent Robotic Systems (SIRS), Toulouse, France, July 2001.
3. Knapek M., Swain-Oropeza R. and Kriegman D. Selecting Promising Landmarks in the IEEE International Conference on Robotics & Automation (ICRA), San Francisco, USA, May 2000.
4. Cadenat V., Swain-Oropeza R. Soueres P. and Devy M. A Controller to Perform a Visually-Guided Tracking Task in a Cluttered Environment in the IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS), Korea October 1999.
5. Swain-Oropeza R., Devy M. and Cadenat V. Controlling the Execution of a Visual Servoing Task in Journal of Intelligent & Robotic Systems, Theory and Applications (Incorporating Mechatronic Systems Engineering), Kluwer Academic Publishers, Vol 25 (4), August 1999.
6. Swain-Oropeza R. Contrôle de Tâches Référencées Vision pour la Navigation d´un Robot Mobile en Milieu Structuré, PhD Thesis, LAAS-CNRS, Toulouse, France, June 1999.
7. Swain-Oropeza R. and Devy M. Motion Control using Visual Servoing and Potential Fields for a Rover-Mounted Manipulator in the IEEE International Conference on Robotics & Automation (ICRA), Detroit, Michigan, USA, May 1999.
8. Swain-Oropeza R., Devy M. and Cadenat V. Visual Navigation and Obstacle Avoidance for a Service Robot in the International Symposium on Robotics & Automation (ISRA), Saltillo, Coah, Mexico, December 1998.
9. Swain-Oropeza R., Devy M. and Jonquieres S. Navegación de un Robot Móvil por Medio de Control Visual en un Ambiente Estructurado in Computación y Sistemas: Experiments with Domain Knowledge in Unsupervised Learning, Vol. 1 (3), p 161-169, 1998.

10. Swain-Oropeza R. and Devy M. Visually-Guided Navigation of a Mobile Robot in a Structured Environment, in the International Symposium on Intelligent Robotic Systems (SIRS), Stockholm, Sweden, July 1997.
11. Swain-Oropeza R. Asservissement Visuel d´un Robot Mobile Non-Holonome, Journées des Jeunes Chercheurs en Robotique (JJCR), LAAS-CNRS, Toulouse, France, June 1997.
12. Aceves-López A. and Aguilar-Martin J. Using Multivariable Nonlinear Stability Theory for Override Control Systems in European Control Conference (ECC), Karlsruhe, Alemania, August 1999.
13. Aceves-López A. and Aguilar-Martin J. A New Simplified Version of the Fuzzy Controller: The Natural Logic Controller in International Multiconference on Circuits, Systems, Communications and Computers (CSCC), Athena, Greece, July 1999.
14. Aceves-López A. Nouvelle approche de la commande non linéaire sous contraintes à partir de la logique floue: Le contrôleur logique naturel, PhD Thesis, LAAS-CNRS, Toulouse, France, Nov 2000.
15. Junco A., Espinosa E., Ramos F.; "Soccer Strategies that Live in the B2B World of Negotiation and Decision-Making"; (To be published vol 35/3 pp 287 - 310), International Journal on Decision Support Systems, Elsevier.
16. Junco A., Ramos F.; "A Distributed Q-learning Model for Rational Team Decision-Making in Soccer Domains"; FIRA Robot World Congress. Seoul, Korea; May, 2002.
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18. Junco A., Ramos F.; "Learning Team Strategies for MultiAgent Systems Environments"; YU INFO 2001, International Symposium on Information Technologies; Yugoslavia, Belgrado; 19-23 de Mars 2001.
19. Junco A., Ramos F.; "Improving Multi-Agent Coordination with an Approach Based on a Distributed Rational Decision-Making Model"; International Journal of Knowledge-Based Intelligent Engineering Systems (IJKBIES); October, 2001.
20. Ramírez Uresti, J.A. & du Boulay, B. (Accepted). Expertise, Motivation and Teaching in Learning Companion Systems. International Journal of Artificial Intelligence in Education.
21. Ramírez Uresti, J.A. (2001). The LECOBA Learning Companion System: Expertise, Motivation and Teaching. International Journal of Continuing Engineering Education and Life-Long Learning, 11(3), 216-228. Special issue of the best of PEG99.