RoboFEI TEAM 2009
Team Description Paper

André de O. Santos, Felipe R. Zanatto, Gabriel Franceschini, José Angelo Gurzoni Jr., Luis Roberto Lutti, Milton Cortez, Flavio Tonidandel
{jgurzoni}{flaviot}@fei.edu.br

Dept. of Electrical Engineering
FEI University Centre, Brazil

Abstract. In this paper we present the RoboFEI Small League 2009 team description. Along this text we will introduce how we got to the Small Size League, where we stand as of February of 2009 and what goals we expect to reach until the Robocup 2009.

1 INTRODUCTION

The RoboFEI team exists since 2001, when we started competing in the IEEE very small league. We took the decision to move on to the Small Size League because we consider our research has reached maturity in the IEEE very small and would be benefited in a more complex environment. We leave the Very small as the first team in the historical rank in Brazil, with results such as three national championships and three second places in national competition. We describe in the coming sections the main portions of our new team, created for the Small League debut, namely the hardware, the vision system, the navigation and control and the strategy, both in terms of where we stand and where we expect to be by end of June 2009.

2 Robots Hardware

We have designed robots with four ominidirectional wheels, one dribling and one kicking device. The motors are 4 Faulhaber 2232006SR for the wheels, factory-mounted with a 512 pulse per revolution encoder (Faulhaber IE2512), and 1 Faulhaber 1724006SR for the dribbler, with the same encoder model. The external gearheads onto the wheels produce a reduction ratio of 10:1 and, this way, allow a robot maximum speed of 2.5 m/s. The diameter of the robot is 180.0 mm, its height 120 mm and the weight 2.8 kg. The maximum percentage of ball coverage is 16 percent and its projection to the ground is 146 mm, and the robot is assembled in aluminum, to provide high-endurance and resistence. Figures 1 to 3 show the robot in different views. The electronic circuitry is composed of an ARM7-based microcontroller (LPC2148), designed to be the maestro of the system, responsible for the control of all other peripherals and microcontrolers, and 5 microcontrollers Freescale MCM9S080GB, responsible for the PID control of each wheel (and dribler). Still on the logic circuitry we have the transmission system, which uses a 2.4 GHz PSK transceiver.

The system has a total of four Lithium Polymer batteries of 1300 mAh, being two for the booster circuit of the kicking device.

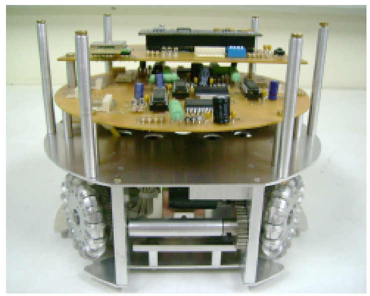

Fig. 1. Frontal view of robot

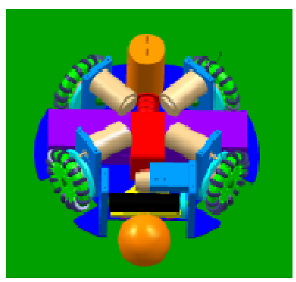

Fig. 2. Top-view of the robot's motor mounting - CAD Drawing

3 Vision System

The vision system (screenshot shown in [**?**] uses the Intel's OpenCV library to capture the video from the firewire cameras and synchronize the video frames. Subsequently, we classify the color classes using an artificial neural network trained during the pre-game stage with the well known backpropagation algorithm. The output of the neural network is then fed on the Blobbing algorithm based on the CMUVision system [1], which outputs the objects grouped and with their statistics. The last stage then is the heuristics-based module and the Kalmann filter predictor, responsible for inserting the domain-specific knowledge. The heuristics, for instance, give higher preference for objects with neighbors meeting the criteria of distance between circles of the same robot (given that we use the butterfly pattern to distinghish robots), lower preference for objects in positions too far away from the Kalman's predicted position and objects in impossible positions (like a ball in the middle of a robot).

4 Navigation and Control

Being an ominidirectional robot with four wheels like the one presented in [2], we can move to any direction in relation to the robot's front without considerable loss of speed. This enables us to use relatively simple control system. Basically each wheel has its PID control, performed by its own microcontroller, and the ARM7 is responsible for calculating the speed of each wheel given it's orientation and the speed vector sent from the PC.

To navigate the robots through the field, we applied a technique known as Piecewise Bezier [3] to trace the path of each robot of the team. The first path traced is composed just by line segments, as can be seen in Figure 3a. Each object that intersects a line segment has a potential field that makes the algorithm to retrace the line segment to avoid that obstacle. Given the line segments, Bezier is used to smooth the path and the points are passed to the control system. Figure 3b shows the smooth path generated by Bezier algorithm. The control of the path is done based on the estimated time for the robot to follow the path. The next point that the robot must follow in the next 30 milliseconds is determined and it's applied to the control system. This time is fixed in 30 milliseconds because the system captures 30 images per second. So, the vision system, strategy and control must spend a maximum of 30 milliseconds per iteration. If it won't happen, image frames will be lost.

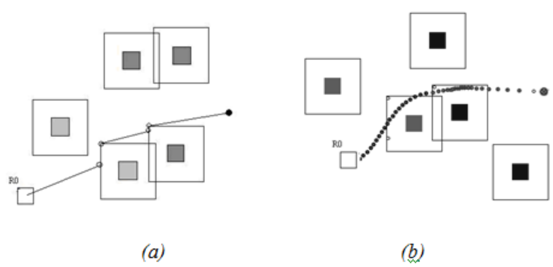

Fig. 3. Path Planning generation

5 AI System

Our AI system is still basic, using simple action selection based on hard-coded criterias, but we obtained good results in the simulator with a newly implemented algorithm based on a Reinforcement Learning with heuristics [4] system to define between actions such as pass and positioning. Although the simpler system worked very well for the Very Small League, the added capabilities of the Small Size and bigger number of robots involved pose a constraint which might hinder our future development and thus we decided to move to new, and actual AI, algorithms.

6 Where we are now and where we expect to be in July

We currently finished the building of our final design hardware, after changes to the prototype. We also completed development of our new vision system and obtained good results and have an average navigation system (enough to move without collision, but not the best maneuverability).

This is where we stand right now.

Our goals for July are (i) to redesign the navigation system, which includes the aiming system as well, to one born and bred into the Small Size system, as the main limitations of the current one come from the fact that it was designed for the differential drive system of the Very Small. (ii) We have to work on the AI system to transpose the RL algorithm which works in the Teambots simulator to the real game scenario, what we expect will take most of the time until July.

[1] We would like to thank the Small Size League Comitee in advance for the consideration of our material and all the staff of the Centro Universitrio da FEI for all the help we always received.

References

1. Bruce, J.: Realtime machine vision perception and prediction. Bachelor's degree thesis. Carneggie Mellon School of Computer Science (2000)
2. INIESTA, E.D.S.: Diseno e implementacion de los robots f180 del itam. Engineering Graduate Thesis (2006)
3. Hwang, J., Arkin, R., Kwon, D.S.: Mobile robots at your fingertip: Bezier curve on-line trajectory generation for supervisory control. Proceedings of the IEEE/RSJ International Conference on Intelligent Robots and Systems (2003)
4. Bianchi, R.A., Ribeiro, C.H., Costa, A.H.: Accelerating autonomous learning by using heuristic selection of actions. Journal of Heuristics (2007)