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5dpo Team description

5dpo

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Abstract. *This paper describes the 5dpo team. The paper will be divided into three main sections, corresponding to three main blocks: the Global Level, the Local Level and the Interface Level. These Levels, their subsystems and some implementation details will be described next.*

1 Introduction

This is our second participation in the Robocup Competition. Our robots comply with the F-180 League Regulations that constrain their dimensions: the occupied floor area must not exceed 180 square centimeters and the height must be bellow 15 centimeters. That limits the processing power and the kind of sensory devices that can be fitted in. On the plus side it also limits the costs and eases the mechanical design.

The main options that shape the way the 5dpo team was designed were: the use of a global vision system with more than one camera, the relative autonomy (in a short time frame) expected from the robots and the unidirectional nature of the radio link.

The whole team can be seen as a system divided in three basic levels.

The global vision system saves us from building robots with onboard cameras and the corresponding processing power. It also gives us a global view which is independent from the robots state. As the radio link cannot be complete ly reliable we tried to fit the robots with some autonomy so that they can survive a small starvation of orders from the global controller. That can ease the problem of lost packets over the air.

We will now describe each level and its subsystems.

2 The Global Level

This is the global Control Level. The global state of the system is updated based on the vision. Data fusion is attempted and adversary robot moves

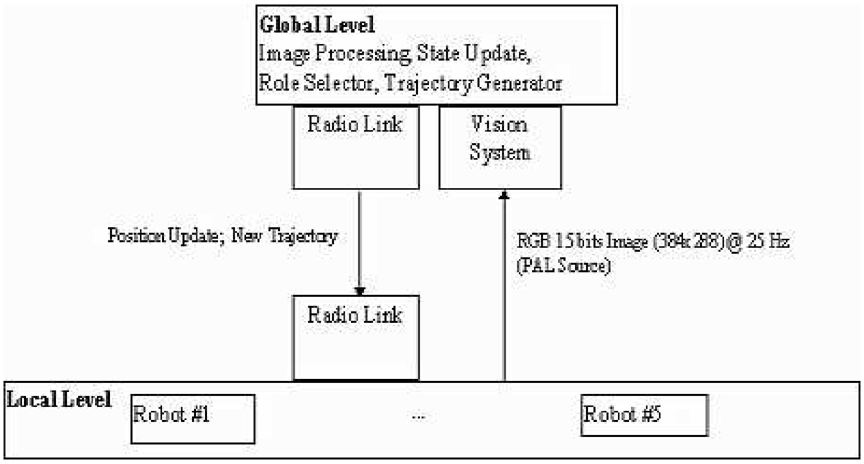

Figure 1: The three levels with their interrelationships and the information flowing between them.

are tracked. A rule based engine is used to classify opponents intents. By obser ving the present system state as well as a global mid-term strategy, short term orders are generated and sent to the players.

This layer closes the global loop. It must be stressed that while the "sampling" frequency of this loop is 25 Hz, there is some intrinsic lag that degrades its optimal performance. The PAL signal takes 20 ms to deliver the frame, then some t ime is lost processing it, the reasoning unit must decide the new course of action and it is necessary to wait for the next time slot to send some orders to the robots. That is why the local loop, running at 50 Hz (only the double), can show a much better performance in some tasks than a globally closed loop.

Short term orders try to account for typical adversary moves. They are anticipated using a model for their behavior. Naturally, the quality of this model has a direct link with the quality of the tactic behavior achieved by the team.

Some team tactics are maintained at all times like some defense mechanisms that are enforced during the match. In any case, the defense robots stand in alignment in such a way that the robot that holds the ball cant easily shoot for goal. This implies the presence of a path planner not only for the robots but also for the ball and the opponents.

All these systems are implemented in C++ in DOS with a 32 bits extender. That was the only way to ensure the hard real-time nature of the tasks. Other operating systems could not guarantee hard real-time behavior or there were no drivers available for some of our hardware.

3 The Interface Level

3.1 The Radio Interface

The radio link allows sending and receiving short packets that carry messages from the Global Controller to the robots. We have the radio channel time slotted synchronously with the global Control Loop.

3.2 The Video Interface

Our team uses a global vision system as a primary sensorial source. This is our global positioning system for our robots, for the opponent robots and for the ball.

This system consists in one or more color video cameras, placed directly above the playing field. The TV signal from these cameras is feed to a video acquisition board placed in a PC. This board is capable of placing a digitalization of each image fram e in the PC memory without CPU intervention, thus wasting almost no processor time. In the end of this process the board can signal the processor the conclusion of that task.

As we are using PAL cameras the image frequency is 50 Hz with alternating even and odd frames. For the single camera setup we are only using even frames therefore we have an image update frequency of 25 Hz. For the two camera setup, the synchronization procedure (even while using all frames), forces the update to 25 Hz too.

Based on the acquired image we must identify the ball position and also the robots position and orientation. As the robots are fitted with colored Ping-Pong balls, the second problem is similar to the first one. It is easier because the background is stable and, in the case of our teams robots, chosen by us. Better, there is not any kind of occultation for these balls. The playing ball can be partially or totally hidden by the robots body. It can have the green or the white of the lines as backgroun d. That makes its tracking more difficult. There is another problem: typically, the balls speed can be grater than the robots speed.

Another problem is distinguishing each of our robots. That is being achieved by reading a bar code placed on the top of each robot. The bar code uses only three bars which give us 8 possible numbers, excluding the all whites and all blacks case we rema in with 6 possible codes. That is enough for the five robots team.

4 The Local Level

In this layer we have the local control system that runs in each robot.

A robot is an autonomous unit considering a short time frame. The robots are capable of retaining a queue of tasks to be performed. These tasks may include following a specified trajectory, holding the ball, passing it along to another team member or m aybe shooting for goal. The local control system tries to enforce those orders in the predefined sequence.

Next we describe the basic mechanical and electrical design of the robots.

The robots are fitted with two differential wheels. The wheels are driven independently by separated stepper motors. There is no third wheel and the robot is sustained by a pod. A castor would result in a more complex mechanical design as well as an in creased uncertainty in its dynamical model.

The robots are presently powered by embedded Ni-Cd batteries. The motors are driven by two H-bridges that are directly powered from the batteries. The on board controller is a 8-bit RISC microcontroller (Atmel AVR90S4414). All digital circuitry gets it s power from a low dropout linear regulator.

Two small single frequency RF modules (433 MHz and 418MHz) are used to communicate with the external global controller. Only one can be used at a time.

5 Future Work

A disclaimer must be made at this point: between now and the competition there is yet a lot of time to make changes in the described setup. As we test the performance of each subsystem and find better alternatives we will try to implement them. We want the overall system to show a more robust and efficient operation. There is the possibility of adding some kind kicking device to some of our robots.

The Decision System is, right now, very defensive and not very actively cooperative in the attack. That is being improved.

6 Conclusions

In this paper we described the 5dpo team and the solutions we found to this problem. Recognizing the overall system state (the ball position and speed, our teams robots state and the adversarial robots state) using vision is still a very difficult task. And the quality of the team behavior is very dependent from the accuracy of that system.

The decision of what to do, even with accurate knowledge of the system status, it is a major task on its own. The range of options, some discrete and some continuous has many dimensions and cannot be easily searched. A lot of heuristic rules must be us ed to trim the possibilities and the best framework to represent and find them is a matter that requires still a lot of research.

We hope to achieve a performance level that can leave us with the idea that our approach to this problem was justified and worthy of more development.

7 Bibliography

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