RoGi Team Description

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Abstract. This paper resumes the main features of the RoGi Team. It explains whole system, including global vision and decision systems and robots.

1 Introduction

RoGi team started up in 1996 at the first robot-soccer competition as the result of a doctorate course in multi-agent systems. In 1997, 1998 and 1999 it has participated at the international workshops held in Japan, Paris and Stockholm. The main goal has been always the implementation and experimentation on dynamical physical agents and autonomous systems. Through these years this platform has become in a stable system where experiments can be repeated and new theories regarding unstructured, dynamic and multi-agent world can be tested.

1.1 New Features

This year, the team has dealt mainly with the changes on rules. Also, it has improved some aspects as:

- Use robots with different dynamics.
- Correct the distortion introduced by the lens of the camera.
- Introduce roles to the decision system in order to co-ordinate the play.

2 Team Description

The system that implements micro-robot soccer is made up of three parts: robots, vision system and control system. The vision and control systems are implemented in two different computers and they are connected by means of a LAN, using TCP/IP protocol. This allows a faster communication between them. The control system analyses data coming from the vision system and takes decisions based on it. The decision is split up into individual tasks for each robot and is sent to them via radio link.

2.1 Robots' Description

The robots have on board 8 bit Philips microprocessors 80C552 and RAM/EPROM memories of 32kBytes. The robots receive data from the host computer by means of a FM receiver. The FM receiver allows working with two different frequencies 418/433 MHz in half-duplex communication. The information sent by the host computer is converted to RS-232C protocol. The two motors have digital magnetic encoders with 265 counts per turn. They need 10 V to work and consume 1.5W at a nominal speed of 12.300 rpm. Ten batteries of 1.2 V supply the energy. There are two power sources, one DC-DC switching regulator, which provides stable 10 V to motors, and another one that guarantees 5 V to the IC.

At present, the RoGi team is formed by robots with different dynamics, which is non-linear but linear piece-wise.

2.2 Vision System

A specific hardware has been designed to perform the vision tasks, merging specific components for image processing (video converters, analogue filters, etc.) with multiple purpose programmable devices (FPGAs). A real time image-processing tool is obtained, which can be reconfigured to implement different algorithms.

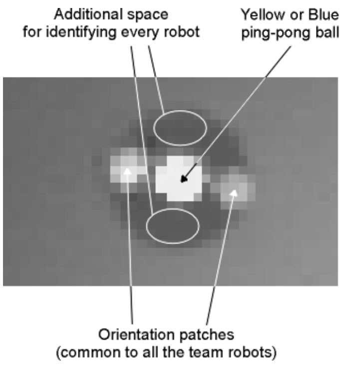

Figure 1. Top view with the team-colored Ping-Pong ball and orientation patches

According to RoboCup F-180 League Rules, each robot has to be marked using a yellow or blue Ping-Pong ball mounted at the center of their top surface. In order to provide angle orientation and robot identification, additional color markings are allocated on top of the robots.

2.2.1 Camera Distortion

The lens of the camera produces a radial distortion on the acquired image, as shown in figure 2. This effect introduces an error on the position measurements.

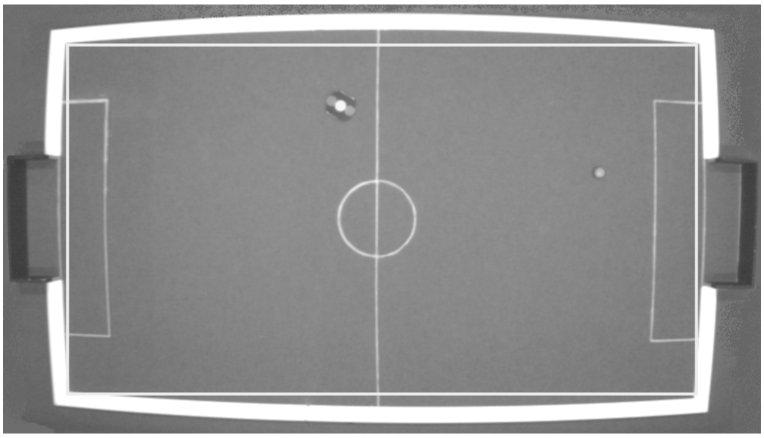

Figure 2: Distortion due to the lens of the camera.

To minimize this error, a filter is applied to data after processing the image. Also, there is a algorithm that exclude anomalous data, that is, measurements that can not be right according to the size of the field for instance. Figure 3 shows the complete treatment that receives the image before share data with the control system.

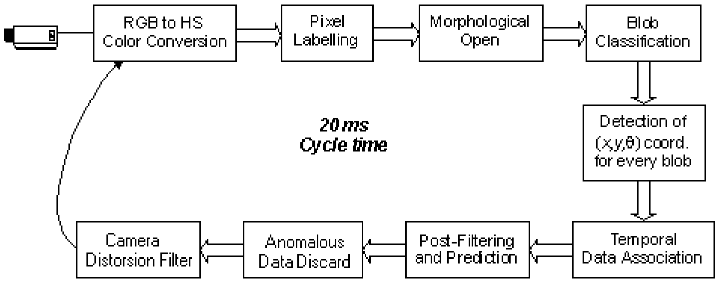

Figure 3 Treatment of the image.

The filter to minimize the effects of distortion is based on the Tsai algorithm [Tsai, 87]. This algorithm converts data with distortion into other without it, considering a set of parameters obtained by a previous calibration of the camera fulfilled with the landmarks of the field.

In addition to this filter, a Kalman filter is used to get stable data, which also gives a prediction of the position of the ball some time after.

Resuming, the data given by the vision system are the co-ordinates of all robots, the ball and the prediction of it.

2.3 Control System

The control system is a multi-agent environment in which the agents decide the best action to do. Each agent takes first, a reactive decision based on data given by the vision system, and second, a deliberative one considering the teammates decisions. Once all the agents get an agreement, each one transforms the actions in orders understandable by the robot, and sends them via radio link.

2.3.1 Coordination

As each agent is capable of taking autonomous decisions about a given task in a multi-agent system, they need to be coordinated in order to first, avoid interference among them when executing the task and second to plan the best way to carry out the task together.

In RoGi Team this feature is implemented in a very simple way: robots have roles. These roles have specific capacities as can be for example, that the attacker moves near the opponents goal and when receives the ball tries to score while a midfield player tries to drive the ball to the opponents field and pass it to the attacker. With this different capabilities it is achieved whole team behavior and conflicts are significantly reduced.

Humans assign the roles of the robots before starting the game and during it, agents can change roles accordingly to the progress of the game.

This coordination is improved using deliberative decision in the decision system (see section 2.3.2).

2.3.2 Decision System

This is the core of the system and target of all the efforts. The decision is taken in a two-steps algorithm:

Reactive Decisions Step: In a first step of reasoning, every agent decides a private/local action. To take this private decision, agents have a global real world perception (see figure 4), and a set of capabilities (actions they can perform) that varies according to the role they are carrying out. The world perception is the result of high level abstraction using fuzzy sets of data given by the vision system. With this knowledge of the environment and its capabilities, all the players take the reactive decisions using fuzzy logic. The agent converts this reactive action into its actual belief.

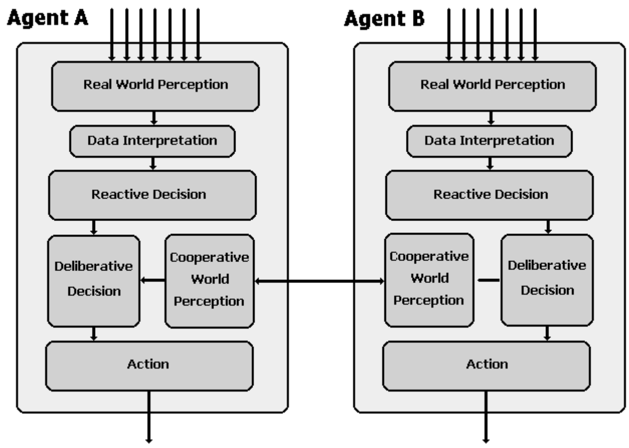

Figure 4. Schematic structure of agents.

Deliberative (Cooperative) Decisions Step: Deliberative reasoning in the sense of [Busetta 99] is implemented by communicating the former reactive belief. Every agent knows the beliefs of the other teammates. Beliefs contain the reactive decision, the certainty of this decision and the identification of the player-agent *(reactive_belief, certainty, ID_player)*.

When two or more agents realize their beliefs are in conflict, they use this certainty coefficient in a consensus algorithm based on a positional method to resolve it. In this positional method players are specialized since they have assigned roles. One possible effect of their specialization is that they prefer to stay in certain position on the playground. Agents take advantage of this feature and modify their vision of the co-operative world according to the positions of team players. These modifications lead the agents to reinforce or to change the former reactive decision. As a result, collisions among playmates are significantly reduced comparing to non-adaptive perception of the co-operative world.

3. Conclusions

This year team goal has been to settle the platform with the aim of developing experiments that can be repeated and testing new theories in an unstructured, dynamic and multi-agent world, simulating a football game.

4. References

[Busetta, 99] Busetta P., Rönnquist R., et al., “JACK Intelligent Agents-Components for Intelligent Agents in Java”, Agentlink Newsletter, No.2, pp. 2-5, January 1999.

[Tsai, 87] Roger Y. Tsai, *"A versatile Camera Calibration Technique for High-Accuracy 3D Machine Vision Metrology Using Off-the-Shelf TV Cameras and Lenses"*, IEEE Journal of Robotics and Automation, Vol. RA-3, No. 4, August 1987, page 323-344.