Rogi 2 Team Description

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Abstract. This paper describes the main features of the new Rogi Team and some research applied focused on dynamics of physical agents. It explains the vision system, the control system and the robots, so that the research on dynamical physical agents could be performed. It presents part of the research done in physical agents, especially consensus of properly physical decisions among physical agents, and an example applied to passing.

1 Introduction

Our team started in 1996 at the first robot-soccer competition as the result of a doctorate course in multiagent systems. In 1997 and 1998 it took part at the international workshops held in Japan and Paris. The main goal has been always the implementation and experimentation in dynamical physical agents and autonomous systems. This year a step further towards the platform to develop this type of research is done

1.1 New Features in the 1999 Generation

The new team has evolved from past generations. This new generation has solved many important problems existing in previous versions and are more focused to deal with *dynamical* physical agents. Here, dynamical means related to dynamics of the robots, from the point of view of automatic control. This generation is designed to let study further the impact of dynamics of the body in the co-operative world.

- The robots have been improved and its structure has changed in order to have a better-fit dynamical behaviour for control.
- The new vision system is able to process up to 50 frames/sec, locating ten robots a and a ball, with a dedicated hardware result of our research.
- A rational physical agent's approach is operative for robots co-operation, for instance, applied in passing actions. This is also result of our research.

M. Veloso, E. Pagello, and H. Kitano (Eds.): RoboCup-99, LNAI 1856, pp. 679–682, 2000.

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. The control system is also called the host system. The control system and the vision system are connected by means of a LAN, using TCP/IP protocol. This fact allows remote users to perform tests over the micro-robots platform and lets co-operative research. The vision system provides data to the control system that analyses the data and takes decisions. The decision is split up into individual tasks for each robot and is sent to them using a FM emitter at the host computer.

2.1 Robots' Description

The robots have on board 8 bits microprocessors 80C552 from Philips and RAM/EPROM memories of 32kBytes. The robots receive data from the host computer by means of a FM receiver. The FM receiver is prepared to work with two 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 9V to work and consume 1.5W at a nominal speed of 12.300 rpm. 9 batteries of 1.2 V supply the energy. It is compensate to have clear 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, analog filters, etc.) with multiple purpose programmable devices (FPGAs). A real time image-processing tool is obtained, which can be reconfigured to implement different algorithms.

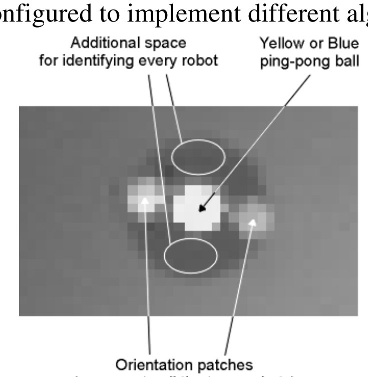

Fig. 1. *Top view with the team-colored Ping-Pong ball and orientation patches.*

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, additional color markings are allocated to the top of the robots. As shown in **Fig. 1**, purple and olive-green color patches have been added as the orientation patches in a basic configuration for our team robots. However, the robots may incorporate additional color patches to be distinguished from each other.

2.2.1 Algorithm

In order to locate the robots and the ball, the first step consists in their segmentation from the scene. The discriminatory properties of two color attributes, *hue* and *saturation*, are used so as to segment the objects. In this way, a pixel labeling of the image is obtained.

Since the size of the objects to track is rather small (5-6 pixels of diameter) mathematical morphology is applied in a 3×3 neighborhood of the processed pixel. Erosion and dilation operations are performed at video rate by using the tracking processor. In this way, particles smaller than the tracked patches are removed from the image and the remaining blobs are classified. The position and orientation of the 5 robots is computed using the blobs and the knowledge of the robot-patches geometry. A data association process solves the temporal matching problem at the highest abstraction level. However, the *identification* process is executed periodically to check that the data association has kept track properly of the robots' locations. As a last step, the measured locations of the objects are filtered in a sequence of images by means of an Extended Kalman Filter.

The low-level image processing operations are performed in hardware, while identification, data association, post-filtering and prediction are implemented in software. The cycle time is 20 ms, being limited by the PAL video standard.

2.3 Control System

The control system contains the strategy and the team decision making. The control system, using the positions of the robots and the ball provided by the vision system, has to determine which is the best decision to score a goal or to prevent the opponent team from scoring a goal. The system has been implemented using Lab-Windows. There are some advantages, but some problems have come up using it.

3 Research Challenges

The research is based on physical agents and focuses on the dynamics of the agents. We try to demonstrate that considering it when deciding prevents from undesirable situations. Knowing that a controller modifies the dynamics of the agents, we propose agents that are aware (introspection) of the set of controller their physical body has.

AGENT0 is used as an agent language. In this language an agent is described as an entity whose state consists of mental components such us *beliefs, capabilities, choices* and *commitments*. In our point of view, the capabilities are precisely the ones that let us represent the dynamics of the system. We believe that some of the capabilities are associated to the control of the system and we proposed them as a way for the agent to be aware of what it can or cannot do.

As a first approach our research is applied to passing the ball between two robots. This experiment consists on having to robots with crossing trajectories, that is, the trajectories have a common point and which will be the meeting point of one robot and the ball. We consider that there are no obstacles in the trajectories and the robots have several controllers to move forward in a one-dimensional linear movement. We know the transfer function of the robots and the ball.

The undesirable situations in this example could be that the robot 2 is too slow to be in the crossing point at the same time that the ball, or that the robot 1 does not give the necessary impulse to the ball to arrive to the crossing point, etc. Both robots have to agree on the time of doing the pass based on the knowledge they have of their dynamics. To do the pass, robot 1 will apply an impulsive kick to the ball and robot 2 will catch it in the crossing point. We want the ball arrives there at the same time that robot 2. Thus, the amplitude of the impulse will depend on distance to the meeting point, on the way in which the ball responds to this impulse (its transfer function) and on the time needed by robot 2 to arrive to the meeting point. But the latter condition depends on distance and on the transfer function of robot 2. The way to do it is modifying the parameters of the controllers. Once agreed, the robot 1 must kick the ball and robot 2 must be in the crossing point at the same time that the ball.

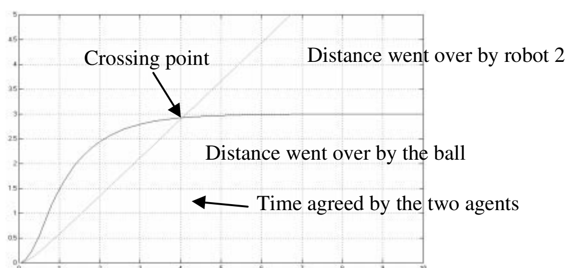

Fig. 2 *Distances went over by robot 2 and ball, the crossing point and the agreed time.*

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