Experiments of soccer robots system

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Abstract: The micro robot soccer playing system is introduced. Studying and learning, evolving in artificial agents are very difficult problem, but on the other hand we think more powerfully challenging task. In our laboratory, this soccer-system studies mainly centered on single agent learning problem. The construction of such experimental system has involved lots of kinds of challenges such as robot designing, vision processing, motion controlling. At last we will give some results showing that the proposed approach is feasible to guide the design of common agents system.

Keywords: micro robot soccer playing system, agent, vision processing, motion controlling

1. INTRODUCTION

At our laboratory we use micro robot soccer playing system (Robot-Soccer) as test bench to investigate multi-agent learning problem. The system is a robot contest that involves two robot teams to rival each other in scoring goal, very like that played by human.. At our laboratory we constructed system to do experiments.

In spite of these advantages, how to control agent system to accomplish assigned tasks successfully within a dynamic environment is a very challenging task. And in fact up to now it is not ideal in building up such an applicable system. The extreme difficulties mainly lie on the following two facts at lest. At first, there are too much uncertainties not only among agents but also between the interior system with the extern environment. Especially in real time system, the behavior of any agent will change the surroundings continually. Our before system is 3vs3 system, now our system change to 5vs5 system. On other hand, the errors and noise unavoidably exist in the sensor system. Those error and noise keep us from mapping the sensors input to the optimal output, especially in those system whose requirement to system real time ability is exacting. It is very important problem for vision system, lightning condition changed. We were thinking and testing this problem, few method is usefull.

These controllers handle such problem by pre-wiring the special behaviors with corresponding sensors input in advance. But such an approach suffers from several problems. For example, the increasing complexity of the design process made it impossible for designer to consider all conditions the agent may encounter so that the pre-wired behaviors show unable to adapt to circumstances unforeseen at design time. Efforts to resolve these difficulties bring about the ideal of decomposition of control architectures and mechanism of self-learning in natural. Up to now a number of learning algorithms have been utilized for this purpose including kinds of neural networks, reinforcement learning, evolutionary algorithms and genetic algorithms, genetic programming and so on.

Studying and Learning is faced to problem by an agent of how to obtain optimal problem-resolving policy through trial-and-error interactions with a dynamic environment. Agent's behaviors can be learned from two kinds of information. First in the case of agent associations can being provided, supervised learning takes place. Secondly, if existing agent's behaviors can be evaluated.

2. SOCCER ROBOT SYSTEM

In our laboratory, as a realistic experimental system for the research on the agent system, a kind of robot tournament system called micro robot soccer playing system is constructed.

2.1 Before robot soccer playing system

This system included two robot teams, each of which must be composed of three micro robots at least to play the game. Up to now several relatively complete regulations have been drawn up by some international organization concerned. This systems robot has simple components part, several time off parts or tire… We think soccer robot set up to more hard and useful body. In 2002 years, some offer is happened, we change a new system.

2.2 New system

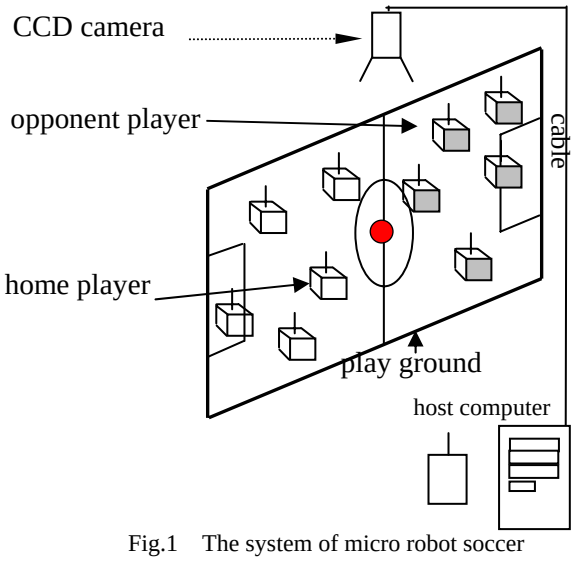


Fig.1 The system of micro robot soccer

host computer

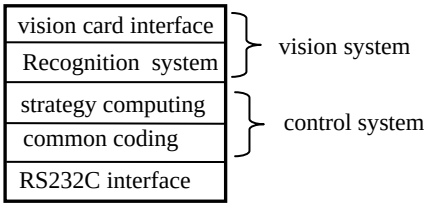


Fig.2 The system of host computer

Robot: 7cm x 7cm x 6cm. antenna 17cm
Ball: An orange(red) golf ball
Field size: 220cm x 180cm. wall tall 7cm
Computer: handmade, CPU P3, win98, graphics board, Video capture board, mouse and keyboard included

The new system include two robot teams like before system. It is changed before system three robots to five robots. In fact, this things is growing up to more complex system, we think.

The overview system is shown in Fig.1.

This robot equipped with two wheels driven by DC motor independently is used. No sensors are installed on the robot. The CCD camera serves as only sensors of whole system. The speed of vision sampling and processing must be fast enough to meet the need of control in real time. In our real system, because of using a high performance Vision Capture Card with the technology of Direct Memory Access, our system is capable of capturing vision frame from CCD camera with the sampling speed of 30frames/second. The software partition is developed using C++ language based on a personal computer.

Robot control process is below,

(1) capture a visual data form CCD camera
(2) recognition ball and robots position
(3) Strategy computing
(4) all home robot movement is decided
(5) coding of control signal
(6) control robot
(7) this process is continuously doing

2.3 Vision processing for recognition ball and robots

The vision processing is the first stage to the application of controlling a soccer robot. The sensor of the vision processing is one CCD camera only presented Fig.1. Mainly, Other soccer-robot system, itself has vision sensor on the robot, but in our laboratory, robot has only driving system proposal.

From it capturing visual data, host computer recognize not only the position, but also the reference angle, and robot potion. The experiment results of recognition objects and some considerations are given in [1]. Its image processing has been greatly increased by digital video special effects used in all kinds of fields.

A system for image processing is this. From an image digitizer, an image can be converted to numerical form with vision card interface before processing by computer. The basic principle is that:

(1) the image is divided into small regions called pixels
(2) the value of each pixel reflects the brightness of the image at the corresponding point
(3) Where are the black-white image has one value of brightness at each point, the color image has three values of brightness, hue,…

Although a number of control strategies may be applied to operate a soccer robot, achieving a good control effect remains a difficult problem. There are lots of methods of image processing, a method of fuzzy is given to keep visual tracking systems. As a result, main problem is lighting condition changes. Therfore we use auto attached value of brightness or hue by computation.

This image processing is below:

(1) Input (capture) Image form real vision system
(2) Pre-processing
(3) The basic principle (1)-(3)
(4) Computation and calculation
(5) recognition ball position form color patch in Fig.3
(6) recognition all robot position from image data

After recognition all potision, all robot movement is decided about strategies.

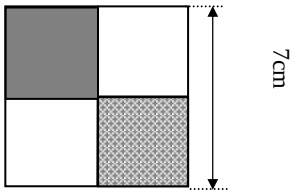


Fig.3. The color patch attached on top of robot

2.4 Soccer robot

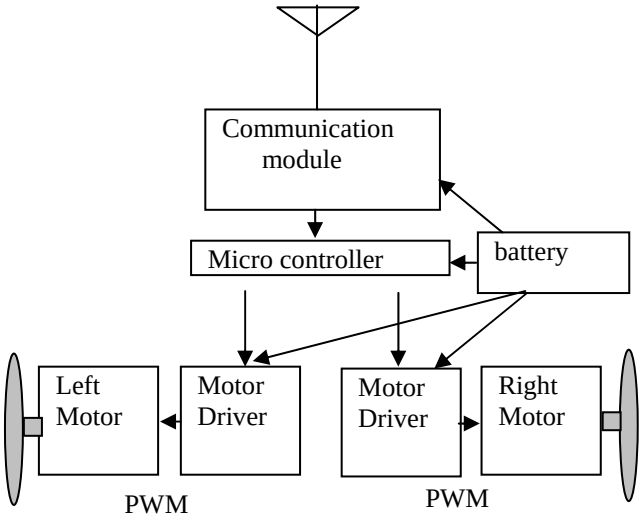


Fig4. Soccer robot system

Robot system consists of four parts; micro-controller, motor driver, communication, and power unit. The robot has a circuit board, battery, motor, and body (including wheels). The circuit board can be separated into the upper circuit board that has power devices, voltage regulator, motor driver, and RF module. The lower circuit board that has the micro-controller The motors gear, an inscribed gear is used. Encoder is included in the motor and its resolution is 512 pulses / revolution. If an external clock is selected, the timer counts on both the rising and falling edges of the clock. The robot has two DC servomotor controlled by pulse wide modulation.

3. Motor driving control method

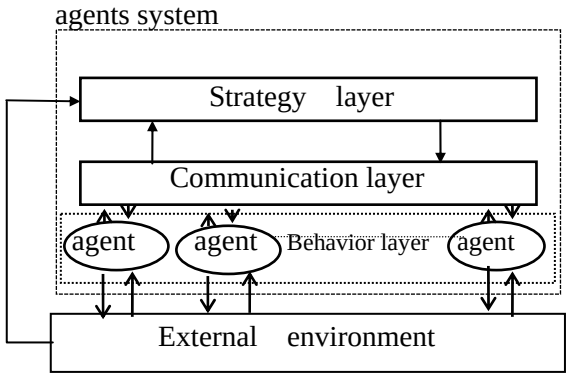
DC servomotors are controlled by the one board computer based on the singnal obtained from host computer using RF module. Two DC motors are driven by the pulse wide modulation (PWM) controller. This PWM Duty ratio is calculated by some methods, rule table, fuzzy and so on.

Fuzzy logic controller is described by the form of if-then rule such that

If e is Ai1 and ⊿e is Ai2

then ⊿u is Bi (1)

where e is present difference of robot and ball position and⊿e is change of difference and ⊿u is the difference of control value. The fuzzy logic control rule is described by if-then form. The fuzzy reasoning used is min-max method (Mamdani, 1974; Sugeno, 1985, 1988). The output from employed from the experiments for the fuzzy logic controller. We experimented for use this fuzzy rule and change the rule set. The comparison of the results obtained from the experiments, at first 0 point to 5 point, poor results, the after some experiments and change this rule and parameters, 3 point to 2 points. We need more sophisticated the fuzzy logic controller in the sense of stability and robustness. The fuzzy logic controller is the best among them in order to obtain smooth moving of this type robot.



Strategy: kick, pass, shoot, …
Agent: soccer robot
Environment: light, RF, ….
Behavior : drive robot motor

Fig.5 A simplified model of the agent system

4. Chosing soccer strategies

4.1 Developed method

Originally all of them were developed for solving single-agent learning problems. Recently multi-agent learning drew more and more attentions in several research areas. In our case, we use simulated soccer to investigate multi-agent cooperative learning. But here the micro-robot soccer-playing game is adopted as a standard test bed for the research on single-multiple agent system. Agent, multi robot, is controlled by one computer, not really muiti-agent system. Behavior layer is composed of agents themselves, which are basic behavioral cells of whole system. Communication and protocol layer supplies a information channel among agents and between the layers. In our lab., simulation is OK, no system is real system. It is our next step for this research. Strategy layer responds to analysis environment information in real time and make optimum decisions to guide the agent to complete the task assigned in advance. Cooporative moving is now developed. Some starategies was developed, Simple rule and short turn calculate is best usuful control.

4.1.1 By GA, GP before reserarch

Robot soccer contest is a kind of multiple robot tournament. In our case we try (3 by 3) and (5 by 5) games. At the same time the simple genetic algorithms (SGAs) is used for the autonomous evolution of cooperative behavior among micro-robots. This GA method was we can extend single-agent GP learning into multi-agent area. The simplest one is to learn all home player strategies separately where partners in the play field are treated as part of environment. Another approach named sub-group learning treats all home players as an indivisible group or several divided sub-groups. In our work we use simulated soccer to study intelligent multi-agent system. Especially we put our emphasis on how to co-learn multiple agents simultaneously..

5. EXPERIMENT

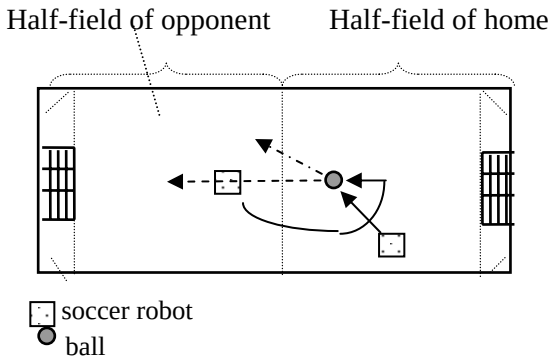


Fig.6 Experiment (same condition before research)

. For doing experiment, at first we create an initial strategy library manually considering those typical conditions. It is same condition of before research in fig. 6..

Then we experiments more sophisticated movement like this turn-round ball several times. And we chose good parameter of PWM fuzzy control. After that we train such initial strategy. After we obtain a relatively ideal result. Now the five real robots driven by the control method shown above play the game with opponents driven by our before version control method.

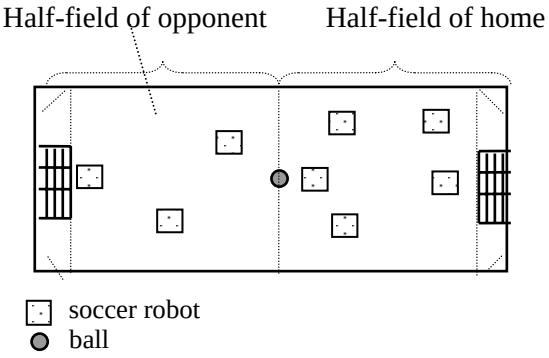


Fig.7 Experiment of real system

We have one system for five robot, experiment versus old version soccer robot. This experiments result presents in table 1. We joined competion, the score, first game 0 : 12, in this game our some robot was broken. We repair the system and tried to adjust the color, next game score was 3 : 2. Our control method was not good but bad..

Table 1 The results of experiments (3 minutes)

	Home	Opponent (first version)
3 vs 3	3	3
5 vs 3(old)	0	5
5 vs 3(new)	3	2

average score

6. CONCLUSIONS

In this paper, we show the new micro robot paying system, vision processing and control methods. The mode l is applied on a realistic experimental system of micro r obot soccer playing system. Learning model such as neur al network or Q-learning will be tried to emerge these b ehaviors autonomously. It is very difficults to install this system, but we must do next step for the soccer-robot. I n addition, the procession of scoring and feedback calcula ting is too simple yet and the online training strategy is of unsteady. In 5 by 5 game, we divide the home team i nto 3 sub-group of {2(attacker), 2(defender), 1(goalkeepe r)}. The sub-group learning works better than simple tea m learning. But some problems still exist. Our system, vi sion process includes some ploblem, britheness and so on. This problem is continuously mentioned, we tried some approach, auto-tuneing lights. Best approach is now not s olved. We must more study vision system. The motor co ntrol method is fited, Robot moving starategies up to dat e is our future work.

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