EIGEN Team Description

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Abstract. EIGEN team aims at establishing an intelligent control method for autonomous mobile robots, which can adapt to the dynamical environment. In order to achieve our purpose, EIGEN robot system is designed based on *System Life* concept which is proposed as one of the concepts for constructing artificial systems adapting to the environment. And, we propose some original methods for approaching to object, cooperative behavior, estimating ball-position and so on. This paper describes EIGEN robot system and related works.

1 Introduction

EIGEN, whose name comes from Enthusiastic, Intelligent and Global Engineering, has participated in the RoboCup Competition since 2001. In the laboratory of EIGEN team, intelligent control is one of the main research interests. RoboCup is chosen as a test bed of intelligent control method for autonomous mobile robots to achieve appropriate action in the dynamical environment. System Life concept [1] was proposed to make artifacts symbiotic with natural system. The robots are shown in Fig.1. We aim at establishing some methods to realize cooperative behavior, approach to the object, self-localization and so on based on the system life concept.

Fig. 1. EIGEN team's robot

2 Robot System

2.1 Background

System life concept consists of four elements, Sensing, Processing, Activating and Expressing that are governed by System Life information. Here, the system life information is defined as systematic and global information with respect to artifacts and their environments including the governing principle, the control objective, the design priority and so on of the systems.

From the viewpoint of the system life, intelligent control of mechanical systems, particularly robots have been already studied. In this study, we aim to prove effectiveness of the intelligent control based on the system life concept in the dynamical environment like RoboCup situation.

2.2 Application of System Life

The soccer robot system is designed based on system life as shown in Fig.2. The system includes environmental model, memory, estimated state, purpose and self-evaluation as the system life information. The robots consist of Sensing, Processing, Activating and Expressing; camera, CPU, motor, communication device and so on. This system has Integrator which selects actions by integrating system life information.

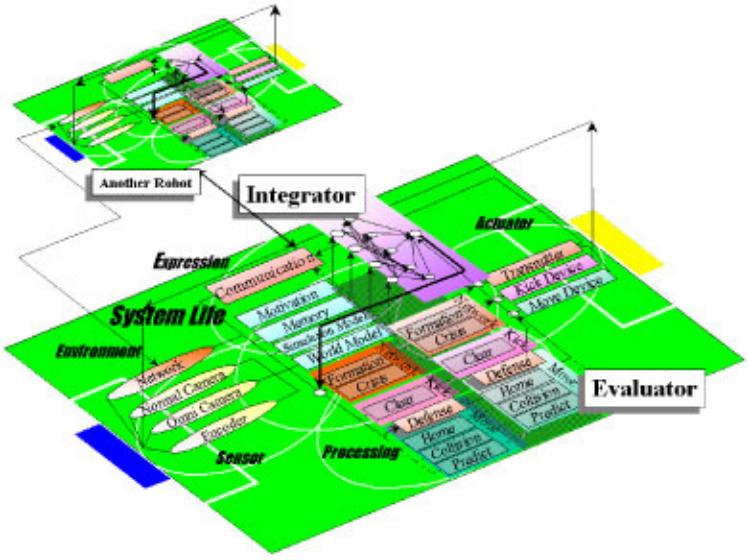

Fig. 2. System life concept on RoboCup soccer

In this study, two types of integrators are proposed, one is the rule-based integrator and the other is the integrator using a neural network learned with genetic algorithm. To combine the rule-based integrator and the neural network integrator is also proposed.

2.3 Approaching to the object

Fuzzy Potential Method [3] has been proposed for mobile robots to realize an effective approach to the object and avoidance of obstacles. Figure 3 shows the path of the robot. The robot can avoid the obstacles and approach to the ball by this method. This method uses Potential Membership Function from omni-directional vision. The omni-directional camera provides directional information with few errors and it is difficult to get accurate distance information. Furthermore, the information from mobile robots' views includes many noises in the dynamical environment. The advantages of this method are the robustness against the noises. The characteristics of potential membership function are easy to understand intuitively, since label is based on direction and grade representing the priority of the direction. To apply this grade for the speed control element, the robot is able to decrease the speed naturally near the obstacles.

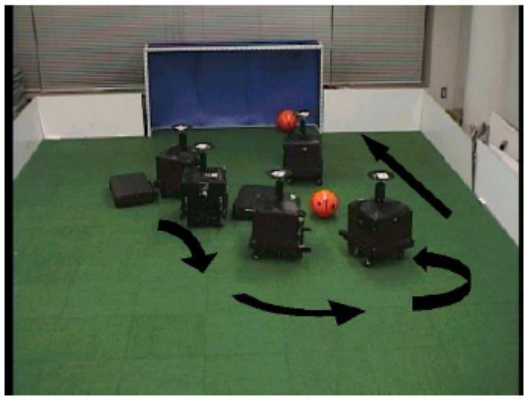

Fig. 3. The path of the robot

2.4 Cooperative behavior

The robot system uses a system satisfaction factor to realize cooperative behavior. The system satisfaction is defined as evaluation of achievement degree of team's objective. Each robot calculates the satisfaction value according to the situation and shares information via the wireless LAN. In this method, each robot communicates not directly sensory data but qualitative evaluation data. This method enables the system to perform flexible cooperation by selecting behavior based on the calculated global evaluations and the objectives.

The robots, which act as the defender or the midfielder, determine the waiting position according to Dynamic Potential Method.

2.5 Self-localization

The robots are equipped with an omni directional camera and odometers as sensors. The robots estimate the self-position and the world model using these sensors. In this case, the world model is defined as a model of the field on robot's egocentric reference frame. The robots are able to get the distances and the directions from landmarks by this model.

The outline of our Self-Localization method is shown in Fig.4. At first, the robot recognizes landmarks by processing the omni directional image. Secondly, the robot estimates self-position and constructs the world model from the information about observed landmarks by LMedS estimator. By this estimation, the first position of the robot on allocentric reference frame is determined. Next, the robot estimates the self-position and the world model using three methods. One is the method using odometers and the others are the method using omni directional camera. These methods are used in parallel. The two process results are evaluated, and better estimated result is selected. Then, these processes are repeated.

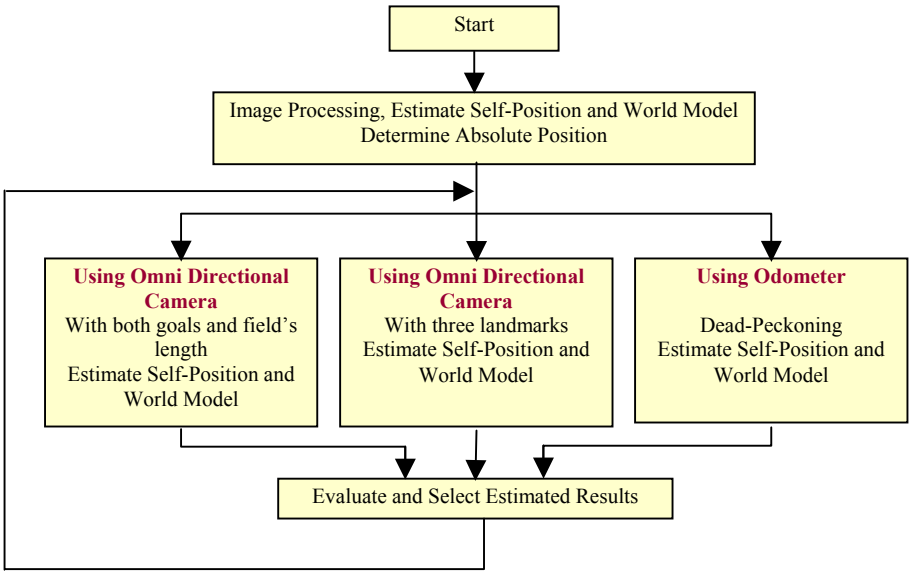

Fig. 4. Self-Localization method

2.6 Estimation System

Ball-position is calculated by Euler's method and Kalman filter through omni-directional vision. Furthermore, the short-term memory for robots is used to estimate present ball-position without ball-position information by occlusion. The estimated information provides adaptation to the dynamical environment and robustness for lack of information.

3 Conclusions

An intelligent control method for autonomous mobile robots was presented through participation in the RoboCup project. In the method of intelligent control, some method about approaching objects, cooperative behavior and estimation of ball position were proposed based on System Life concept. EIGEN team tries to verify an effective intelligent control method for mobile robots in the practical field.

References

1. K. Yoshida, ”Intelligent Control Using Cubic Neural Network”, Systems Control and Information, Vol.43, No.7, 1999, pp.328-336 (in Japanese).
2. K. Yoshida, “Intelligent Control Using Cubic Neural Network Possessing System Life”, Proceedings of International Symposium on System Life, JSME, No.97-209, 1997, pp.185-190.
3. R. Tsuzaki, K. Yoshida, “Motion Control Based on Fuzzy Potential Method for Autonomous Mobile Robot with Omnidiractional Vision”, Journal of the Robotics Society of Japan, Japan Robotics Society, Vol.21 No.6, 2003, pp.656-662 (in Japanese).