Evaluation of real robot performance with different control program structures

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PURPOSE

Computer simulations have been performed by many robot researches.

However, unlike the virtual world, various noises and restrictions exist in the actual world, and they influence a real robot by them. The purpose of this research is to implement distributed control programs and to estimate the performance. As a real robot, a consumer product called MindStorms of LEGO Co. was used.

BACKGROUND

How to use multiple robots has been studied for various kinds of problems which single robot cannot solve. There are three kinds of methods to control multiple robots as follows:

1) central control: The central control method collects immediately all the information that the robots acquired in the environment, judges by the global information, and controls each robot.
2) distributed control (with communication): Each robot processes an independent task while it communicates each other.
3) distributed control (without communication): Each robot processes an independent task without communication.

Since each system has both of merits and demerits, we cannot conclude that which

system is most excellent. However, the distributed control methods are expected to be more robust than the central control, because each robot controls itself independently. In this research, we focus on the distributed control without communication because of the robustness and lower cost.

EXPERIMENTS

In this research, in order to analyze the control program structure suitable for autonomous mobile robots, the characteristics by the differences in control program are evaluated.

The problem of pushing twice a target is given to the multiple moving robots and each program structure is evaluated by comparing the results. The goal of this problem is to find the target and push it twice from the front and the back. The control program of the robot, in which behavior-based approach is implemented, consists of three modules for corresponding basic actions as follows : search, evasion and pursuit. Especially the search action and pursuit action are very important for this problem. Then four control programs with different kinds of program structures to make these actions were designed as described below.

①1 task type: The search action and the pursuit action are executed in one task.

②2 task type: The search action and the pursuit action are executed in two independent tasks, respectively.

③multiple task type: The search action is executed in multiple tasks, and the pursuit action is executed in one task.

④OnlyTouch type: This type does not execute the pursuit action, but the search action only.

RESULT

Four kinds of control programs were implemented in the real robot, and the performance in the problem was evaluated by average time to reach the gorl. When multiplex comparison was performed by statistical hypothesis at 5% of significant levels, the results are obtained as follows.

①and②, ①and④, ②and④, ③and④: These combinations have significant differences.

①and③, ②and③: But these combinations have no significant differences. Analyzing these results, we conclude that it is effective to watch the environment continuously by the sensor, even if the control module have more load by the increase in the number of tasks.

CONCLUSION

From the above-mentioned result, the structure that assigns all actions to respectively

independent tasks is suitable for an autonomous moving robot's control program.

In the near future, moving robots will be sold as a consumer product. It will be required to balance the cost against the performance to produce such a consumer robot. In this research, autonomous moving robot was implemented using MindStorms, which have limited restrictions. Even if the hardware has low capability, we showed that the robot can adapt itself to the environment dynamically. The method using a consumer level robot in this research suggests one approach to low costs of moving robot products.