

Title	自律移動ロボット群による環境に適応した編隊移動制御に関する研究
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Generation of formation for multiple autonomous mobile robots adapting to an environment

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The conventional work robot repeated the pre-programmed motion in the fixed position. Nowadays, many types of autonomous robots that judge an appropriate action for given task have been developed. With this advance of the robotics technology, researches related to formation control have enabled the robots to achieve a task with cooperation. Cooperative multiple robots in formation have advantages in efficiency, fault-tolerance, costs per robot, and generality comparing with one high-performance robot. They are expected to be applied to a variety of areas, such as mine exploration, load carriage, scout, security, and rescue.

It is necessary to have the following functions, when the robot group carries out the cooperative work in formation.

- a. To establish some formation pattern from random separated position.
- b. To maintain formation pattern while moving.
- c. To change the pattern of the formation.
- d. To avoid the obstacle or pass through the narrow space while keeping formation.

Various researches related to the formation control with multiple autonomous mobile robots are mainly divide into (a)achieving the specific formation pattern and (b)(d)keeping the formation pattern while moving in the environment with obstacles and narrow spaces.

This paper noticed that many researches related to (a) have not come to establish the various patterns of formation, and even did not consider (b)(c)(d). If the robot group can form various patterns, it will be possible to adapt to environments by changing patterns from one to another. Also, it is necessary to consider both the mechanisms of forming and maintaining patterns simultaneously. Although there are a few researches that have considered (a)(b)(c), those researches depend on the specific devices such as the different appearances of the robots and the sensors to distinguish each robot.

In this paper, I present a new algorithm to achieve the variety of pattern formation for the group of anonymous autonomous mobile robots, which does not require any distinctions among robots. By this algorithm incorporated into every single robot, the robot group can achieve desired formation patterns from random positions. Besides, the algorithm makes it possible to change pattern and maintain it while moving.

There are three important elements to achieve mobile formation: common coordination, roles for each robot, and existence of a leader robot. Common coordination enables the robot group to make an agreement on the positions to make the formation. The roles allocate the positions of vertexes or sides in the formation pattern among robots. Deciding one robot as a leader, the robot group can move as a unit entrusting the path planned by the leader robot.

Acquiring these elements for randomly positioned anonymous robots is enabled by the gradual agreement on common knowledge. Common knowledge is the direction or the position that every robot recognizes commonly. First, robots get one common knowledge that can obtain in a relatively easy way, then they can get another common knowledge by using the one that was obtained before. By repeating this, the robots are enabled to acquire the common coordination and to decide the roles and the leader.

With these elements, randomly positioned anonymous mobile robots can

form a lot of mobile patterns. Robot group decides leader and roles dynamically, so formation is robust against the loss of the group members by any troubles.

From the simulation results of this algorithm, it is shown that randomly positioned anonymous robots can achieve many types of formation patterns. Moreover, the robots maintain the patterns while moving and change the patterns if necessary. Also, robots pass through a narrow space by changing the pattern adapting to the space.

By the above, this paper shows the possibility of the formation movement control adapting to environments for multiple autonomous mobile robots.