Rearrangement task using multiple mobile robots
(Prof. J. Ota)

A rearrangement of multiple objects is a basic manipulation task. The applications of a rearrangement system are numerous, such as manipulating objects and assembling parts. Generally, distributed autonomous systems using multiple robots are considered superior to others in terms of reliability, expandability, and flexibility.

The cost for a robot to convey a specific object depends on the configurations of objects other robots are conveying, all robots and objects, and the environment (e.g., walls). In some cases, there are constraints among tasks, which require a sequential execution. Because of very high computational complexity, it is infeasible to calculate all constraints beforehand.

Much research has been conducted on this subject, which can be classified into two main topics: (a) variation of the basic motion planning, (b) multi-robot cooperation. Approaches in (a) assume several (not more than 5) objects and that environmental information is always completely known to the robot. Researchers in category (b) have focused on rearrangement projects with a low degree of complexity. However, as far as we know, no research has been conducted on a rearrangement task requiring multiple robots in a dynamic environment. We developed a rearrangement system using multiple robots in an iterative manner of planning and execution.

To decrease the computational complexity, we classified task constraints into three groups and a different strategy is applied for each group as shown in Fig. 1: (I) constraints that can be calculated by the initial and the goal configuration of objects, (II) constraints that require path planning repetition before they can be detected, and (III) constraints depending on the relationship between robots. Group (I) has low computational complexity; therefore, a robot attempts to locate this group at every allocation process. Group (II) requires a higher computational complexity; therefore, robots accept these kinds of constraints only in cases in which allocated tasks are inachievable. Group (III) requires the highest degree of computational complexity to determine its influence. The proposed system has been tested in a simulated environment (Fig. 2).

Keywords: Multi-robot cooperation, Task constraints, Rearrangement problem, Movable objects, Mobile robots

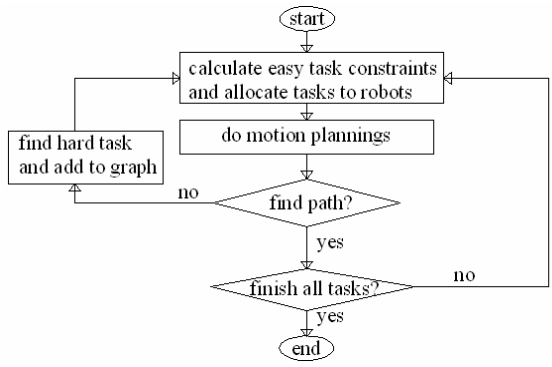

Fig. 1 An overview of the system

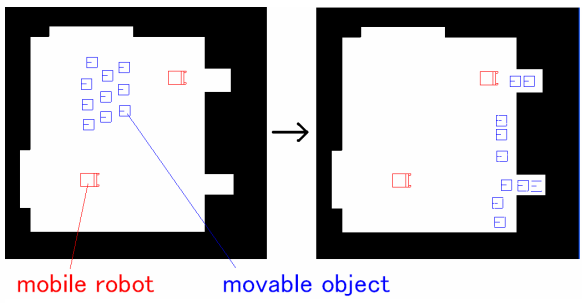

Fig. 2 A rearrangement task with two robots and ten object