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Cooperative transport in an unknown environment associated with task assignment

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This paper deals with a task-assignment architecture for cooperative transport by multiple mobile robots in unknown environment.

A group of mobile robots that works in a coordinated manner has potential to be a flexible material handling system because of their ability to take a free formation. So far, the focus of research on this topic has been on control problems, e.g. methods to control internal forces or to optimize handling positions (regrasping). The final goal of cooperative transportation is to handle a given object until it achieves a given configuration. However, in places such as construction sites and distribution centers, robots will share their work space with other robot groups or humans. That means that not all of the environmental information can be acquired *a priori*. Therefore, it is necessary for robots to satisfy various requirements besides handling an object (Fig. 1): recognition of their own position based on known landmarks, searching around to detect unexpected situations as soon as possible, removing the object obstructing their way, instructing a moving obstacle (e.g. a human) to get out of the way, etc. In this paper, we call these various requirements 'tasks' and focus on a task-assignment architecture.

The architecture should satisfy three features. First, it should deal with the variety of tasks in time and space. Second, it should deal with an execution order/timing of tasks even if there exists a large amount of tasks compared with the available number of robots. Finally, it should decide on the robots' behavior in real-time. The authors propose the following approach. (a) We consider the

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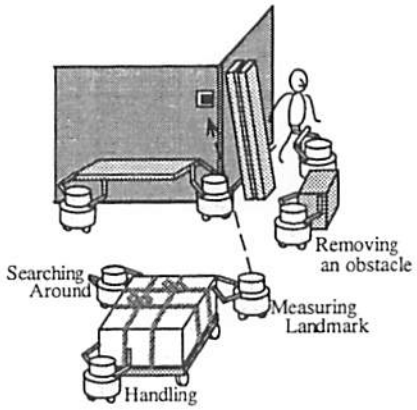

Figure 1. Cooperative transport in an unknown environment.

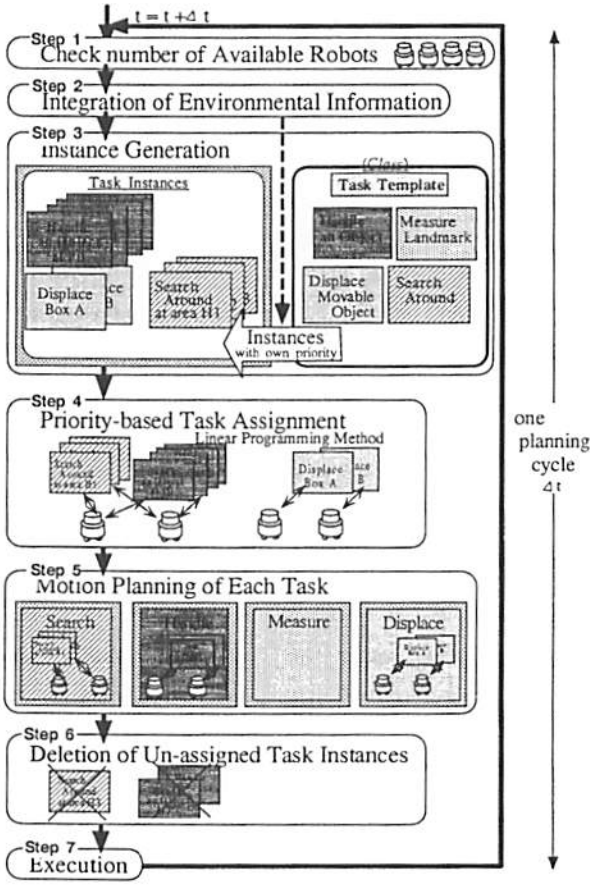

Figure 2. Profile of the task assignment architecture.

unit of task (task instance) as the form that should be done in a short time by one robot. Task instances are dynamically generated using task templates by inputting environmental information. (b) The priority of each task instance is evaluated

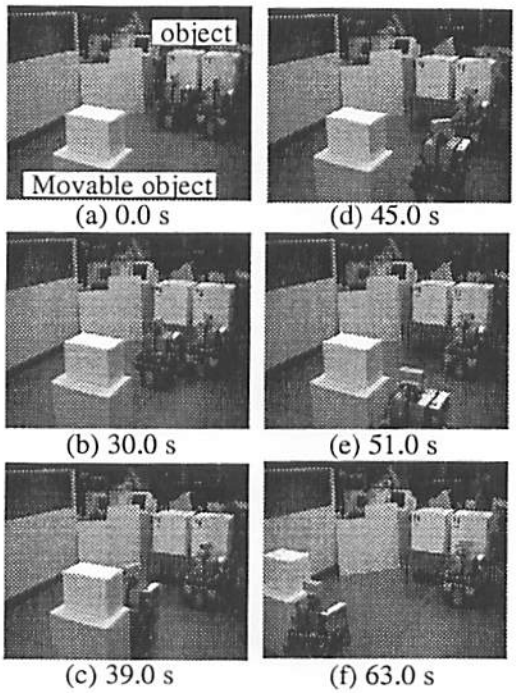

Figure 3. Experimental results.

dynamically based on the number of robots and the configuration in the work space. Then a task-assignment problem for the short term is formulated, which we call the 'assignment problem', which can be solved in real-time by using a linear programming method. A robots' behavior is planned by iterating the following every constant sampling time: generation of task instances, priority-based task assignment and motion planning based on an estimation for a short period of time (Fig. 2).

The effectiveness of the proposed architecture is verified by a cooperative transport simulation and also by an experiment using two omni-directional robots (ZEN) in an unknown environment (Fig. 3).

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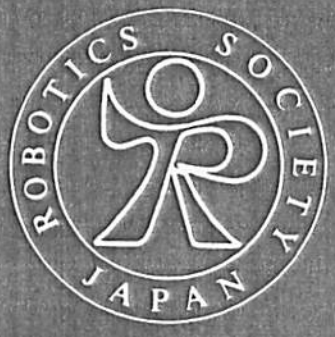

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