Part Dispatching Rule-Based Robust Multi-Robot Coordination against Goal Variation in Pick-and-Place Task

In a pick-and-place task, goal variation occurs because the parts on the conveyor are fed following a certain probability distribution with various random seeds. To make the manipulator system complete the task reliably and efficiently, the robust solution should be obtained against goal variation.

In this study, we propose a method (Fig. 1) to obtain a robust solution against goal variation in a pick-and-place task. The multi-robot conveyor system is used to complete the task (Fig. 2). The part flow is considered as the performance index. The combination of part dispatching rules is set as the design variable to coordinate the actions of robots. In the proposed method, the greedy randomized adaptive search procedure (*GRASP*) is utilized to search for the appropriate combination of part dispatching rules [1]. The Monte Carlo strategy (*MCS*) is used to estimate the minimum-maximal part flow for one combination of part dispatching rules. The proposed method (*GRASP+MCS*) is verified to be effective and practical through a comparison with two methods through simulations. The task completion success ratio derived by the proposed method can reach 99.4% for 10,000 patterns (the process of feeding parts on the conveyor following a given probability distribution with 10,000 different random seeds), which is improved by 73.3% and 19.6% relative to that derived by *O_GRASP* and *GRASP+GA*, respectively (Table 1).

Keywords: Part dispatching rule, Multi-robot conveyor system, Robust optimization, Goal variation, GRASP, MCS

Reference

[1] Y. J. Huang, R. Chiba, T. Arai, T. Ueyama and J. Ota, Part Dispatching Rule-Based Multi-Robot Coordination in Pick-and-Place Task, In Proceedings of the 2012 IEEE International Conference on Robotics and Biomimetics (ROBIO2012), 1887/1892, (2012).

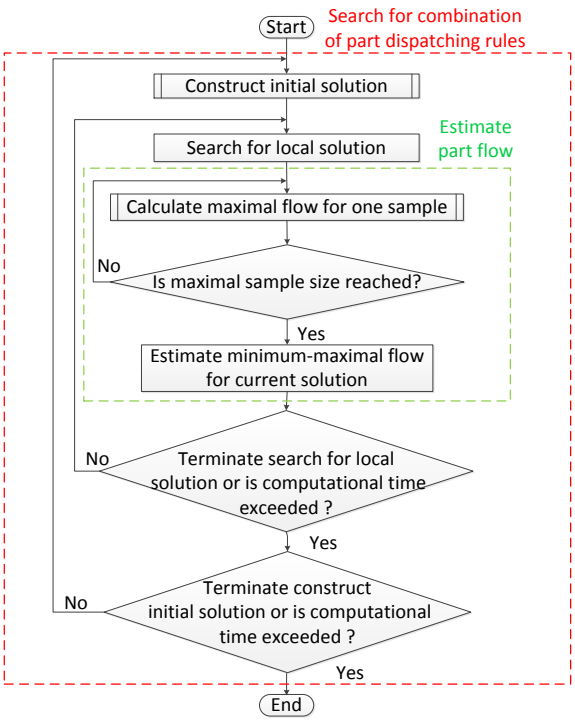

Fig. 1 Proposed method

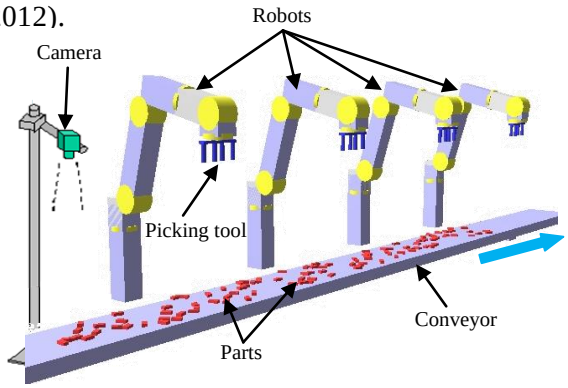

Fig. 2 A multi-robot conveyor system that consists of multiple robots, a moving conveyor, a picking tool with multiple absorbers, and a camera.

Table 1 Solution obtained by using three different methods

Method		*O_GRASP*	*GRASP+GA*	*GRASP+MCS*
Obtained solution	Obtained combination of part dispatching rules	(SR, SR, SR, FIFO)	(SPT, SPT, SPT, FIFO)	(SPT, SPT, SPT, FIFO)
	Estimated part flow (piece/s)	17.1	17.0	15.8
Task completion success ratio		26.1%	79.8%	99.4%
Computational time (h)		0.3	10.0	10.0