# Integrated Design of Multi-Robot System for Pick-and-Place Tasks

To improve the productivity, reduce the purchase cost, and apply a multi-robot system for a pick-and-place task quickly, the appropriate robot arms and their base positions should be rapidly selected. However, a large computational time is required to select the appropriate robot arms and their base positions because they are selected by the experienced engineers through evaluating the performance index in several trials.

In this study, we call the selection of robot arms and their base positions as integrated design of multi-robot system and propose a method (Fig. 1) to rapidly realize the integrated design of multi-robot system (Fig. 2). We use the multi-objective particle swarm optimization (MOPSO) to select appropriate robot arms from a set of candidate robot arms to make up an appropriate multi-robot system, use the particle swarm optimization (PSO) to search for the base positions of the robot arms, and use the *M/M/1* queuing model with impatient customer to estimate the performance index. A simulation proves that the proposed method is effective and efficient in comparison to a comparative method that uses simulation-based statistical inference to estimate the performance index. The robot arms and their base positions derived by the proposed method are similar to that derived by the comparative method. The computational time for the proposed method is 0.48 hour, which is less than 1/20 of the computational time for the comparative method (Fig. 3).

***Keywords:*** integrated design of multi-robot system, MOPSO, PSO, *M/M/1* queuing model, pick-and-place task

**Reference**

[1] Y. J. Huang, R. Chiba, T. Arai, T. Ueyama, and J. Ota, Integrated design of multi-robot system for pick-and-place tasks, in Proc. IEEE Int. Conf. on Rob. and Bio., pp. 970-975 (2013)

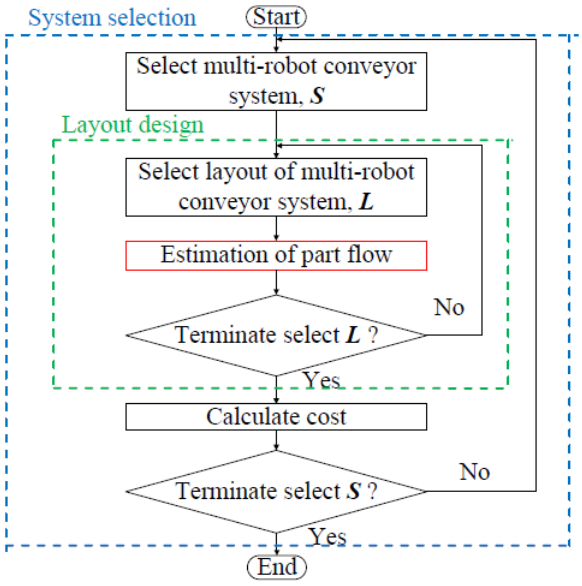


**Fig. 1** Proposed method

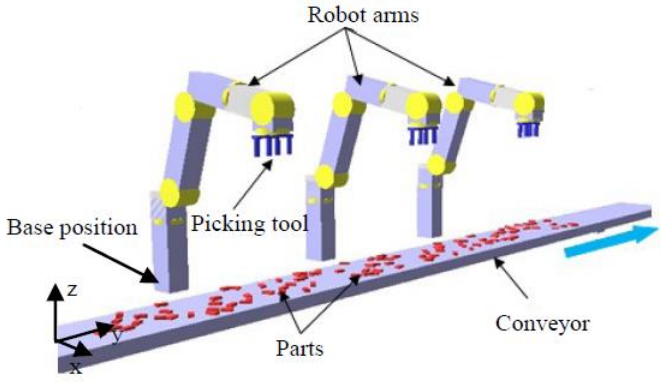


**Fig. 2** A multi-robot system consists of multiple robot arms

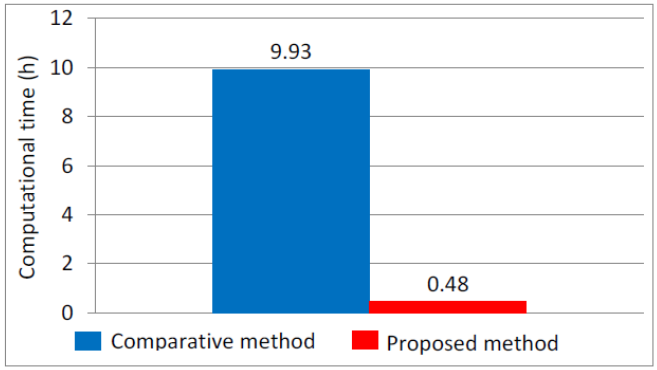


**Fig. 3** Computational time for proposed method and comparative method