Robot System Arrangement Using Experience-based Hierarchical Optimization Methods

Industrial robots perform various tasks such as welding, assembling, spraying, and transportation in practical industrial environment. Although the motion planning or motion planning of the industrial robots are mostly focused on to improve the working efficiency, it is also highly influenced by the arrangement of the robot environment components, such as the base, conveyors, sensors, objects, and robots, during the execution of these tasks. Moreover, if the environment of a robotic system changes, the robot's motion must also change, even if it performs the same task, leading to significant changes in its tact time or energy efficiency. Therefore, the location and arrangement of the robotic environment significantly impact industry efficiency, and to enhance the productivity of a robotic system, it is crucial to have a proper setup of the robot system environment, along with planning effective robot movements.

However, most of conventional studies focused on the motion planning or path planning among those two aspects, hence, there is few studies which developed the algorithm to identify both optimal motion and environment arrangements. Therefore, this study proposed the new optimization methods for industrial robotic system which can facilitate both robot motion and environment arrangements' optimization. Specifically, to address the difficulty of combined optimization problem of motion planning and environment arrangement, we used hierarchical algorithm [1] and experience-based method [2-3]. The former is to decompose the complicated problem into more simple ones to reduce the calculation cost, and the latter is to reuse the past solutions in similar optimization problem to find optimal solution faster, and we introduced two experience-based method for both motion planning and environment arrangement part.

To verify the effectiveness of the proposed method, we conducted the simulation experiment with a pick and place robotic system (Figure 1). In the experiment, the optimal robot motion from pick position to the place position, and positions of conveyors are calculated and compared with conventional techniques. Figure 2 shows the results of the experiment. As shown in Figure 2, we can solve combined optimization problem faster than conventional methods though our proposed method (left plot in Figure 2). Based on the results of this study, we will add further improvements on the proposed method.

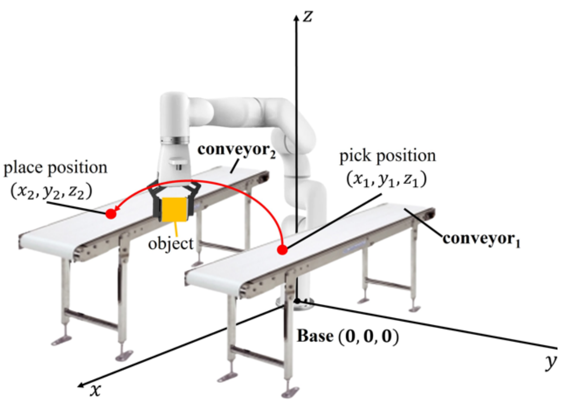

Figure 1. Schematic image of the typical pick and place robotic system.

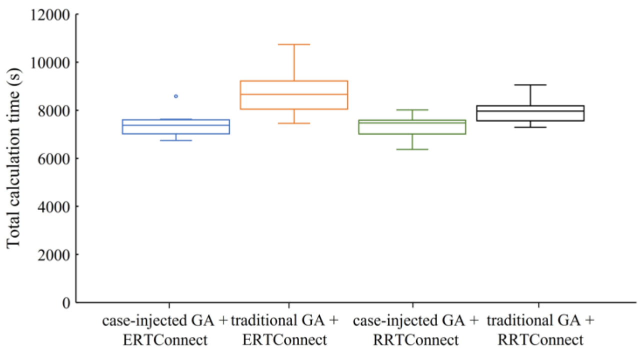

Figure 2. Boxplot of path length of four combinations of method.

Keywords: Robot motion planning, Environment arrangement, Experience-based optimization

References

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