Dual-arm demonstration based single-arm robot motion planning for pick and place task

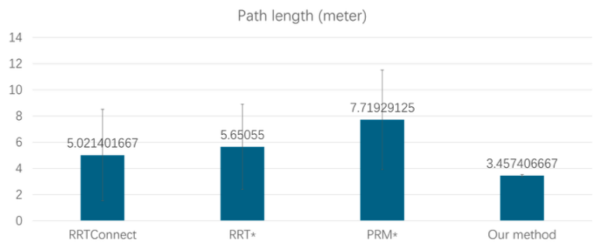
Demonstration-based learning has achieved great success in the area of robot motion planning [1]. In this process, a human demonstrator shows the ideal motions to the robot, and the robot tries to reproduce it. In general, the human demonstrator can only use the single hand to show the demonstration to the single arm robot even for the task where the human usually uses bi-manual hands (e.g., [2]). This is because the differences in the structure of the human and the single-arm robots. However, these "unnatural" demonstration may decrease the effectiveness of the demonstrations.

Therefore, on the basis of the above background, this study developed new demonstration-based motion planning algorithm which can facilitate the plan of the single arm robot using dual arm demonstration of humans. Figure 1 shows the target task of this study. In the process of the proposed algorithm, it first identifies the points that the human's both hands in the closest position. This point represents the change of the hand to be an effector to add the force to the target object. Then, the motions of both hands before and after this point are connected and generated the entire trajectory. Because the trajectory discretely "jumps" in the connection point, the low-pass filter was applied to smooth the data. Finally, the obtained trajectory information in the 3-dimensional space was converted to the robot motion in the configuration space by solving the inverse kinematic function. Through these processes, a single arm robot can learn how to solve the planning problem from a human's bimanual demonstration.

To verify the effectiveness of the proposed method, we conducted the experiment. In the experiment, the motion of the robot in the task shown in Figure 1 was evaluated and compared with some existing algorithms. The experiment results revealed that the proposed algorithm can solve the planning problem with higher success rate than the existing algorithms (Figure 2 (a)), and also increase the quality of the solution path (Figure 2 (b)). Based on the results of this study, we will add further improvements on the proposed algorithm, and verify the effectiveness of it in the more realistic situations.

Figure 1. The target task of this study.

(a) Success rate



(b) Path length

Figure2. The results of the experiment. (a) Success rate, (b)Path length.

Keywords: Motion planning, Learning from human demonstration, Bimanual motion

References

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