Learning difficult robot motion from human demonstration collected via a single RGB camera

Demonstration-based learning has achieved great success in the area of robot motion planning. In this process, a human demonstrator shows ideal motions in the target task using some demonstration techniques, such as kinesthetic teaching, in which human operators directly contact and move the robot end-effector [1], or teleoperation, in which human operators indirectly move the robot through the controller and some other devices [2].

In this study, we propose a new demonstration-based motion planning method that can facilitate difficult motion planning problems in cluttered environments by using only human motion data collected via a single RGB camera as demonstration data [3]. Since existing methodologies in this research area require expertise in robot systems or robot motion planning, using such a simple measurement system (a single RGB camera) to facilitate robot motion planning is worthwhile from the viewpoint of the application.

Figure 1 shows an overview of the proposed method. As shown in Figure 1, the human demonstrator first shows the ideal motion in the target task in front of the RGB camera, and the motion is recorded as image data (Figure 1(a)). Then, the three-dimensional human skeleton information is extracted from the recorded image using skeleton recognition software, which serves as the demonstration data for robot motion planning. The extracted skeleton data is converted to the robot motion through the optimization process and saved as the motion template (Figure 1(b)), and then used as the demonstration data for solving difficult motion planning problems as shown in Figure 1(c). The point of this approach is that the extracted human skeleton data includes a large amount of noise, which decreases the reliability of the demonstration data. Hence, it cannot be directly used as the "strict solution" of the robot motion planning problem. To address this issue, we specifically introduce the path modification and adaptation process to fit the primitive robot motion generated from unreliable human demonstration data to the new environment [4].

The results of simulation experiments showed that our proposed method can solve difficult motion planning problems faster and with a higher success rate than the state-of-the-art motion planner. Based on the results of the simulation experiment, we will add further improvements to our proposed method and enable its use in more practical situations.

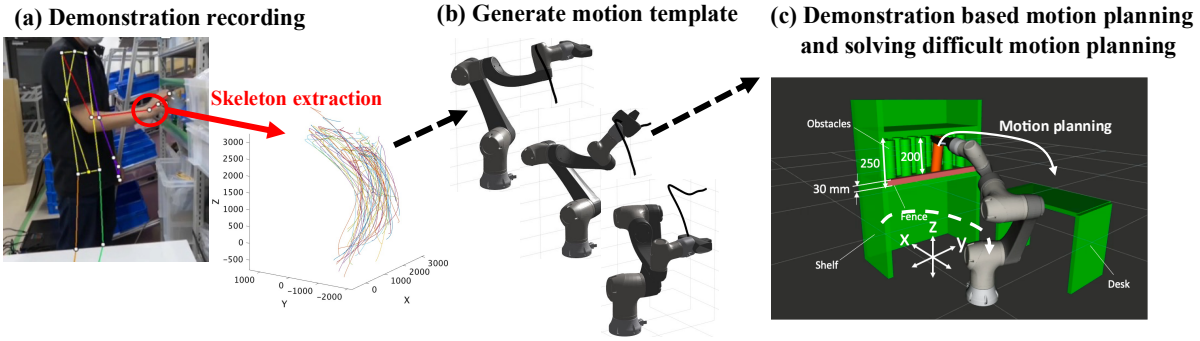

Figure 1. Overview of the proposed method. (a) Recording human motions and skeleton extraction, (b) Generate robot motion template based on the recorded human motion data, (c) Demonstration-based motion planning and solving difficult motion planning problem in the cluttered environment.

Keywords: Lerning from Demonstration (LfD), Motion Planning, Skeleton Recognition

References

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