Measurement Pose Optimization for Joint Offset Calibration with a Hand-Eye Camera

Accuracy of the robot motion manipulation is critical aspects for industrial manufacturing, since industrial robot arm owes various delicate works, such as assembling and welding. Hence, calibration of the robotic arm is very important processes for the practical industrial situations. In this regard, robotic manipulators' motion accuracy can be affected by several factors, such as manufacturing tolerance, set-up errors, and wear and tear. While online teaching can ensure that manipulators coincide with the desired and actual motions, it can be a lengthy and resource-intensive procedure. Offline teaching with robot calibration can reduce the cost of online teaching, but joint offset calibration is essential for accurate motion. Several methods for calibration have been proposed, including using specialized equipment to constrain the end-effector or tracking a laser pointer. However, joint angle offsets can account for up to 90% of the RMS value of the error, and joint offsets often change with daily use, making calibration an ongoing challenge.

To address this challenge, researchers have proposed using a single camera and a marker on the ground for calibration. However, the accuracy of pose estimation using this method is lower than laser tracking because of physical constraints. Therefore, in this study, we propose a new method for determining optimal measurement poses using a hand-eye camera and a marker. Based on the previous observability index O1[1], we proposed a new index Ov1 to evaluate the effect of the error in the pose estimation based on the camera images on the offset calibration. The offset calibration with the marker measurement at the poses, which obtained the optimization to maximize the proposed index, realized higher accuracy than other approaches. Figure 1 and 2 shows the comparison of the optimized pose for calibration by the hand-eye camera. As shown in these figures, the calculated poses from our proposed method are different from the one calculated from the method of previous study. Based on the results of this study, we will add further improvement into the proposed method to achieve higher precision which can be applicable in the practical situations.

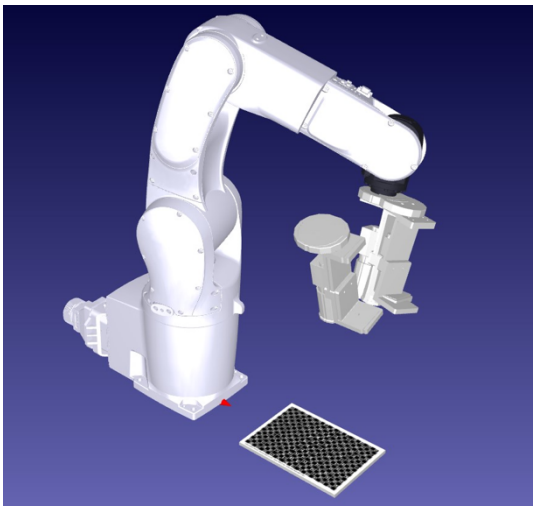

Figure 1. Optimized poses by the method of previous study [1].

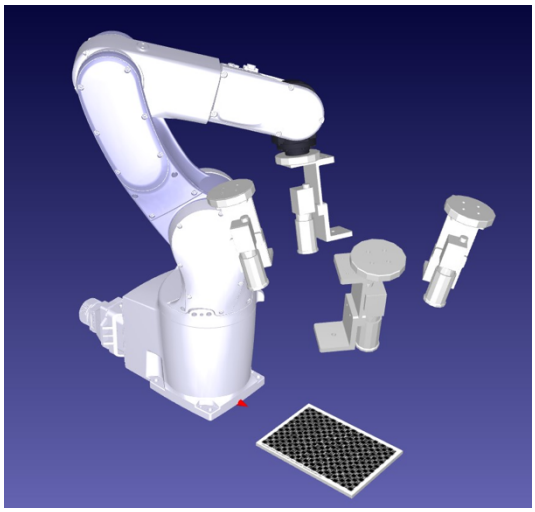

Figure 2. Optimized poses by our proposed method.

Keywords: Calibration, Measurement pose optimization, Hand-eye camera

References

[1] Jin-Hwan Borm and Chia-Hsiang Meng. Determination of optimal measurement con- figurations for robot calibration based on observability measure. *The International Journal of Robotics Researc*h, 10(1):51–63, 1991.