

Measurement Pose Optimization in Robot Calibration Using a Hand-eye Camera

A kinematic model for controlling a robot is constructed based on kinematic parameters such as link length and joint offset. However, the kinematic parameters are subject to errors due to factors such as variations in robot processing and assembly and thermal expansion. Therefore, correction of the kinematic parameters, i.e., robot calibration, is necessary. In recent years, however, the use of hand-eye cameras has been attracting attention for its simplicity. However, the measurement accuracy of the camera is relatively low, and the calibration accuracy also decreases. In other words, there is a trade-off between the ease and accuracy of camera measurement.

On the other hand, it has been reported that the accuracy of robot calibration depends on the measurement pose, i.e., it depends on what pose the robot is placed in for measurement. In this regard, there is a study that optimizes the measurement pose under a certain constraint by sensitivity analysis of the relationship between the measurement pose and kinematic parameters. However, this method cannot be applied to robot calibration using a hand-eye camera, because the hand-eye camera must be able to capture the calibration marker, and the constraints of the robot hand change depending on the location of the marker.

Based on the above background, in order to achieve high accuracy in robot calibration using a hand-eye camera, we have proposed a method to optimize the measurement poses considering the constraints imposed by the hand-eye camera. By taking into account the effects of noise in the camera image on the estimation of the hand pose and the effects of errors in the hand-eye pose on the robot calibration, we can find a calibration pose that is less sensitive to the accuracy limitations of the hand-eye pose measurement by the camera through optimization. For example, simulation results show that an optimized measurement pose can be obtained as shown in Fig. 1, which confirms the improvement of calibration accuracy. Compared to conventional calibration using specialized equipment, this approach enables highly accurate robot calibration with a simple setup.

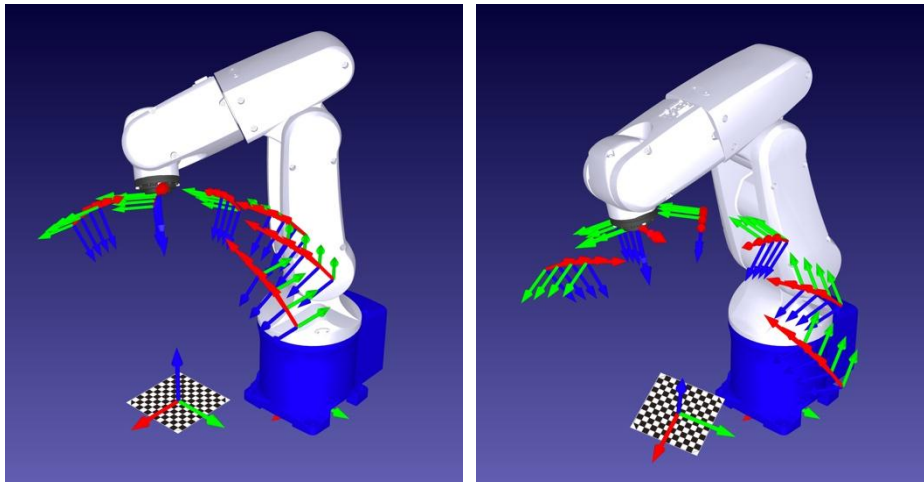


Fig.1 (Left) Initial measurement pose. (Right) Optimized measurement pose.

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