

Based On Assembly Features and a Consistent Coordinate System, Pose Measurement and Spacecraft Component Assembly are Performed

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Abstract

It is essential to measure the relative spatial pose (position and orientation) of the assembly features of the spacecraft components prior to assembly in order to assemble spacecraft automatically and correctly. The global measuring approach is primarily used to direct assembly control for big spaceship components, however its accuracy and effectiveness have eventually fallen short of expectations. An innovative measurement technique is suggested to deal with this problem. The suggested approach measures it directly to ensure the compatibility of the measurement and assembly coordinate systems since the objective is to measure the relative spatial posture of the assembly features of the spacecraft components. Because it may lessen the impact of structural parameter mistakes and is not constrained by the size of the spacecraft components, this technique has the advantage of high precision.

Keywords: Precision assembly, Consistent coordinate system, Spacecraft component

Introduction

The final step in the production of a spacecraft is assembly, and the precision and effectiveness of this step directly influence the spacecraft's service performance and lead time. Currently, manual assembly is still the main method used to manufacture spacecraft, in which employees use crude measuring and handling tools to complete the assembly operation. Due to a lack of accurate motion control and real-time data feedback, assembly activities using this method are inefficient, risky, and have low precision. The accuracy and efficiency standards for the assembly task are rising in line with the expansion of space exploration missions in order to enhance the functioning and performance of the spacecraft, thus it is evident that the current method cannot meet these standards. Using robots rather than trained labourers to carry out precise and sophisticated processes in industrial automation has become a common practise in recent years. Due to its dexterity, stability, high efficiency, and high accuracy, robotic assembly systems are increasingly often utilised in automobile and aerospace manufacturing lines. In essence, assembly complies with technical standards by fitting the unique components of two assemblies. Therefore, determining the relative spatial pose of the assembly features—which is often accomplished by a measurement system—is essential for directing the robot to finish the assembly operation. Numerous measurement techniques have been suggested to accurately assess the pose. The present approaches

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can roughly be divided into two groups—local measurement methods and global measurement methods—depending on where the measuring system is located. The moveable component and measurement system are fixed to the robot's end-effector in the local measurement technique, which then uses the measurement system to measure the fixed component's spatial posture and calculate the relative spatial pose between the fixed component and mobile component. This measurement technique is most frequently used to mount a monocular camera on a robot's end-effector and determine the posture of a fixed object with straightforward architecture. Schmitt et al. estimated the relative spatial pose between the cylinder and the cylinder block to insert the cylinder into the cylinder block using a monocular camera installed on the robot's end-effector to estimate the pose of the assembly features of a cylinder block. In the local measurement technique, the moveable component and measurement system are fixed to the robot's end-effector. The local measurement technique then makes use of the measurement system to determine the relative spatial posture between the fixed component and mobile component by measuring the spatial posture of the fixed component. The most common application of this measurement method is to put a monocular camera on a robot's end-effector and ascertain the posture of a simple fixed object. Schmitt et al. determined the relative spatial pose between the cylinder and the cylinder block to insert the cylinder into the cylinder block by using a monocular camera installed on the robot's end-effector to estimate the pose of the assembly features of a cylinder block.

Conclusion

The unique measurement technique suggested in this study is based on assembly features and a reliable coordinate system. This measurement technique measures the spatial posture of the assembly features of another spacecraft component while the measurement instrument is directly attached to the assembly features of a spacecraft component. With less reliance on the structural properties of the spacecraft components, this measuring method may directly assess the relative spatial posture of the assembly features. The CMG assembly task is used as an application case in this paper to assess the proposed method's viability. The measurement system is created and directly mounted on the CMG assembly features in accordance with the specifications of the CMG assembly work. The relative spatial posture between the assembly characteristics of the CMG and the MB is then measured using the measurement system. A calibration tool is created and used to precisely and effectively calibrate the installation mistakes of the measurement equipment in order to increase measurement accuracy. Finally, six sets of tests are run on the prototype, and the verification device measures how accurately each experiment was assembled.