HUMAN SPACE ENDEAVOURS SYMPOSIUM (B3)
New Technologies, Processes and Operating Modes Enabling Future Human Missions (7)

Author: Dr. Ming Qi
1.Beijing Institute of Control Engineering,2.Space Precision Bearing Applications Laboratory, China

Mr. Dengyun Wu
1.Beijing Institute of Control Engineering,2.Space Precision Bearing Applications Laboratory, China

KINEMATIC PERFORMANCE OPTIMIZATION OF A CLASS OF FOUR-DEGREE-OF-FREEDOM SPATIAL PARALLEL MANIPULATORS BY REDUNDANT ACTUATION AVAILABLE TO SPACE ROBOT MOUNTED IN CAPSULE

Abstract

Space station is an essential step in human exploration of outer space. There are many tasks which bring risk greatly and cost highly while accomplished by human being in space station utilization. So the space robot is developed in order to finish or assist human being to complete those tasks such as scientific experiments and so on, and the space robot becomes a concernful research field recently. Thereof, more and more scholars focus on the research on parallel mechanism which can be used as the prototype of space robot mounted in capsule. The purpose of this paper is to research a class of four-degree-freedom (4-DOF) parallel manipulators in order that it can enrich the study of space robot. Parallel manipulators with lower-mobility have drawn a lot of interest in recent years for their advantages of lower costs of design and manufacturing due to their simpler architecture. Thereof, the 3T1R 4-DOF parallel mechanism is an important issue in the family of parallel manipulators with lower-mobility for their 3-DOF translational counterpart. This paper gives a thorough investigation on the relevance between actuator selection and kinematic performance of the 4-DOF parallel manipulators. Such manipulators able to generate 3-DOF translations and a rotation (3T1R) consist of a movable platform attached to a base through three identical limbs. For the sake of simplicity, select the 3-PUU (P, translational joint; U, universal joint) parallel mechanism as a typical example using for analysis. Firstly, the inverse and forward kinematics analysis is carried out. It's found that the forward kinematics problem turns easier with reasonable redundant actuation. Subsequently, the kinematic performance in each possible condition of actuator selection is analyzed based on a thorough singularity analysis. The results show that it has best kinematic performance with reasonable redundant actuation than those without redundant actuation and other cases. Finally, it can be inferred from the typical example that the 4-DOF parallel manipulators with reasonable redundant actuation may have better kinematic performance than those of any other cases. Furthermore, the redundant actuation makes more fault tolerant advantages which resulting in greater potentialities for space applications such as space robot mounted in capsule. Research on the 3T1R 4-DOF parallel mechanism available to space robot mounted in capsule will build a solid theoretical foundation for the space station utilization.