SPACE SYSTEMS SYMPOSIUM (D1)
Interactive Presentations (IP)

Author: Dr. Hou Yueyang
Shanghai Aerospace Control Technology Institute(SACTI), Shanghai Academy of Spaceflight Technology (SAST), China, houyueyang_hit@163.com

Dr. Shan Lu
Shanghai Aerospace Control Technology Institute(SACTI), Shanghai Academy of Spaceflight Technology (SAST), China, 9175393@qq.com
Mr. Wang Fengwen
Shanghai Aerospace Control Technology Institute(SACTI), Shanghai Academy of Spaceflight Technology (SAST), China, wangfengwen@163.com

FINE MANIPULATION AND CONTROL OF A MOLLUSCOID ROBOT DRIVEN BY MAGNETIC REPULSION FORCE IN LIMITED AND NARROW SPACE OF SPACECRAFT

Abstract

There are plenty of accessories and components of spacecraft need to be serviced and maintained by astronaut or space manipulator on orbit usually. However, astronaut or space manipulator is impossible of entering into or passing limited and narrow space of spacecraft to accomplish fine manipulation, such as screwing bolts and plugging connectors. In the face of the exigent passing and operation ability in the limited and narrow space of spacecraft, the molluscoid robot is adopted to complete the task, which flexibility will be applied more sufficiently in microgravity.

The biological inspiration of space robot movement is observed. The motion mechanism and mode of molluscoid robot is introduced to space robot domain, which provides a technical solution for the difficult problem of the passing and operation in the limited and narrow space of spacecraft. According to the kinematics analysis of mollusc complex movement, the time asymmetry rule of mollusc muscle movement is abtained, which is applied to a molluscoid robot driven by magnetic repulsion force. Magnetic repulsion force means electromagnetic contrary force of adjacent homopolar permanent magnet, which uses to make the robot body extend and bend.The magnetic repulsion drive is used to simulate mollusc movement, which changes the traditional motion mode of space robot. That means the molluscoid robot can come into the limited and narrow space of spacecraft by peristaltic movement, also can pass the complex unstructured entironment and avoid obstacles by body hanging. The molluscoid robot's end-effector has visual and tactile sensor using to recognise and evaluate the manipulated target, which makes the molluscoid robot adapt to the unstructured and changeable environment, and can complete the complex task of limited and narrow space.

In order to realize the fine operation and movement in the limited and narrow space of spacecraft, the molluscoid robot dynamic model and control strategy are focused on. A efficient and simple modeling method of the molluscoid robot with multi arms and multi joints is proposed.The molluscoid robot has infinite degrees of freedom, so the common dynamic model cannot be applied. A robust control strategy of molluscoid robot is implemented, which can decouple the complex movement.The simulation results show that the molluscoid robot can pass a limited and narrow space, which indicates the control strategy is effective.