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CEREBELLUM-INSPIRED TRACKING CONTROL OF UNKNOWN MODELS FOR SPACE IN-CABIN SERVICE ROBOTS WITH DUAL CONTINUUM ARMS

Abstract

As a result of the rapid development of human spaceflight technology, in-cabin service robots have attracted more and more attention. In the paper, a new scheme of space in-cabin service robots with dual pneumatic continuum arms is proposed to help the astronauts do some things including taking pictures and carrying things. Compared to traditional rigid manipulators, pneumatic continuum arms are safer and more flexible, which has great potential in interactive scenarios and tight spaces. However, the structural complexity and the particularity of space application make it difficult to build and compute an accurate model for space in-cabin robots with dual continuum arms. In practical engineering applications, the coupling motion between the continuum arms and the space-moving base brings a series of new challenges for high-precision trajectory tracking control. Inspired by the cerebellum associated with human motion control, the paper researches a cerebellum-inspired tracking control method of unknown models for space in-cabin service robots with dual continuum arms based on zeroing neuron network (ZNN). The proposed method can achieve the tracking control of the end-effector when the parameter and the structure of the kinematic model are unknown. The real-time Jacobian matrix can be estimated just by relying on the actuator input, sensory output and the attitude of base information. Besides, the tracking accuracy and robustness are increased by the fine-tuning of the cerebellum. In addition, the theoretical analyses of the convergence and the stability are given for the proposed control approach. Finally, simulation results are given to show the effectiveness of the proposed control method in tracking accuracy and robustness for space in-cabin service robots with dual continuum arms. The main contributions in this paper are listed as the following facts:
(1) The new scheme of space in-cabin service robots with dual pneumatic continuum arms is proposed, and the coupling motion model between the pneumatic continuum arms and the moving base is established.

(2) A cerebellum-inspired tracking control method of unknown models based on dual ZNN is proposed for solving the coupling motion problem of the moving base and the pneumatic continuum arm.
(3) The convergence, stability and simulation results are proved and presented. The accuracy and the robustness of trajectory tracking are greatly improved by employing the fine-tuning of the cerebellum.