Integrated Research on Human-Machine Hybrid Intelligent Perception, Decision and Execution for Manned Space Missions

Professor Yongchun Xie 解永春

Beijing Institute of Control Engineering

Abstract

This talk conducts research on the integration of human-machine hybrid intelligent perception, decision-making and execution for manned spaceflight, targeting diverse and complex mission scenarios including space station on-orbit rendezvous and docking, manned lunar flight, and lunar base operation and construction. A closed-loop human-machine collaborative intelligent system suitable for multi-scenario space-earth missions is established. By integrating multi-modal information of space motion situation, extreme cislunar environment, equipment operating conditions and astronauts' capability status, a global collaborative perception model is constructed. According to the characteristics of different missions, human-machine authority allocation is clarified, and a hierarchical hybrid intelligent decision-making mechanism is developed to adapt to differentiated task requirements, such as precise rendezvous and docking control, complex lunar surface exploration, and long-term lunar base operation and maintenance. Hierarchical full-link data transmission and dynamic feedback channels covering perception, decision-making and execution are realized. Preliminary application results verify that the integrated architecture effectively improves the accuracy and efficiency of multi-scenario mission execution, reduces astronauts' operational burden, and enhances the autonomous fault-tolerance performance of the system. The research findings can provide technical support for space station on-orbit missions, manned lunar exploration and sustainable operation of lunar bases, and offer a reference for the comprehensive intelligent development of manned spaceflight.

Yongchun Xie currently serves as Director of the Science and Technology Committee and Chief Technical Expert in the field of space rendezvous and docking at Beijing Institute of Control Engineering (BICE), as well as Director of Tianjin Key Laboratory of Micro and Low Gravity Environment Simulation. Her academic affiliations include Vice Chair of the Aerospace Technical Committee of the International Federation of Automatic Control (IFAC), Corresponding Member of the International Academy of Astronautics (IAA), Member of the Manned Spaceflight Committee of the International Astronautical Federation (IAF), Fellow and Standing Council Member of the Chinese Association of Automation (CAA).She has won 1 Second Prize of the National Technological Invention Award and 7 First Prizes of Provincial/Ministerial-level Science and Technology Awards. She has published 5 academic monographs and 180 academic papers, and holds 90 authorized invention patents. Her honors include the 4th National Innovation Forefront Award, National March 8th Red Banner Holder, Outstanding Leading Scientific and Technological Talent of Central Enterprises, Outstanding Contributor to China's Manned Space Engineering, Aerospace Outstanding Contribution Award of CASC, First Prize of the Yang Jiachi Science and Technology Award, WIPO Best Woman Inventor Award, and she is a recipient of the Special Government Allowance of the State Council.