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DESIGN AND VALIDATION OF A FLEXIBLE EXOSKELETON FOR MANNED DEEP SPACE EXPLORATION

Abstract

Although robotic arms and rovers are playing an increasing role in human spaceflight and exploration programmes, astronauts remain the most important part of manned deep space exploration. In the immense deep space beyond the earth, astronauts will face more and more complicated, changeable and harsh environments, and need to perform a wider range of extravehicular activities and space operation tasks, which require astronauts to have sufficient hiking, carrying, grasping and other sports capabilities. Exoskeleton robots, as wearable devices for human-machine fusion, can actively enhance human body functions and effectively reduce metabolism through active limb-assisted. LMT, Raytheon and many other companies have successfully developed exoskeleton for military, fire fighting, rescue, medical and other fields. Here, a flexible exoskeleton for manned deep space exploration is developed, which addresses the problems of poor mobility and high joint motion damping of existing spacesuits, aiming at minimizing health damage, reducing physical energy consumption and expanding the capabilities of astronauts. First, the characteristics of deep space exploration are sorted out, and the composition of extravehicular spacesuit is deeply analyzed. On this basis, through the research of human motion intent recognition, joint flexible driving and compliant motion control, the product breaks through the mapping mechanism and decoding technology of human behavior intention based on flexible sensors, discrete variable stiffness flexible driving technology, flexible human-machine compatibility technology and other key technologies. Finally, the novel highly integrated design of electrics, mechanism, sensor, and energy systems is combined with existing spacesuit to complete the development of a flexible exoskeleton for manned deep space exploration. After a number of tests on the ground, the assistance effect of exoskeleton robot is obvious. This paper explores the possibility that exoskeleton can be appropriately combined with astronauts in manned deep space exploration to promote the efficient use of resources, improve safety and reduce the costs of exploration.