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A TELEOPERATION PLANETARY SURFACE WALKING ROBOT BASED ON FORCE FEEDBACK HUMAN-ROBOT INTERACTION SYSTEM

Abstract

With the in-depth development of planetary exploration missions, astronauts walking on the surface of planets such as the Moon and Mars has become a trend of demand, walking robots have the ability to perform tasks and replace astronauts to adapt to the environment of planetary surfaces in advance, and at the same time, the planetary surface of the complex terrain environment of the robotic walking system adaptability and maneuverability put forward higher requirements. Aiming at the lack of haptic feedback of existing walking robots, which leads to the lack of operator perception, this study proposes a planetary surface walking robot teleoperation system with two-way force feedback, focusing on the breakthrough of real-time foot force sensing and haptic feedback technology, aiming to improve the operator's perception of the lunar surface terrain and the precision of the robot's walking control.

The system adopts a multimodal human-computer interaction architecture, including force feedback module, terrain adaptation module, and intelligent decision-making module: the contact force data are collected in real time by the six-dimensional force sensor array, and the haptic feedback device is driven by dynamic filtering; combined with the operator's gait intention recognition and adaptive algorithm, the closed-loop terrain-gait-feedback control system is constructed, and the online optimization of the walking strategy is realized based on the haptic sensing. Optimization. Based on ROS/GAZEBO, a planetary environment simulation platform is constructed, and the validation results show that the designed force feedback system can enable the operator to perceive key terrain features such as soil hardness and obstacle morphology; together with the trajectory optimization algorithm, it can improve the success rate of the

robot walking on the planets surface and reduce the amount of slippage under the soft planetary soil environment.

This study confirms that the force feedback mechanism can effectively enhance the immersion and safety of remotely operated robots, and integrate the sensory information of the robot body into the operation decision loop through the haptic channel to form an intelligent control system of “human in the loop”, which provides a new technical way for the remote control of planetary surface carriers and astronauts’ collaborative operation in future manned lunar and mars missions.

Keywords: planetary surface walking robot, force feedback, teleoperation, human-computer interaction, adaptive