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RESEARCH ON HUMAN-IN-THE-LOOP LUNAR SIMULATOR SYSTEM

Abstract

Aiming at China's manned lunar landing mission in 2030, a manned landing simulation system on the lunar surface has been built to conduct the research on multi-scientific simulation verification and man-machine collaborative control. The system takes the lunar module as the main object to simulate the flight process from the power descent stage to the final soft landing stage. And it also supports the manual control flight simulation in the loop when the lunar module is tens of meters above the ground at the final landing stage. Facing the overall goal of building a multifunctional lunar landing simulator, the joint architecture of hardware and software is conducted and the corresponding computers and human-computer interaction equipment are deployed. In terms of software implementation, the reaction control attitude engines, main deceleration engines and landing buffer legs are modeled to build the lunar module dynamics model. Based on the simplified guidance, navigation and control system, the man-machine joint control strategy is put forward to realize human-in-the-loop flight control in the real time simulation. In the aspect of display, the instrument and the third person display evaluation interface are designed to support the astronaut driving monitoring and flight situation information to the instructor. Finally, the human-in-the-loop lander co-simulation system is constructed. This system could analyze the different control strategies of the lunar module according to the test results. Furthermore, considering the subsequent iterative upgrade, the designed functions of software update, modular hardware replacement and database external interaction are explained. The construction method and simulation framework corresponding to the prototype system can be applied to the construction of multi-degree-of-freedom large-stroke modular simulator. Through the simulation training of human-in-the-loop, the astronauts will be more familiar with the process of manned lunar landing, with the improved ability to perform manned lunar landing. It can also be applied to the research of human-computer interaction and carry out experiments in the fields of astronaut vestibular perception function and human-computer intelligent cooperation. For the overall design, from the perspective of top-level design, the rapid simulation verification of multi-disciplinary content for different schemes, different working conditions can be carried out to guide the formulation of the overall scheme. The realization of the above technical and engineering projects will help to improve China's theoretical level and engineering capabilities in human-computer interaction, human factor engineering, collaborative control and other aspects.