Paper ID: 41376
interactive
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SPACE EXPLORATION SYMPOSIUM (A3)
Interactive Presentations (IP)

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CONCEPTUAL DESIGN OF AUTONOMOUS GNC AIDED OPERATION SYSTEM FOR FUTURE CHINA MANNED LUNAR PINPOINT LANDING

Abstract

Manual control is widely used in manned space missions including Apollo manned lunar landing. With the advance of technology, China indeed has some advantages although its progress lags behind the United States and the Soviet Union in this field. On the one hand, China's manned spaceflight rendezvous and docking mission successfully verified the TV-guidance based manual rendezvous and docking technologies. On the other hand, China's unmanned lunar soft landing mission has successfully verified the autonomous Guidance Navigation and Control (GNC) technologies for powered descent, hazard avoidance and safe landing. In order to achieve safely pinpoint landing close to the scheduled lunar facilities, it is necessary to develop an autonomous GNC aided operation system for future manned lunar pinpoint landing. This system makes the autonomous GNC mode and the manual mode mutually cooperated and backuped, which is conductive to enhance operation efficiency, accuracy, reliability and safety. This paper will report a conceptual design of the autonomous GNC aided operation system for future manned lunar pinpoint landing based on China's current technological accumulations. First, the integrated navigation system solves and outputs the real-time absolute/relative flight state parameters of the lunar module, and the outputs of each sensors and navigation modes are also displayed. Second, the terrain recognition system real-time outputs the three-dimensional terrain and television images of local lunar surface, the corresponding hazardous/safe zone distribution map and fuel consumption map for hazard avoidance, the optimal landing site and candidate landing sites. Third, the guidance and control system real-time outputs the difference between reference trajectory and real trajectory, the deviation between predicted and theoretical landing sites, corresponding hazard avoidance route to reach selected landing sites, state of thrusters and remaining fuel. Then, a human-machine interface is utilized for astronauts to check, confirm or revise the GNC modes according to the above maps, images, parameters, flight trajectory, and the remaining fuel. The guidance mode and destination can be modified at any time throughout the descent and landing process, and the corresponding guidance law will be automatically implemented. The astronauts can modify the selected landing site or directly manually point out the desired landing position on the television image, and the system performs the solution and guidance control accordingly. Additionally, astronauts can also switch the operation mode to completely manual control mode at any time according to the actual situation.