SPACE OPERATIONS SYMPOSIUM (B6)
Training Relevant for Operations (3)

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APPLICATION OF VIRTUAL REALITY IN TRAINING ASTRONAUTS FOR SPACE OPERATIONS

Abstract

Space operation is one of the major tasks in manned spaceflight mission. Astronauts will be faced with various operations in space exploration so that they need to get adequate training to master skills of working in space. This study focuses on the utility of Virtual Reality (VR) to ground-based training of astronauts in preparation for extravehicular activity (EVA). A prototype VR simulation system integrating high-fidelity graphics, force-feedback and real-time computer simulation for EVA is developed to achieve an immersive training environment. In previous researches the human-computer interaction mainly focused on visual feedback rather than force feedback. In this paper we developed a VR Simulation System in which both visual and force feedback is provided to astronaut to make training more realistic. Here, we describe the immersive VR system for astronaut training and the key techniques solved in this research including model construction of virtual space environment, design of man-computer interface, human body and hand motion tracking, collision detection, hand force computation taking into account weightless, and cooperative operation simulation. An experiment was conducted to evaluate the system performance and usability in EVA tasks of space walking and payload retrieve in which two astronauts cooperate with each other. The experimental results demonstrate effectiveness and usability of the system and the methods developed in this work.

This paper is organized as follows. Section 1 describes the framework of VR simulation system. The system is composed of human, human-computer interface, computational simulation software, and virtual space environment. Section 2 presents model construction of virtual space environment. The virtual environment comprises spacecraft, the earth, star field and astronaut with spacesuit. Section 3 describes human body and hand motion tracking in which inverse kinematics method of body motion tracking as well as the noise processing in data acquisition are introduced in detail. In section 4 two collision detection algorithms developed in this research (dynamic collision detection based on moving direction of fingers,

and collision detection based on approach direction) are presented. In section 5 hand force modeling and feedback is provided. We utilize the suspending platform with aerostatic slideways as a weightless environment to collect the experiment data of grasp force and establish the hand force computation model. At last a case study of space walking and payload retrieve is conducted and the future work is discussed.