SPACE OPERATIONS SYMPOSIUM (B6)
Human Spaceflight Operations (1)

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A VISUALIZATION SIMULATION PLATFORM OF COGNITIVE WORKLOAD AND PERFORMANCE ANALYSIS FOR SPACE OPERATIONS

Abstract

The modeling and simulation technologies have been applied in space mission plan since the development of spaceflight, and human modeling and simulation starts to play more and more important role in the field of aerospace especially entering the 21st century. To support the study of astronaut operation capability in spaceflight, we establish a visualization simulation platform of cognitive workload and performance analysis in which a virtual human combined with physical characteristics and computational cognitive model is developed. The virtual human is used to substitute for an actual astronaut for the prediction and analysis of cognitive workload and task performance of space operations. The simulation platform can provide an experiment bed for analyzing the mechanism of astronaut operation capability. The paper firstly describes the architecture of the visualization simulation platform and then gives the implementation methods of simulation platform which include visualization methods of cognitive process and task process, cognitive workloads and performance prediction as well as visualized analysis interface, and the management and scheduling of the simulation platform. Finally, a case study on cognitive workload and performance simulation is conducted on the simulation platform. Cognitive modeling is the basis of cognitive process visualization. We adopt ACTR-QN, integrating Queueing Network (QN) and Adaptive Control of Thought-Rational (ACT-R), as a cognitive architecture to build cognitive models for specific tasks of space operation, and choose Micro Saint Sharp as a cognitive simulation platform to implement cognitive process simulation and visualization. The simulation platform provides three-dimensional visualization of task execution process to achieve the synchronous visualizations of the cognitive process and task process. Cognitive workload and performance predictions are based on the simulation results from the cognitive and task simulation systems. Cognitive workload has a linear relationship with module utilization in ACTR-QN, and we therefore implement cognitive workload prediction by computing averaged utilization time for all modules over the whole task process. Task performance prediction is implemented through a series of simulation results from task simulation system. The individual performance's evaluation is carried out by considering both task performance and cognitive workload. A variety of representation formats is provided to visualize the performance evaluation results. The manual space rendezvous and docking is selected as a simulation scenario to test the functionalities of cognitive process

visualization, task process visualization, cognitive workload and performance prediction and analysis etc. The experimental results demonstrate the usability and effectiveness of the simulation platform.