SPACE LIFE SCIENCES SYMPOSIUM (A1)
Behaviour, Performance and Psychosocial Issues in Space (1)

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MODELING HUMAN PERFORMANCE IN MANUAL RVD UNDER THE QN-ACTR ARCHITECTURE

Abstract

Human performance modeling has been applied to various tasks in aviation and space industry, and has provided useful guides for ergonomic design of the human-machine system and for operator selection and training. The present paper focuses on the modeling of human performance in manually controlled rendezvous and docking (manual RVD), which is an important task for manned space missions. Based on the analysis of the cognitive processes of the operator performing the manual RVD tasks, we deduced that speed perception in the sense of time-to-contact (TTC) estimate dominates the decisions of control actions. Then a human performance model was proposed, the model consists of a TTC model for speed perception and a series of control strategies which take the estimated TTC as the inputs. The proposed human performance model was implemented in the QN-ACTR cognitive architecture. A network interface was developed to enable the communications between the human performance model in QN-ACTR and the manual RVD simulator used for training the astronauts, so that the human performance model can "perceive" the information in the manual RVD simulator, and the manual RVD simulator can "receive" the control signals of the human performance model. The human performance model and four human participants each performed eight trials of RVD tasks with different initial conditions. RVD performance indices such as the fuel consumption, the docking accuracy were extracted, and the indices of the human performance model were compared to that of the human participants. Results show that the performance indices of the model are all within the [Mean-3Std, Mean+3Std] range of the corresponding indices of the human participants, and when the task demands increase, both the model and the human participants perform worse. In conclusion, the human performance model we proposed reveals the key cognitive processes in the manual RVD task: speed perception in the sense of TTC estimate. Human interfaces of the manual RVD task shall be designed to support speed perception in the right way, and astronauts chosen to perform the manual RVD task should possess good TTC estimate ability.