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For a successful space program: Quality and Safety! (1)

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SPACECRAFT PRODUCT ASSURANCE METHOD BASED-ON DATA-DRIVEN PHM CLOUD PLATFORM

Abstract

The spacecraft product assurance method has a great impact on the success of space missions and on the financial side of the program. At present, Prognostic and Health Management (PHM) has gradually developed into one of the important spacecraft product assurance methods. The advanced technology concept of data-driven PHM is introduced into the quality management process of spacecraft products such as space exploration and LEO constellation, through data acquisition and processing, condition monitoring, fault diagnosis, health prediction, analysis and decision making, it can effectively reduce various unexpected risks in the process of spacecraft products performing tasks and affect or improve product design. It also can provide support for product state prediction, defect avoidance and solution, and provides important support for the realization of product quality assurance. Based on big data, cloud platform, artificial intelligence and other technologies, it conducts in-depth research on the assurance methods of spacecraft products based on data-driven PHM cloud platform. Firstly, the concept and application scope of the data-driven PHM method are analyzed, and the application principal framework of the method is put forward. Secondly, based on the Data Driven Cloud-platform for PHM industrial software (DD-CPHM), the implementation steps of the data-driven PHM method are studied and proposed, including knowledge data collection, architecture design, requirement analysis, function division, data acquisition, algorithm selection, module development, integration and verification, and use improvement, etc. On this basis, for the prediction and evaluation system of a navigation satellite power system and China space station thermal control system, the application of data-driven PHM method based on the PHM cloud platform is given. The verification results show that the research can provide technical reference for the research and application of spacecraft product safety and assurance, with the following technical characteristics: (1) integrated cloud service, integrated customized development of data, model, service and interface; (2) big data service engine, supporting PHM data preprocessing and feature extraction; (3) deep machine learning engine, supporting intelligent diagnosis, predictive analysis and reasoning; (4) support the integration of expert knowledge and machine learning. At present, the method proposed has been applied to the product assurance process of nearly 10 types of spacecraft typical systems, such as the power and control system of the navigation and remote sensing satellite, the thermal control system of China space station, etc., and ultimately can improve the safety and reliability of the space exploration, LEO constellation and other spacecraft products.