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INTELLIGENT HEALTH MANAGEMENT PLATFORM FOR AEROSPACE ELECTRONIC SYSTEMS

Abstract

With the increasing complexity and integration of electronic systems in spacecraft, the maintenance strategy for aerospace equipment electronic systems needs to evolve from simple state detection to comprehensive health management. The shift from traditional passive post-maintenance activities to proactive and predictive maintenance activities is essential to reduce the overall lifecycle costs of aerospace equipment. Artificial intelligence algorithms, particularly deep learning, have been widely applied in computer vision and natural language processing, achieving significant success in recent years. Data-driven deep learning methods can extract high-level semantic representations through multi-layer convolution architectures. As monitoring data grows, the potential for implementing new-generation artificial intelligence health management has emerged. The health management platform we have developed selects key representation parameters for electronic system failures and health states and samples, transmits, and stores these parameters with minimal increase in system complexity. Artificial intelligence can primarily address several aspects of spacecraft electronic systems. Firstly, anomaly detection focuses on determining the regular operation of electronic devices. Since anomalies typically do not have fixed patterns and occur infrequently, techniques such as autoencoders and generative adversarial networks are used to reconstruct normal working states to identify anomalies. Furthermore, since anomaly states are few and isolated, clustering techniques can identify high-dimensional anomaly points or intervals in complex scenarios. Secondly, fault diagnosis involves classifying fault patterns and identifying the causes of failures. By establishing deep neural network learning models, fault pattern classification can better identify the mapping relationship between vast data and health conditions, enhancing diagnostic capabilities. Knowledge graphs organize information such as design instructions, parameters, structures, and functional require-

ments of electronic systems into a structured semantic network, facilitating rapid fault localization. Fault tracing and reasoning strategies based on knowledge graphs guide automatic recovery and manual repair of electronic systems. Lastly, degradation trend prediction technology forecasts electronic systems' degradation trends and remaining service life based on historical and current monitoring information through time-series deep networks. In electronic system degradation trend prediction, neural network models based on self-attention mechanisms, such as Transformer or its derivative models, extract temporal features through self-attention mechanisms from running state data as sequential inputs and then perform classification or regression predictions. Through continuous research and improvement, our aerospace electronic health management platform can provide more comprehensive and accurate analysis and prediction capabilities for the health management of electronic systems, contributing to the efficient and reliable operation of aerospace equipment.