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AUTOMATED SPACECRAFT HEALTH ANOMALY DETECTION USING YOLO BASED DEEP LEARNING MODELS

Abstract

The ground segment plays a critical role in the success of any space mission, and one of its key components in ground segment is spacecraft operations. The primary objective of spacecraft operations is to monitor and maintain the health of the spacecraft, ensuring the overall success of the mission. Traditionally, this health assessment involves a detailed analysis of spacecraft data, typically represented in graphs, plots, and tables. This process requires substantial human effort and time as analysts manually review patterns across various parameters to evaluate the spacecraft's condition. This traditional process is neither scalable nor sustainable, especially as the number of spacecraft increases significantly however, this manual approach can be significantly enhanced through the application of artificial intelligence and machine learning (AI/ML) techniques. In this paper, we propose an innovative framework for automated spacecraft health analysis using AI/ML algorithms. The system harnesses the power of AI to streamline and accelerate the spacecraft health evaluation process by analyzing data from various subsystems and parameters on a daily basis. The proposed framework is versatile, capable of being applied to a wide range of spacecraft, and aims to improve the efficiency of health monitoring. By automating routine health checks, the system reduces the time and resources traditionally required. Moreover, since spacecraft data is often recorded at irregular intervals, our image-based approach allows us to bypass the need for uniformly spaced samples. This method reveals distinct patterns in the data, independent of sampling frequency. In this study, we per-process data subsystem-wise and evaluate spacecraft health using YOLO based deep learning algorithms. We have implemented and tested three different algorithms in the operational environment, detailing the daily workflows involved. In summary, this research presents a pioneering solution for spacecraft health evaluation, leveraging machine learning to deliver timely and accurate assessments. The result is enhanced efficiency and reliability in spacecraft operations, contributing to mission success.