

Anomaly Detection in Space Systems Testing via Machine Learning

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Abstract

Spacecraft are exceptionally complex engineering systems that generate vast amounts of multivariate telemetry data during pre-launch environmental and functional testing. Traditional quality assurance processes rely heavily on manual analysis and static limit checking to detect anomalies and non-conformances. However, these methods often fail to capture contextual anomalies — situations where individual parameters remain within prescribed thresholds yet exhibit unnatural temporal or correlational behaviors. This study proposes a machine learning-based decision-making mechanism to automate the analysis of time-series datasets generated during satellite testing phases. By utilizing predictive algorithms, the model learns the nominal behavioral patterns of subsystems from historical test data to establish dynamic, context-aware thresholds. The performance of these data-driven models is evaluated on test datasets containing various contextual anomaly scenarios. The findings indicate that the machine learning approach effectively identifies complex discrepancies that conventional static limit checks fail to capture, thereby significantly reducing false positive rates. Ultimately, this framework serves as a robust decision-support tool for quality engineers, optimizing the anomaly detection process and ensuring higher reliability in space mission deployments.

Keywords

Space Systems Testing, Contextual Anomaly Detection, Deep Learning, Quality Assurance, Decision Support Systems

Biographies

Abdurrahman Korucu is a Quality Assurance Specialist at the Space Technologies Research Institute (TUBITAK UZAY) in Ankara, Türkiye. He holds a Bachelor of Science degree in Electrical and Electronics Engineering and is currently pursuing a Master's degree in the Advanced Technologies Department at Gazi University. With five years of professional experience in the aerospace industry, he manages acceptance, testing, and non-conformance processes for various critical space projects. His research interests focus on integrating artificial intelligence into quality assurance processes, specifically deep learning applications for anomaly detection and automated decision-support mechanisms in high-reliability systems.

Aylin Adem received her Ph.D. in Industrial Engineering from the Gazi University, Ankara, Türkiye in 2020. She is an Associate Professor at the Department of Industrial Engineering, Gazi University, Türkiye. Between 2024 and

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