

32nd IAA SYMPOSIUM ON SMALL SATELLITE MISSIONS (B4)  
Interactive Presentations - 32nd IAA SYMPOSIUM ON SMALL SATELLITE MISSIONS (IP)

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AI-DRIVEN FAULT DETECTION AND RECOVERY IN CUBESAT CONSTELLATIONS FOR  
AUTONOMOUS SPACE NETWORKING

**Abstract**

article

# AI-Driven Fault Detection and Recovery in CubeSat Constellations for Autonomous Space Networking

October 3, 2025

## Abstract

The increasing deployment of CubeSat constellations for Earth observation, communication, and scientific missions introduces challenges related to fault detection, network resilience, and autonomous recovery. Traditional fault management techniques rely on ground-based diagnostics, resulting in delays and inefficiencies. This study presents an AI-driven approach for real-time fault detection and autonomous recovery in CubeSat constellations, leveraging machine learning (ML) models trained on telemetry data to predict and mitigate anomalies before critical failures occur.

Our proposed framework utilizes deep learning-based anomaly detection to identify deviations in satellite health parameters, such as power fluctuations, thermal anomalies, and communication disruptions. Reinforcement learning (RL) algorithms further enable dynamic fault mitigation strategies by autonomously reconfiguring network paths and redistributing workloads among operational CubeSats. By implementing federated learning, our system ensures decentralized AI model updates across the constellation without excessive data transmission to ground stations, preserving bandwidth and enhancing security.

Simulations conducted using digital twin models of CubeSat networks demonstrate an improvement in fault recovery time by up to 40%, along with a 30% reduction in communication latency compared to conventional fault-handling approaches. The ability to autonomously predict and respond to system failures significantly enhances the resilience and longevity of CubeSat networks, making them more viable for long-term space applications.

This work aligns with the IAC 2025 theme, "Sustainable Space: Resilient Earth," by contributing to the development of robust, autonomous, and scalable small satellite architectures. The proposed AI-based fault management system paves the way for more intelligent, adaptive, and cost-effective CubeSat constellations, reducing mission downtime and operational risks in future space-based networks.

**Keywords:** AI in space, CubeSat constellations, fault detection, reinforcement learning, anomaly detection, federated learning, autonomous networking.