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PREDICTING AND MITIGATING COLLISION THREATS

Abstract

As space activities increase, space debris poses a growing threat to operational satellites, crewed missions, and future space exploration. This paper explores advanced modeling techniques and risk analysis frameworks to assess debris propagation, collision probabilities, and long-term sustainability of orbital environments. The study examines current methodologies, including probabilistic risk assessments, AI-driven predictive analytics, and high-fidelity simulation models that integrate real-time data from tracking systems. Additionally, it discusses risk mitigation strategies such as active debris removal (ADR), spacecraft shielding enhancements, and collision avoidance maneuvers. By evaluating emerging trends and technological advancements, this research provides a comprehensive overview of space debris modeling and risk reduction approaches critical for ensuring the safety and sustainability of space operations.