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DEBRISSS: A BLOCKCHAIN-POWERED SECURE SPACE DEBRIS TRACKING SYSTEM

Abstract

The expansion of space activities has led to a rise in space debris. This trend has made tracking debris and managing collision risks increasingly vital, while also creating a need for more comprehensive data collection. As the amount of debris data grows, it becomes essential to use and share this information securely. Protecting the data from unauthorized access is crucial to prevent misinterpretations or malicious interference and to ensure the safety of space operations.

To meet these challenges, a reliable solution has been developed for effective space debris management and collision prevention. The proposed system offers a decentralized, secure, and scalable mechanism for space debris tracking and data sharing, benefiting space agencies, private enterprises, and researchers.This system leverages NORAD Two-Line Element (TLE) data, blockchain technology, and the Shamir Secret Sharing (SSS) method.

The proposed system calculates the trajectory parameters of space debris by processing TLE data. By analyzing historical trajectory data, future potential collision scenarios are predicted with machine learning algorithms. Random Forest algorithm is used for trajectory determination and Support Vector Machine is used for collision prediction. Data on objects with a high probability of collision are automatically shared with relevant space agencies and private organizations through smart contracts.

Blockchain technology provides transparent, immutable and secure storage of space debris data and forecast data. Space debris data is processed on the blockchain, preventing unauthorized changes and protecting the reliability of the data. Instead of directly storing large datasets on the blockchain, datasets are uploaded to the InterPlanetary File System (IPFS) for scalability. IPFS enables immutable links and these links are used in the blockchain records. The SSS method safeguards sensitive space debris data by fragmenting it into multiple shares, reconstructing it only when a predefined threshold of participants is met.

A proof of concept implementation is being implemented in the DS4H blockchain test network. The findings are very encouraging, confirming that our approach works effectively with various spacecraft and space robotics. They also point the way for future refinements and further progress.