23rd IAA SYMPOSIUM ON SPACE DEBRIS (A6)
Interactive Presentations - 23rd IAA SYMPOSIUM ON SPACE DEBRIS (IP)

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AEYE2: AI-ENHANCED CUBESAT PAYLOAD FOR SMART EARTH OBSERVATION AND SPACE DEBRIS TRACKING

Abstract

The increasing accumulation of space debris poses a significant challenge to satellite operations and future space missions, while the need for more efficient and autonomous Earth observation continues to grow. Traditional remote sensing and space debris tracking systems often rely on ground-based processing and high-power consumption, limiting real-time capabilities and increasing operational costs. Addressing these challenges, AEYE2 is a CubeSat payload designed to integrate both remote sensing and space debris monitoring within a single system, enhancing autonomous data processing and reducing reliance on ground stations. AEYE2 features a Multi-Spectral Imaging Payload (MSIP) for Earth observation, enhanced by AI-powered image classification to detect and analyze terrestrial features such as ports and stadiums. Simultaneously, the system is equipped with optical sensors and machine learning algorithms to detect and track space debris, contributing to space situational awareness. The AI-based image classification model is trained on a dataset of Earth-based features and optimized using TensorFlow Lite conversion and quantization to minimize power consumption. Additionally, RAID memory redundancy techniques are implemented to enhance fault tolerance and ensure data integrity in space environments. The CubeSat payload is designed with onboard GPU processing to facilitate real-time data analysis, reducing dependency on ground-based processing and improving operational efficiency. By combining remote sensing with active debris tracking, AEYE2 supports applications in environmental monitoring, disaster management, and space sustainability. Future recommendations include expanding AI capabilities to enable adaptive learning for improved debris classification, integrating inter-satellite networking for collaborative data sharing, and refining onboard processing techniques to further reduce energy consumption while enhancing mission longevity. This project aims to contribute to both Earth observation and space safety by leveraging AI and machine learning advancements to enhance data accuracy and reliability while addressing the growing challenges of space debris.