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SPACE SITUATIONAL AWARENESS AND SPACE DEBRIS MITIGATION: CURRENT STRATEGIES AND FUTURE ADVANCEMENTS

Abstract

With the growing benefits of space technology, the interest in exploring space grows. And consequently, the number of satellites deployed each year rises quickly. The long-term sustainability of satellite operations, human spaceflights, and any other space activity depends on SSA and space debris mitigation because space debris is growing rapidly in conjunction with this. In order to track, predict, and monitor space debris in orbit, SSA is essential. In addition, SSA participates in Space Debris Mitigation as a key player where it leads the techniques of Collision Avoidance, Space Traffic Management (STM), and Active Debris Removal (ADR). This study provides a review of SSA technologies, including Active Debris Removal (ADR), Laser Tracking, Space-Based Radars (RadaX), Artificial Intelligence (AI), and Machine Learning (ML). It examines the growth of SSA private companies and startups, as well as major SSA programs and initiatives like ESA's Space Safety and US Space Surveillance Network. Despite technological advances, the expansion of SSA remains restricted by some challenges, including economics, regulations, and policies. In order to guarantee safe space operations in the future we are in need of improved rules, policies, and international cooperation. The study explores these challenges and proposes An integrated approach that combines advanced technologies, international cooperation, and regular investments to enhance SSA and Space Debris Mitigation. This paper highlights the importance of enhancing SSA and Space Debris Mitigation strategies and the need for an international approach; otherwise, the future for space operations will be at risk.

Keywords: Space Situational Awareness (SSA) - Space Debris Mitigation - Future SSA Technologies.