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IN-ORBIT CHANGES USING THRUST VECTOR CONTROL (TVC) IN SATELLITES: A SOLUTION TO COMBAT SPACE DEBRIS

Abstract

The growing problem of space debris is becoming an increasing threat to spacecraft and satellites as the number of artificial objects orbiting around the Earth continues to rise. To address this issue, various technologies have been developed to manage space debris, with thrust vectoring emerging as a promising solution. Research on this topic has been at the forefront of what the paper aims to cover.

Thrust vectoring allows the alteration of the orbit or trajectory of satellites by adjusting their thrust vectors, thereby avoiding collisions with space debris. This technology has already been successfully implemented in several satellites, including the European Space Agency's (ESA) Sentinel-1A and Sentinel-1B satellites. The Electric Propulsion System (EPS) utilized by these satellites uses electrically charged ions to generate a thrust, which is more efficient than traditional chemical propulsion systems. The EPS system provides precise thrust vectoring, enabling effective avoidance of collisions with space debris. However, technical challenges need to be addressed to further improve the performance of EPS systems.

This research proposes several methods to address design and control system issues and improve the performance and reliability of EPS systems. Carbon-based materials like graphene and carbon nanotubes can offer better performance and reliability for ion thrusters and power supplies. These materials possess conductivity, thermal stability, and high strength, making them ideal for EPS applications. 3D printing and nanofabrication offer higher precision and scalability, while machine learning algorithms and advanced sensors like LIDAR and RADAR can be used for EPS applications, providing accurate and reliable measurements of spacecraft or satellite position and velocity.

In conclusion, the implementation of thrust vectoring in satellites is a promising solution to combat the growing problem of space debris. The proposed design and control system improvements will help to advance this technology and ensure its successful implementation in future space missions, ensuring the safety of both spacecraft and satellites.