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NEXT-GENERATION INFRARED TRACKING TECHNOLOGIES FOR SPACE DEBRIS MONITORING AND MITIGATION

Abstract

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The growing quantity of space debris in low Earth orbit (LEO) creates a significant danger for satellite missions and space operations. Existing tracking tools, such as radar and optical sensors, lack the capacity to identify small particles of debris and are inefficient under certain environments. This research targets the establishment of advanced infrared (IR) tracking systems in an effort to enhance the monitoring and detection of space debris, especially in situations where traditional methods fail.

Thermal tracking systems are exploiting thermal emissions of objects and present a lot of benefit with respect to using optical sensors. In comparison with optical systems, infrared sensors respond less to states of light and are able to trace objects with their temperature signatures, which is exceedingly useful in tagging debris objects not visible using optical systems. This research attempts to optimize infrared sensor design against sensitivity, range, and accuracy problems in LEO debris detection, where there are high-velocity debris velocities and temperature change fluctuations.

The study explores emerging infrared technologies that are capable of detecting smaller fragments of debris and distinguishing them from operational satellites and other objects. It also explores the use of AI and machine learning algorithms to improve the processing of infrared data to classify, track, and predict potential collisions more effectively. These emerging technologies are essential for real-time tracking and risk assessment of space debris.

In addition, the research targets the integration of infrared tracking technology with other sensor technologies such as radar and lidar to create a comprehensive, multi-sensor surveillance system. The sensors can be combined to enhance detection and identification accuracy and allow continuous tracking of debris to possess better collision avoidance systems.

By the development of infrared tracking technology, this study aims at improving the effectiveness, accuracy, and scalability of space debris observation. The achievement of successful development of infrared systems will be pivotal in ensuring long-term space activities' sustainability, reducing collision debris risks, and preserving the space environment for further activities.

Keywords: Space Debris, Infrared Tracking Systems, Debris Detection, Multi-Sensor Systems, Real-time Tracking, Sensor Optimization