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ACTIVE SPACE DEBRIS REMOVAL WITH ARTIFICIAL INTELLIGENCE ASSISTED CUBESATS USING ROBOT TECHNOLOGY AND SWARM INTELLIGENCE FOR TRAJECTORY PREDICTION, DEBRIS CAPTURE, AND DEORBITING IN LOW EARTH ORBIT

Abstract

Low Earth Orbit (LEO) space debris buildup is a serious problem that puts important dangers to space missions and assets. The application of Artificial Swarm Intelligence (ASI), a new technology that can improve the efficiency of ADR operations, is a viable approach to solving this issue. This research suggests a unique method for ADR that employs robot equipped CubeSats with ASI support to collect and deorbit space debris. To enable coordinated and autonomous debris clearance, the proposed system combines several cutting-edge technologies, including swarm robotics, computer vision, and communication networks. The CubeSats can recognize, track, and collect space trash thanks to their sophisticated sensors and actuators, including robotic arms and cameras. To enable effective debris, capture and deorbiting, the ASI algorithm regulates the swarm's mobility, allowing it to respond to changes in the debris trajectory and surroundings. Realistic LEO settings and scenarios of the distribution and movement of debris are used in simulations to assess the performance of the proposed technology. The results demonstrate that in terms of effectiveness and thoroughness of debris removal, ASI-assisted CubeSats with robot technology beat conventional ADR techniques. The proposed technology has several potential advantages for the next space missions in addition to enhancing the security and sustainability of space operations. The system's flexibility and autonomy will allow for more effective and focused debris removal, improving the operational viability of ADR missions. Moreover, using CubeSats offers a scalable and affordable method for system deployment. The proposed system has restrictions that necessitate more study. The ASI algorithm's computational resource requirements are one restriction; however, this can be overcome with new hardware and methods. Future studies might potentially investigate the incorporation of other sensors and technology, such as robotics and machine learning, to boost the system's efficiency. The proposed ASI-assisted CubeSats with robot technology, in conclusion, offer a viable ADR strategy that can handle the growing problem of space debris in LEO. The findings of this study lay the groundwork for future research in this field and show how cutting-edge technologies like ASI have the potential to revolutionize space technology and exploration. We might gain a better understanding of the space environment and considerably increase the safety and sustainability of space activities using the suggested technology.

Keywords: Space debris, Pattern Recognition, Computer Vision, LEO, Swarm Robotics, CubeSats