A Novel CubeSat-Based System for On-Orbit Millimetric Debris Detection and Characterization

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Orbital debris are known to pose a severe threat of damage or destruction to orbital assets such as communications satellites and the International Space Station. NASA estimates that there are over 2 million objects with a 3-10 cm diameter in Low Earth Orbit (LEO, 400-2000km altitude), each with the capability to destroy a satellite. In fact, since the year 2000, these objects have hit 10 satellites totaling 3.2 billion dollars in damage. Most of these objects are byproducts of normal human space activities such as rocket propulsion. The average potential collision speed of a piece of orbital debris with an orbital asset exceeds 10 km/s. Although current ground-based radar systems can track objects in LEO with diameters as low as 10 cm, little data exists to determine the flux of 3-10cm diameter debris in LEO. This study developed a system to provide empirical data for orbital debris flux through an on-orbit system. Preliminary simulations showed that a beam-break laser array would be the most effective method of debris detection and characterization. This was then designed and packaged into the form factor of a 6U CubeSat to minimize the system's cost of deployment. Finally, large-scale system analysis was conducted to optimize the satellite constellation size and deployment pattern as well as to characterize the expected data and concept of operations for such a program. This system will provide empirical data that will allow orbital assets and astronauts to be much safer as humans continue to venture into and invest in space.

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