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SPACE OBJECT DETECTION AND CHARACTERISATION WITH A PASSIVE SPACE-BORNE BISTATIC RADAR

Abstract

This paper presents a feasibility and performance assessment of a simple and low-cost system to detect, characterise and potentially track space debris in Low Earth Orbit. The concept, developed within the project CUSPT [1] supported by the UK Space Agency, exploits any Earth-orbiting satellite broad-casting radio waves as illuminators of a bi-static radar system in which the receiver is a small antenna flying at very low altitude on a cubesat.

A similar system, recently proposed, was envisaging the use of a ground receiver. Although on ground one can deploy larger antennae, the system remains limited by the attenuation due to larger distances, atmosphere, atomic oxygen and bad weather.

The concept proposed in this paper overcomes come of this difficulties without increasing mission and system complexity. In fact, in principle the receiver can be installed on any low-altitude satellite (or even the space station) and does not require a dedicated mission. Alternatively, it can be demonstrated that one can install the receiver on one or more cubesats flying at very low altitude (below 400km) and provide a dedicated service that does not increase the debris population.

The paper will present the performance of this system using a single receiver or a swarm of coordinated receivers. The paper will investigate the use of different illuminators at different frequencies. It will be shown that, depending on the integration time, that ultimately depends on the time illuminator, receiver and target, are in view, one can detect objects down to few centimeters in size and recognize targets observed previously. The paper will show that with more than one receiver working collaboratively, a full orbit determination is possible combining Difference Time of Arrival and Difference Frequency of Arrival measurements.

References

[1] Carmine Clemente Massimiliano Vasile. Cuspt: Cubesat-based passive bistatic radar for space debris tracking. *Study Report, NSTP2, UK Space Agency, 2016*