

SPACE DEBRIS SYMPOSIUM (A6)
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DETECTION AND TRACKING OF DEBRIS USING SPACE-BORNE PLATFORMS

Abstract

Currently in the Low Earth Orbit (LEO) environment space debris of size 10cm and above are tracked with ground based radars and optical sensors. However, even small debris of size less than 10cm, which are usually too small to track from ground, can degrade or cause the loss of a mission. Furthermore, given the large estimated number of small debris in LEO which cannot be tracked there is an ever increasing risk to space missions.

In this paper we detail a conceptual design of a constellation of formations of small satellites aimed at providing accurate and precise detection of objects in orbit less than 10cm in diameter. This is achieved by using a combination of optical and radar sensors arranged in a "string of pearls" satellite formation. In the formation radar acts as the lead satellite followed by a pair of co-orbital satellites carrying optical CCD cameras operating in a "binocular" mode. In this arrangement the initial detection and tracking is undertaken by the radar satellite, with estimate refinement by the optical satellites. There will be a constellation of these formations covering both high and low inclination orbits providing coverage across the equator where current ground based systems are not capable of imaging.

The paper will describe the conceptual design of the system as well as demonstrate how small debris, which exhibit small radar cross sections, can be detected using radar and the small optical system. The paper will also detail the mathematical models of the "binocular" vision optical camera system and approaches to solve the ambiguities in single optical system as well as providing a description of the radar system and imaging algorithms. The functionality and performance of the proposed concept are verified using System Tool Kit (STK) and Matlab simulations. In addition, the technical challenges which may affect the range resolution in terms of time synchronization, baseline measurement accuracy and CCD camera spatial resolution are also discussed.