Abstract

Operational spacecraft are currently threatened with collisions with space debris. The potentially high closing speeds can give rise to extremely energetic collisions. Such phenomena may seriously damage a satellite or space station, and therefore there is considerable interest in observing and tracking hazardous space debris. Active systems such as radar have been used to measure the extent of the near-Earth debris population. Optical systems, using the near-constant solar illumination do not suffer the transmission loss experienced by radar; so objects may be detected at a greater distance. This is of particular interest since small particles closing at a typical ~ 10 km s^{-1} could be hazardous. It is important that the near-Earth debris field be catalogued down to the smallest size limit technically feasible.

This report is divided into two main parts, each approaching the ground-based optical debris detection scenario from different angles. Part 1 contains a means to optimise an optical observatory's detection rate by identifying localisations of increased visibility in the sky by running detection simulations incorporating illumination characteristics brought about by factors in the debris' orbit and the observer's locale. The program developed is discussed in detail, and describes the physical and astronomical factors entered into the model. Simulations are run for a variety of observing sites and orbits and the results analysed graphically and numerically. Results show that detection rates can vary greatly with look angle.

In part 2 an algorithm to detect the passage of very faint debris in real-time as it moves through a ground-based telescope's field of view is devised and described in detail. Test runs on simulated frames and real imagery from an observatory in South Africa are presented and the results analysed in terms of performance characteristics of the program and discussions about its suitability for debris detection.