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OPTICAL MEASUREMENTS AND RELATIVE TRAJECTORY DETERMINATION OF COLOCATE GEOSTATIONARY SATELLITES

Abstract

The recent increase in the use of geostationary services causes the growth of the number of geostationary satellites, imposing the operators to place spacecraft close to each other in the orbit leading to the colocation of satellites. Colocation is a geostationary orbit formation strategy where two or more satellites are placed within the same station keeping box. Colocation causes the satellites to move in relative motion ellipses about each other with typical separations varying from 1 to 100 kilometers In order to make an orbital control plan for such a group of clustered satellites to maintain an adequate constellation while avoiding any possibility of collision or unfavorable mutual interference, we first have to know precisely the relative orbital motion of the satellites. It is reasonable to expect that the relative motion should be accurately measured by means of intersatellite tracking but such a kind of measurements should be supported (both in case of failure or in case of unavailability) from reliable ground based systems. Combining the tracking data from the primary ground station and additional remote tracking data is an effective method to increase the orbit determination accuracy. However, remote ranging station is costly and not economically feasible for small operators. To operate these satellites without the risk of collision or any other undesired mutual interference, the Inter Satellite Distance between these satellites should be maintained within certain limits. Hence it is necessary to explore the feasibility of relative orbit determination as accurately as possible. In order to perform an accurate orbit determination and conjunction analysis, the colocate satellites position and velocity vectors are necessary, as well as the state covariance. These parameters can be obtained from the Two Line Element sets; however the accuracy of the provided state vectors is not sufficient for accurate collision analyses, and further orbit determination should be performed in order to determine an accurate state vector and the related covariance. Integrating the TLE parameters with optical measures or even using optical measures only can achieve this level of accuracy. In this paper is presented a study case, based on optical measurements, collected during a dedicated observation campaign, of clustered geostationary satellites. The observatories of the Laboratory of Space Systems of the University of Rome performed the observation campaign. The methods and algorithms used for relative motion analysis rely on systems usually used for space debris close approach study.