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EARTH OBSERVATION SYMPOSIUM (B1)
Future Earth Observation Systems (2)

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TIDAL SYNCHRONOUS ORBIT: A NOVEL APPROACH TO REMOTE SENSING OF OCEANIC REGIONS

Abstract

To-date space-based remote sensing of oceans and coastal regions has principally been conducted from platforms in Sun-Synchronous Low Earth Orbit (LEO). Such a trajectory, while beneficial in terms of solar illumination angle, has limitations in that geometric patterns driven primarily by tidal variation (such as coastal bathymetry and suspended sediment reflectance) may not be captured effectively. As such, tidal-synchronous observations can be expected to provide enhanced remote sensing of oceanic regions where tidal variation plays a key role. This paper introduces the concept of Tidal synchronism, defining it as when the orbit period of a platform is synchronised with the rotation period of the Earth such that a repeat ground-track is achieved after an integer number of 'tidal periods' (twice the 'principal lunar semi-diurnal' constituent). Such a Tidal-Synchronous platform would facilitate analysis of specific locations, at specific times in the regular tidal sequence, resulting in improved monitoring of evolving patterns as a function of tidal variation. Whilst a Sun-Synchronous orbit has been necessary for the majority of large, multi-functional Earth Observation platforms (e.g. ENVISAT), specific mission applications realised through smaller, specialised technologies are becoming increasingly common, for which a tidal synchronous orbit is found to be beneficial.

For the first time, this paper introduces the concept of a Tidal-Synchronous orbit and describes the astrodynamic properties of such a trajectory under the influence of natural perturbations (J2) via a set of Modified Equinoctial Elements. Analytical solutions for low thrust propulsive station-keeping are presented, for the general case of orbit and repeat parameter combinations, indicating the applicability of such a mission to small, resource limited spacecraft. It is shown that a repeat ground-track can be achieved every 28 tidal periods with a single platform, through exploitation of natural perturbations alone (imager field of view would govern temporal resolution over any given region). A constellation of satellites could be deployed to achieve greater temporal resolution (additional satellites in an orbit plane) and greater number of ground-track repeats at specific tidal times (additional orbit planes). It is also shown that orbit parameters attributed to a repeat ground-track after exactly 57 tidal periods are almost identical to those required for a Sun-Synchronous orbit (approximately 5deg drift in relative solar angle per year). In this case, benefits from each class of synchronism could be exploited in order to achieve high quality, reliable visible imaging data at regular times in the tidal sequence.