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LASER RANGING TO SPACE DEBRIS: OVERCOMING CHALLENGES

Abstract

Space debris laser ranging systems are a valuable asset complementing existing observation technology for space surveillance, space situational awareness and space traffic management. The technique is promising for orbit determination and improvement if compared to radar observing systems due to its achievable precision, and the advantageous capability to operate in the absence of an external illumination source irradiating the target object as needed when utilizing passive-optical systems. Additionally, an extended set of observables per target object may be extracted from the acquired laser ranges comprising information such as horizontal angular observations from the pointing direction, the tumbling motion, the average cross-section, or the surface albedo of the observed target object.

For the successful employment of laser ranging systems in space surveillance and tracking applications, it is required that the systems are equipped with: a) a target acquisition and beam locking subsystem to compensate for inaccurate ephemerides and the relatively narrow field of view of the laser beam; b) high output power, which is a critical specification when ranging to targets that do not carry any reflective element on board; c) selected band-pass and temporal filters to potentially enable the acquisition of observations during daylight. Recent work conducted in this area has shown feasible solutions addressing the previous constraints. Nevertheless, while finding new solutions to the aforementioned tasks, we found new challenges. In the scope of this presentation, we will focus on the detection of the weak signal resulting from the system specifications, the type and physical characteristics of the irradiated target object, its attitude state, and the impact of the available ephemerides. Note that the previous factors become noticeable in the signal signature, which can be seen in the so-called residuals: actual observations minus predictions. In this context, we will revisit existing algorithms for signal detection currently in use by many traditional geodetic Satellite Laser Ranging stations, and formulate the problem from a hypothesis testing perspective from which we will present encouraging preliminary results.