Abstract: Attitude Estimation of (defunct) Satellites using Bi-static Satellite Laser Ranging Simulations

This work analyzes the potential of a method for determining the attitude of satellites and space debris using bistatic Satellite Laser Ranging (SLR) simulations. The target of removing defective satellites from orbit is supported in an essential way by the ability to measure the rotational characteristics from ground. The superior precision of SLR allows for an identification of the individual corner cube reflectors (CCR) on a spacecraft's surface within the SLR data. The true distance between two reflectors is known from the arrangement on the satellite or is defined in the simulation. Three CCRs in a line with different distances is a suitable pattern for this method. One CCR is assumed to be in the origin while the position of the others momentarily remain unknown. The objective is to estimate the position of a second CCR in space relative to the first. An unknown attitude limits the area of the potential position to a spherical surface around the first CCR. SLR range measurements yield the range difference between the CCRs in observation vector direction. Thus, a plane can be defined which is perpendicular to the observation vector and shifted by the range difference. The intersection of the sphere and the plane produces a circle of potential positions for the second CCR. Once simultaneous SLR data is available from the second SLR station the circular region is further refined to two potential points in space, by the intersection of the two circles. The two CCRs can now be connected with a surface vector, which can subsequently be used to reconstruct the attitude of this vector over time. Within this work the theoretical limits of this method are investigated. The technique can also be used for a larger number of CCRs, knowing their true arrangement and provided that at least two CCR can be identified.