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SPACE DEBRIS SYMPOSIUM (A6)
Modelling and Orbit Determination (9)

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ORBIT DETERMINATION OF SPACE DEBRIS USING A BI-STATIC RADAR CONFIGURATION WITH A MULTIPLE-BEAM RECEIVER

Abstract

In this work the use of a multi-beaming radar system is analyzed and a possible setup of a closed loop system (i.e. from measurement and data acquisition to orbit determination) is described. The Orbit Determination (OD) algorithms are specialized for a bi-static radar configuration where the Medicina Northern Cross radio-telescope (owned by the University of Bologna - Italy) is considered as a receiver. The Northern Cross is composed of two perpendicular arms: the E/W arm is 564 m long and consists in a single cylindrical antenna with a width of 30 m, whereas the N/S arm is made of 64 parallel antennas with a length of 23.5 m and a width of 7.5 m. The collecting area reaches 27,000 sqm and, by considering a complete upgrade of the radar with the installation of new receivers on the focal lines, up to 22,880 possible theoretical independent beams could cover the field-of-view of 55.47 (E/W) deg x 1.8 (N/S) deg. By looking at the sequence of beams that are illuminated, it is thus possible to estimate, with an higher level of detail with respect to the single-beam system, the ground track of the transiting object.

Given this peculiar system, tailored orbit determination algorithms have to be developed. The orbit determination algorithm receives as input the data processed by the acquisition system, that digitally assembles measured radar echoes, using FFT, to provide the signal for each beam. These inputs are the measured Doppler shift, the illumination time and measured power intensity associated to each beam. By combining these information with the knowledge of beam distribution and pointing it is possible to refine the orbital parameters of known objects or to perform a preliminary OD.

A few LEO objects are considered to generate simulated data that are then used to feed the developed OD algorithms. In this way the performances of the algorithms can be tested and the effectiveness of this

innovative configuration for space debris measurements, that couples a bi-static radar and a multi-beaming receiver, can be assessed.