16th IAA SYMPOSIUM ON SPACE DEBRIS (A6)
Interactive Presentations - 16th IAA SYMPOSIUM ON SPACE DEBRIS (IP)

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LIGHTCURVE INVERSION FOR ATTITUDE DETERMINATION

Abstract

The interest in determining the attitude of an orbiting object has grown significantly in recent years. Besides being one of the key parameters needed to obtain a precise orbital determination the attitude is also crucial in the perspective of planning space debris removing mission. In this paper, we present a method to retrieve the attitude of an orbiting object, based on virtual reality simulation together with global optimization. The attitude will be determined using the object's lightcurve derived informations, i.e. the total reflected light variation in time. This technique derived from the asteroids attitude and trajectory reconstruction techniques has recently been introduced in the uncooperative satellite optical attitude determination. The idea behind the proposed method is to generate, for a selected target, different synthetic lightcurves to be compared with the observed one, the synthetic lightcurve most similar to the experimental one will be chosen as the presumable object attitude. In such context, the crucial procedure step is the synthetic lightcurve generator that needs to be as realistic as possible in terms of optical and physical properties. To satisfy these requirements, the orbital position of the object will be recovered by propagating its orbit from the known TLE (Two-Line Element) through an SGP-4 (Simplified General Perturbations) routine. At the same time, the real positions of the observer and the Sun will be used to derive a precise value of the Phase angle Sun-object-observer aimed at obtaining an estimate of the light reflected by each object part. A realistic image of the object will be then produced at each instant of time using an advanced rendering algorithm, that takes into account parameters such as the atmospheric extinction, the object shape and materials, and the direction of the Sunlight. A particular effort is put to accurately reproduce the shadow areas cast among different object components. Finally, to find the best attitude parameters a evolutive algorithm that minimized the residual between the real and the simulated lightcurves is employed. The results obtained on very heterogeneous dataset show a very promising potential in terms of applicability of the developed method. In this paper, a method developed for the attitude reconstruction is discussed: first the used lightcurve analysis tools are described, and then the simulation environment able to generate artificial lightcurves is presented. The achieved results synthetic and on real data, acquired during January and February 2018, and future perspectives will be inserted in the conclusions.