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METHODOLOGICAL APPROACH TO THE PROBLEM OF ON-TIME IDENTIFICATION OF SPACE DEBRIS WITH THE USE OF SPACECRAFT ONBOARD OPTICAL SENSORS

Abstract

Collision with space debris causes a serious threat to the safety of operated spacecraft flight. Practice shows that it is rather difficult to identify space debris up to 10 cm by ground-based facilities. That is why there is a necessity to determine other ways for detection of hazardous approaches of spacecraft with such space objects. Forecasting of dangerous approximation of spacecraft with space debris using onboard facilities is one of the prospective directions to solve this problem. The efficiency of its implementation is mostly defined by the possibility of accurate and prompt definition of space debris motion parameters using onboard optical sensors. The proposed methodological approach is as follows. The radius-vector of space debris and angular distance between these vectors are calculated by the known values of spacecraft radius-vector and measurements. The angular distance is calculated between the location of space debris in the moments of measurements. The transcendental equations are elaborated at the first stage connecting the parameters of spacecraft relative motion with keplerian integrals. To speed up the calculations the infinitesimal assumption of parameter value of "arcsin" functions in transcendental equation was introduced. It is showed that errors which occur in the infinitesimally conditions of the spacecraft and space debris relative distance do not exceed $0.5-0.7\%$. Considering the application of the known filtering algorithms, the errors are reduced to 0.1%. After introduction of indicated assumption we receive analytical formulae for calculation of orbit parameters of space debris. The effective application field of the proposed approach is identified. Errors do not exceed $0.1-0.2\%$ when space debris orbit parameters with low eccentricities ($e<0.04$) and angular distance between radius-vectors ($\Delta v<15^0$) are calculated. The similar level for errors corresponds to highly-elliptical orbits ($e<0.7$)for measuring spans not exceeding 2 minutes. The proposed methodological approach to the problem decision of operational identification of moving objects can be the basis for the task decision of space debris removal from the near-earth space.