Paper ID: 35371
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SPACE SYSTEMS SYMPOSIUM (D1)
Interactive Presentations (IP)

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A SURROGATE MODELLING METHOD FOR ESTIMATING ORBITAL LIFETIME

Abstract

Orbital lifetime analysis is necessary to support the design of satellite missions and ensure compliance with international regulations. Rapid estimation of the orbital lifetime of spacecraft can enable new mission analyses or optimisation methods which require the evaluation of many different designs. In this paper a method for estimating orbital lifetime using surrogate modelling is presented. In comparison to traditional methods of lifetime estimation, which utilise orbit propagation methods to evaluate each point of interest and can thus be computationally expensive, the presented method requires only the solution of only a limited number of initial cases before a simple equation-driven model for orbital lifetime is generated.

The developed method is demonstrated using a numerical orbit propagation technique to generate the model for orbital lifetime whilst maintaining consideration for the time-varying effect of solar activity. Validation of the model is subsequently conducted using a number of historical satellite missions before comparison of the model is performed against existing methods for orbital lifetime estimation.

Due to the simplicity of the model, rapid numerical analysis of orbital lifetime can be performed enabling characterisation of the effects of uncertainty associated with variables such as ballistic coefficient and solar activity. Confidence bounds on estimated orbital lifetime can also be established by considering the cumulative effects of the various sources of uncertainty. The practical applications of such a model include the ability to rapidly evaluate many different design options, for example vehicle design and operational orbit selection, and the analysis of end-of-life regulatory compliance.