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ACCURATE SATELLITE MATHEMATICAL MODEL GENERATION FOR LINE OF SIGHT JITTER EVALUATION USING SEMI-DIRECT UPDATING TECHNIQUES WITH MODAL SURVEY TEST

Abstract

Accurate satellite mathematical model generation is proposed for line of sight (LOS) jitter evaluation using semi-direct updating technique with modal survey test. In the case of satellites launched in low earth orbit, they have important missions in relation to earth monitoring to acquire optical images with sub - meter resolution. Moreover, high agility and more mission accomplishments are required by the customer in order to acquire more images from satellites. To achieve the goal, many mechanisms, including high capacity wheels, a control moment gyro, and X-band antenna with multi-axis gimbals have been widely adopted, but they become a source of disturbance in the viewpoint of LOS (line of sight) jitter, which could significantly deteriorate the quality of images. To evaluate MTF (modulation transfer function) degradation in orbit by the jitter sources on the ground, a prediction is conducted via an integrated model coupling the measured jitter sources with FE (finite element) model. Before prediction, FE model is updated by iterative methods by matching simulation results with the modal survey test that is performed with a satellite suspended via bungee spring from the ceiling with accelerometers attached on jitter source and mirrors of the optical payload. Several mounting points of jitter sources are excited by impulse hammer to investigate the dynamic behavior between the jitter sources and the optical payload. Besides the aforementioned treatment, to maximize the accuracy of FE model, semi-direct updating technique is applied on the previously updated FE model containing some slight errors such as frequency deviation around 5% widely accepted by many space design standards: NASA, DOD and ESA. In the semi-direct updating technique, it refers to the natural frequencies from the test instead of those from the FE model, but uses the eigenvectors from the FE model. By doing so, it provides an accurate satellite mathematical model generating the reconstructed frequency response functions without the frequency deviation errors and thus making the results of prediction more accurate. Through the example, we show the performance of the proposed scheme in terms of accuracy and efficiency.