World Academy of Science, Engineering and Technology
International Journal of Aerospace and Mechanical Engineering
Vol:12, No:06, 2018

Influence of High-Resolution Satellites Attitude Parameters on Image Quality

Authors : Walid Wahballah, Taher Bazan, Fawzy Eltohamy

Abstract : One of the important functions of the satellite attitude control system is to provide the required pointing accuracy and attitude stability for optical remote sensing satellites to achieve good image quality. Although offering noise reduction and increased sensitivity, time delay and integration (TDI) charge coupled devices (CCDs) utilized in high-resolution satellites (HRS) are prone to introduce large amounts of pixel smear due to the instability of the line of sight. During on-orbit imaging, as a result of the Earth's rotation and the satellite platform instability, the moving direction of the TDI-CCD linear array and the imaging direction of the camera become different. The speed of the image moving on the image plane (focal plane) represents the image motion velocity whereas the angle between the two directions is known as the drift angle (β). The drift angle occurs due to the rotation of the earth around its axis during satellite imaging; affecting the geometric accuracy and, consequently, causing image quality degradation. Therefore, the image motion velocity vector and the drift angle are two important factors used in the assessment of the image quality of TDI-CCD based optical remote sensing satellites. A model for estimating the image motion velocity and the drift angle in HRS is derived. The six satellite attitude control parameters represented in the derived model are the (roll angle φ, pitch angle θ, yaw angle ψ, roll angular velocity φ̇, pitch angular velocity θ̇ and yaw angular velocity ψ̇). The influence of these attitude parameters on the image quality is analyzed by establishing a relationship between the image motion velocity vector, drift angle and the six satellite attitude parameters. The influence of the satellite attitude parameters on the image quality is assessed by the presented model in terms of modulation transfer function (MTF) in both cross- and along-track directions. Three different cases representing the effect of pointing accuracy (φ, θ, ψ) bias are considered using four different sets of pointing accuracy typical values, while the satellite attitude stability parameters are ideal. In the same manner, the influence of satellite attitude stability (φ̇, θ̇, ψ̇) on image quality is also analysed for ideal pointing accuracy parameters. The results reveal that cross-track image quality is influenced seriously by the yaw angle bias and the roll angular velocity bias, while along-track image quality is influenced only by the pitch angular velocity bias.

Keywords : high-resolution satellites, pointing accuracy, attitude stability, TDI-CCD, smear, MTF
Conference Title : ICASET 2018 : International Conference on Aerospace Science, Engineering and Technology
Conference Location : Dubai, United Arab Emirates
Conference Dates : June 21-22, 2018