In-Flight Radiometric Performances Analysis of an Airborne Optical Payload

Authors : Caixia Gao, Chuanrong Li, Lingli Tang, Lingling Ma, Yaokai Liu, Xinhong Wang, Yongsheng Zhou

Abstract : Performances analysis of remote sensing sensor is required to pursue a range of scientific research and application objectives. Laboratory analysis of any remote sensing instrument is essential, but not sufficient to establish a valid inflight one. In this study, with the aid of the in situ measurements and corresponding image of three-gray scale permanent artificial target, the in-flight radiometric performances analyses (in-flight radiometric calibration, dynamic range and response linearity, signal-noise-ratio (SNR), radiometric resolution) of self-developed short-wave infrared (SWIR) camera are performed. To acquire the inflight calibration coefficients of the SWIR camera, the at-sensor radiances (L_i) for the artificial targets are firstly simulated with in situ measurements (atmosphere parameter and spectral reflectance of the target) and viewing geometries using MODTRAN model. With these radiances and the corresponding digital numbers (DN) in the image, a straight line with a formulation of L = G × DN + B is fitted by a minimization regression method, and the fitted coefficients, G and B, are inflight calibration coefficients. And then the high point (L_H) and the low point (L_L) of dynamic range can be described as L_H= (G × DN_H + B) and L_L= B, respectively, where DN_H is equal to 2ⁿ − 1 (n is the quantization number of the payload). Meanwhile, the sensor’s response linearity (δ) is described as the correlation coefficient of the regressed line. The results show that the calibration coefficients (G and B) are 0.0083 W·sr^{−1}m^{−2}µm^{−1} and −3.5 W·sr^{−1}m^{−2}µm^{−1}; the low point of dynamic range is −3.5 W·sr^{−1}m^{−2}µm^{−1} and the high point is 30.5 W·sr^{−1}m^{−2}µm^{−1}; the response linearity is approximately 99%. Furthermore, a SNR normalization method is used to assess the sensor’s SNR, and the normalized SNR is about 59.6 when the mean value of radiance is equal to 11.0 W·sr^{−1}m^{−2}µm^{−1}; subsequently, the radiometric resolution is calculated about 0.1845 W•sr⁻¹m⁻²μm⁻¹. Moreover, in order to validate the result, a comparison of the measured radiance with a radiative-transfer-code-predicted over four portable artificial targets with reflectance of 20%, 30%, 40%, 50% respectively, is performed. It is noted that relative error for the calibration is within 6.6%.

Keywords : calibration and validation site, SWIR camera, in-flight radiometric calibration, dynamic range, response linearity
Conference Title : ICSRD 2020 : International Conference on Scientific Research and Development
Conference Location : Chicago, United States
Conference Dates : December 12-13, 2020