BUNDLE BLOCK ADJUTMENT OF CBERS-2B HRC IMAGERY COMBINING CONTROL POINTS AND LINES

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ABSTRACT:

Earth observation and analysis from space imagery became feasible since the 70s with Landsat programs for remote sensing purpose. In 1988, Brazil and China started the CBERS (China-Brazil Earth Resources Satellite) program aiming at to foster the technological development in the field of Remote Sensing. One advantage of this program is that acquired images of South American and African territories are freely distributed. CBERS-2B carried a High Resolution Camera (HRC) providing images with a GSD of 2.7 meters. Although CBERS-2B satellite ceased operations on 16 April 2010, the images in archives are still of crucial importance for users in Brazil, for several applications, including medium scale mapping. In order to improve georreferencing accuracy, orbital imaging systems are equipped with direct orientation sensors. CBERS-2B had a single frequency GPS receiver and a star track sensor. One problem that reduced positional accuracy of CBERS-2B imagery was the lack of star sensor data, probably due to electronic failures in the area of South Atlantic Anomaly. As a consequence, the images distributed by INPE (Brazilian National Institute for Space Research) have a positioning error larger than a kilometer, in some images assessed. In order to use these images, it is necessary to estimate indirectly the orientation elements of CBERS-2B HRC images using ground control elements in the object space (points, lines and/or areas). Previous works showed the advantages of using Ground Control Lines (GCLs) as alternative to Ground Control Points (GCPs), but the simultaneous adjustment with these sort of data was not assessed yet. Ground surveying of lineal entities is much easier than GCP for the indirect orientation of images with this resolution. For example, road center lines can be surveyed very quickly and with suitable accuracy with kinematic GPS positioning. The aim of this work is to present the results of the assessment of rigorous bundle block adjustment models for orbital imagery using points and lines as control elements. The mathematical models relating object and image spaces are based on collinearity (for points) and coplanarity (for lines) conditions with polynomial modeling of the spacecraft trajectory and attitude. The models were implemented in the in-house developed software TMS (Triangulation with Multiple Sensors), with multifeatures control (GCPs and GCLs). The object space entities were surveyed with a dual-frequency GNSS receiver comprising an area of four HRC scenes. Experiments with this block of four CBERS-2B HRC (level 1 images – only with radiometric correction) images were accomplished using both GCPs and GCLs. The results showed that the combination of collinearity and coplanarity models provided better results in the bundle block adjustment process than conventional bundle adjustment with GCPs only. It was also verified a systematic error in the inner geometry of HRC camera caused by the displacement of one of the three CCD sensors and the lack of proper correction when fusing the three images to generate level 1 image. Experiments to evaluate the effects of these systematic errors will be also presented.