Earth observation for sustainable development and security: Materials of reports of the Fourth International Conference “GEO-UA 2014“ (2014, Kyiv). – ISBN 978-966-02-7248-4 (electronic publication). – P. 17 - 19.

The cross–calibration algorithm of Sich-2 data

Basarab[1, 2] R. M., Kussul N.M.[1]

1. Space Research Institute NAS Ukraine and SSA Ukraine.

2. National university of life and environmental sciences of Ukraine.

"Sich-2" is remote sensing satellite. It is designed for Earth observation in the optical and short-wavelength infrared spectral ranges. There are not existing procedures for inflight calibration of "Sich-2" data. Satellite images are presented as the set of digital numbers (DN). We need to calibrate "Sich-2" satellite data, before we can use it in solving different applied tasks. The purpose of calibration is converting DN into such physical units as surface reflectance or spectral radiance.

In this work we present one of the relative methods of satellite data calibration, namely the cross-calibration method. It is based on cross-comparison of a pair of satellite images that capture the same territory. One is the image which should be calibrated (source data) and second is already calibrated satellite image (reference data). In our case, source data was "Sich-2" images and reference data was Landsat7 ETM+ images [1].

In our research we use data set from 20 pairs of satellite images. Data were selected in special way. Time has passed between capturing each of images from pair was less than 3 days. In case of existing 2 or more Landsat7 images, last were united into mosaic by using Geospatial Data Abstraction Library (GDAL).

All "Sich-2" input images were previously georeferenced [2, 3]. To minimize effects of atmosphere, we performed atmospheric correction for all Landsat 7 images using NASA algorithm [4]. After preprocessing we compared all pixels of each band from source and reference images. It was done to detect pseudo-invariant features (PIF) – pseudo-invariant pixels for each source and reference image. PIF detection was implemented using automated ordination algorithm called multivariate alteration detection (MAD) [5].

We developed models of robust linear regression, using the correlation of digital pixel data of each spectral band (not all pixels, but only PIF's). Separate regression model is created for each band (Green, Red and NIR).

Summarizing the results of the processing of all "Sich-2" images, we can conclude the following. We experimentally demonstrated that there is a linear relationship between the "Sich-2" satellite data and the product of atmospheric correction of Landsat7 ETM+ data. We developed robust linear regression models for "Sich-2" data calibration. Average coefficients of determination of created models for green, red and near-infrared spectral bands are equal to 0.8789, 0.9484 and 0.9816. RMS errors of the developed models are equal to 0.004%, 0.0044% and 0.006% correspondingly.

Also robust linear regression was unable to calibrate of three "Sich-2" images. The reason was in "bad" set of PIFs. A lot of captured territory was covered by clouds or snow.

References

1. Basarab R.M. The method and results of calibration of Earth remote sensing space system "Sich-2" data / Proceedings DNTU series "Informatics, Cybernetics and Computer Science. ISSN 1996-1588, № 2 (18)' 2013. P. 46 – 55. (in Ukrainian)
2. Kravchenko O.M. An algorithm of geographical reference satellite "Sich-2"images / O.M. Kravchenko, M.S. Lavrenyuk, N.M. Kussul // Proceedings DNTU series "Informatics, Cybernetics and Computer Science. ISSN 1996-1588, № 2 (18)' 2013. P. 71 – 79. (in Russian)
3. Fedorov O.P. An information system of geographical referencing of remote sensing space system Sich-2 data for the territory of Ukraine / O.P. Fedorov, N.M. Kussul, O.M. Kravchenko, S.L. Yancevskii, R.M. Basarab, V.M. Krygin, M.S. Lavrenyuk. // Space Science and Technology - 2013, № 80. Vol. 19. P. 3 - 12. (in Ukrainian)
4. Jeffrey G. Masek. A Landsat Surface Reflectance Dataset for North America, 1990-2000 / Jeffrey G. Masek, Eric F. Vermote, Nazmi E. Saleous, Robert Wolfe, Forrest G. Hall, Karl F. Huemmrich, Feng Gao, Jonathan Kutler, and Teng-Kui Lim. // IEEE Geoscience and Remote Sensing Letters. Jan. 2006. Vol. 3. No. 1. P. 68-72.

5. Todd A. Schroeder. Radiometric correction of multi-temporal Landsat data for characterization of early successional forest patterns in western Oregon / Todd A. Schroeder, Warren B. Cohen, Conghe Song, Morton J. Canty, Zhiqiang Yang. // Remote Sensing of Environment, March, 2006. Vol. 103. P. 16–26.