The new algorithm for "Sich-2" image georeferencing

Kravchenko[1] O. M., Lavrenyuk[1,3] M. S., Basarab[1, 4] R. M., Kussul[1,2] N. M.

Space Research Institute NAS Ukraine and SSA Ukraine.

National technical university of Ukraine "Kyiv Polytechnic Institute".

Taras Shevshenko National university of Kyiv.

National university of life and environmental sciences of Ukraine.

The process of transforming different sets of data obtained at different times or from different sensors to a single coordinate system is called geographical referencing. Basic accuracy of georeferencing of "Sich-2" data (by orbital parameters) is 250-2000 m. Such data can't compete with data of well-known spacecrafts as RapidEye (20-50 m) Landsat5 (50 m) or Spot5 (30 m).

Process of satellite images georeferencing as a rule is semi-automatic procedure. Human operator takes part in it for visual control points detection on the image and reference map. Such methodic requires considerable human resources and a lot of time. Nowadays there are several methods for automatic control points detection and registration of images. One of them is described in [1], and adapted for "Sich-2" satellite data [2]. Its accuracy is about 50-100m for almost all images made over Ukraine territory. But in some cases it is unusable. Main problem is in small number of control points (because of clouds, snow or oversaturation of images/pixels due to overexposure image).We propose new algorithm for solving these problems.

First step is to calculate the gradient of the image brightness at each pixel using Sobel operator. Then we use direct and inverse Fourier transformation (based on the Fourier Shift Theorem) over all the image. After it, we obtain a function which is equal to zero almost everywhere, except the place of optimum displacement of one image over another. In such a way we can identify such relatively unchanged objects as forest belts, roads, some man-made, etc. These objects are relatively unchanged over the time.

After filtering the control points set we build a sensor model. It is based on reference points, which will be further used to convert image. We use neural network as the sensor model in this research. It takes three parameters as inputs – two coordinates and altitude.

Calculating the accuracy of georeferencing was done by an independent human operator (expert). His job was to find 5 sites, located on both images (input and reference map) mainly on the corners and in the center. It must be not a simply sites, but stationary objects that are not changing over time. We record coordinates for each object from the original image ("Sich-2"), base image (GEOCOVER 2000), and processed images. Using expert information we calculate RMS errors of georeferencing for each image.

The accuracy of georeferencing "Sich-2" satellite data is increased from 56.3 m (using adaptive AROP algorithm) to 13.9 m with using proposed algorithm. The algorithm is also usable in difficult conditions in which the existing algorithms do not work.

All sample data set consists of 73 "Sich-2" images. 27 of them could not be georeferenced by using existing algorithms, but ivproved algorithm takes the problem. The accuracy of georeferencing was about 36.6 m in average (instead of 668 m with standard georeference by orbital parameters).

The results of investigation were presented on scientific conferences in Ukraine [4] and Russia [5].

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