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MULTISPECTRAL REMOTE SENSING IMAGERY SUPERRESOLUTION: AFTER RESAMPLING

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Вирівнювання просторової розрізненності багатоспектральних дистанційних зображень

У статті наводиться порівняння методів вирівнювання просторової розрізненності різних спектральних каналів багатоспектральних зображень до найкращої. Встановлено принципові недоліки та запропоновано новий підхід, що ґрунтується на аналізі просторових зв'язків опорних спектральних сигнатур.

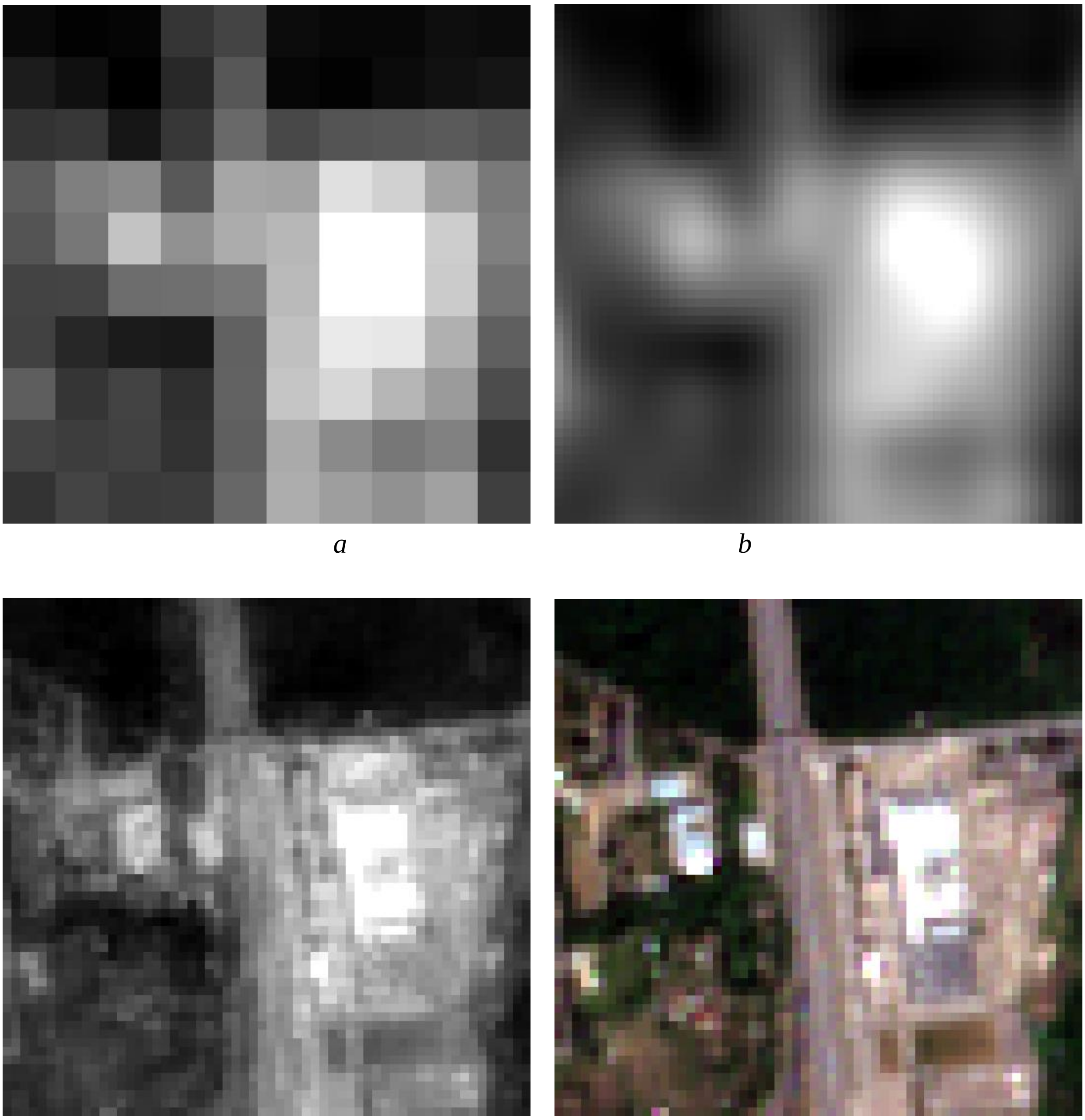
The superresolution is very important when satellite images or separate bands of different spatial resolution used jointly. A comparison of methods for spatial resolution enhancement or equalizing of different spectral bands up to the best one was carried out.

The following three methods were chosen for comparison. The first method consists in simply dividing the pixel by subpixels according to the nearest neighbor rule while preserving the value of original pixel [1]. The second method for calculating the subpixel value engages bicubic interpolation based on a certain number of adjacent pixels of the original image [2]. And the third one is super-resolving multiresolution images method with band-independent geometry of multispectral pixels (Sen2Res) [3]

The results of B1 (443 nm) band processing with a 60 m spatial resolution of the original Sentinel-2 multispectral image by three methods and a subset of the synthesized RGB image with a 10 m spatial resolution are shown in Fig. 1.

The results of B1 (443 nm) band processing with a 60 m spatial resolution of the original Sentinel-2 multispectral image by mentioned three methods as well as a subset of RGB synthesized image with a 10 m spatial resolution are shown in Fig. 1.

Superresolution is intended for two tasks solving. First, the spatial quality of the image should be improved, and secondly, the radiometric consistency of image should be kept up. The nearest neighbor method in comparison with the reference image (Fig. 1*a*) keeps the subpixels' radiometric values within the pixel, but is aliased-prone. Bicubic interpolation method (Fig. 1*b*) slightly smoothing image, but does not preserve radiometry. The average value of subpixels within a pixel is different from the source value of input image. Sen2Res method (Fig. 1*c*) performs the required tasks quite successfully. The radiometry within the pixel is preserved, and the spatial improvement of the image occurs.



a *b* *c* *d*

Fig. 1. The results of B1 (443 nm) band processing with a 10 m spatial resolution: *a* – nearest neighbor, *b* – bicubic, *c* – Sen2Res method, *d* – subset of the RGB synthesized image

Sen2Res method explicitly encodes geometric details from available high-resolution bands and preserves the spectral content of each low-resolution band independently from geometry.

It is proposed to take a method [4] based on the image classification (segmentation) [5] by spectral signatures and the redistribution of values in subpixels, taking into account both the shape of the spectral signatures and spatial topology relationships for each type of land cover (Fig.2).

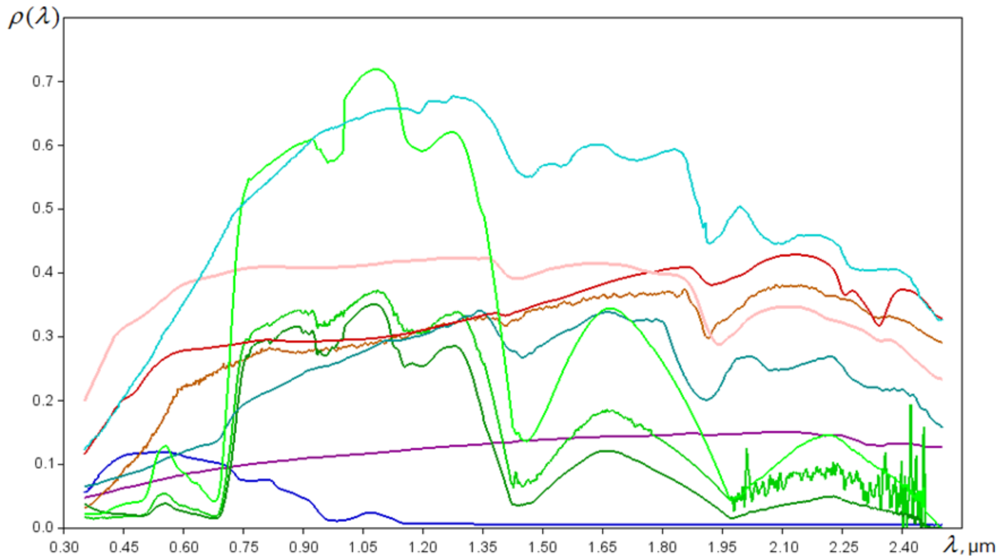


Figure 2. Spectral signatures of basic types of land cover

For each subpixel, similar to the reference spectral signatures, a topological description in *m* bands is calculated as

$$C(X) = \{\text{sign}\,(x_1 - x_2, \varepsilon_1 + \varepsilon_2), \ldots \text{sign}\,(x_{m-1} - x_m, \varepsilon_{m-1} + \varepsilon_m)\}$$
$$C(Y) = \{\text{sign}\,(y_1 - y_2, \sigma_1 + \sigma_2), \ldots \text{sign}\,(y_{m-1} - y_m, \sigma_{m-1} + \sigma_m)\} \quad (1)$$

where *x*, *y* – subpixel reflectance values, *σ*, *ε* – measurements errors.

The items number in the topological description for each signature depends on the number of bands.

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