Integration of spectral channels in the classification of coniferous and deciduous vegetation from satellite images

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Research methods

The study of the effectiveness of classification of coniferous and deciduous vegetation was carried out using Landsat–7 images. As the primary classification features of objects, their spectral brightness for each of the seasons of the year in six channels with the same spatial resolution of 30 meters were selected. To increase the information content of these features, the spectral channels of the shooting equipment were combined. At the same time, a new feature is formed for each of the objects – aggregated brightness. This feature is determined by the modulus of the vector in k-dimensional space (k = 2...6), whose coordinates are the luminance B1, ..., Bk of the satellite spectral channels :

$$\left|\overrightarrow{B_k}\right| = \sqrt{B_1^2 + \cdots + B_k^2}\ . \qquad (1)$$

Since the space of spectral brightness is not orthogonal, the relation (1) is a decomposition on the basis of some oblique coordinate system. At the same time, the modules of the generated vectors for different types of vegetation differ from those calculated in the orthogonal basis. Nevertheless, it is assumed that such aggregated brightness may increase the probability of correct classification of vegetation compared to its brightness in individual spectral channels. The implementation of the proposed approach to the formation of standards for each object was carried out by combining in different combinations a different number of channels of shooting equipment. This made it possible to choose the best combination of channels for each of the classified objects, form an appropriate standard from them and compare all pixels of the image with it. This procedure is performed for each of the seasonal images.

The probability of correct classification was determined by the ratio:

$$P_i = \frac{N_{iV}}{N_i}\ . \qquad (2)$$

Here P_i is the probability of correct classification of the object of the *i*-th type, N_{iV} is the number of correctly classified and N_i is the total number of pixels of the object of this type.

Experimental results

Considering the six images for single channels and the fact that all their combinations are analyzed for each of the six seasonal images, studies were conducted for 378 possible variants. The nearest neighbor method was used as the decisive rule for classification.

During the experiment, $P_{10X\,max}$ = 1.0000, in addition to the already available results, was obtained for the July snapshot when aggregating 1 and 4 channels, as well as for several combinations of three, four and five channels. As for deciduous trees, the probability of correct classification for them increased to $P_{10L\,max}$ = 0.9899 when aggregating 2 and 4 channels of the May snapshot. The same result was obtained for the July image when combining 4 and 7 channels.

Date of shooting	21.02.2000	28.04.2001	14.05.2010	14.07.2000	12.10.2001	24.11.1999
$P_{10X\,max}$	0.9882 (2; 3)	**1.0000** (7)	**1.0000** (4)	0.9941 (4)	**1.0000** (1; 2; 3)	0.9882 (1; 2)
	0.9882 (1+2);	**1.0000** (5+7)	**1.0000** (1+4)	**1.0000** (1+4)	**1.0000** (1+2)	0.9882 (1+5)
$P_{10L\,max}$	0.9293 (1)	0.8990 (7)	0.9596 (4)	**0.9697** (4; 5)	0.8889 (1)	0.8788 (1)
	0.9293 (1+7)	0.9495 (3+5)	**0.9899** (2+4)	**0.9899** (4+7)	0.8687 (1+2)	0.8889 (1+2)

At the same time, when classifying coniferous and mixed vegetation (50% coniferous and 50% deciduous), the effectiveness of aggregated standards turned out to be worse than simple ones selected by spectral channels and shooting seasons. The obtained results suggest the continuation of research when dividing plant objects into a larger number of classes.

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