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THE TECHNOLOGY OF INTERPRETATION OF SATELLITE IMAGES FOR THE CREATION LARGE SCALE AGRICULTURAL MAPS

Abstract: *The article is devoted to the issues of interpretation of satellite images with high spatial resolution for creating large-scale agricultural maps. It gives particular attention to visual interpretation. Despite the facts that in recent year's machine based methods of interpretation have been developed, the visual method is still an accurate and reliable method for interpreting aerial and satellite images.*

Keywords: *satellite image, visual interpretation, supervised classification, unsupervised classification.*

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ТЕХНОЛОГИЯ ДЕШИФРИРОВАНИЯ КОСМИЧЕСКИХ СНИМКОВ ДЛЯ СОЗДАНИЯ КРУПНОМАСШТАБНЫХ СЕЛЬСКОХОЗЯЙСТВЕННЫХ КАРТ

Аннотация: *Статья посвящена вопросам дешифрирования космических снимков с высоким пространственным разрешением для создания крупномасштабных сельскохозяйственных карт. В нем особое внимание уделяется визуальной интерпретации. Несмотря на то, что в последние годы получили развитие машинные методы дешифрирования, визуальный метод до сих пор остается точным и надежным методом дешифрирования аэро- и космических снимков.*

Ключевые слова: *космический снимок, визуальное дешифрирование, классификация с обучением, классификация без обучения.*

One of the most important and complex processes in creating large-scale maps of agriculture based on remote sensing materials is the analysis of images. Analyzing or interpreting aerial or satellite images means recognizing objects on the ground according to these images, determining their qualitative and quantitative characteristics [1]. Several methods of interpretation of aerial or satellite images are distinguished. A number of sources present two methods of interpretation: visual and digital methods. In these sources [6, 2] the term interpretation is often used in relation to the visual method (visual image interpretation). Digital or automated methods are usually called image analysis or classification.

The visual method of interpretation of aerial and satellite images is the most accurate and reliable method, which is carried out in office and field conditions. Human eye, brain, experience and intuition serve as the main means of interpretation in this method. At the same time, it is necessary to use technical means that expand the capabilities of the human eye, including computers, equipment that allows stereoscopic vision. In this case, instrumental visual interpretation is performed. In the visual interpretation of aerial and satellite images, objects on the ground can be recognized by their direct signs, such as shape, size, contrast, color, shade, and texture. If it is not possible to interpret the objects in the place by their direct signs, they can be identified by the filler signs. Placeholders can be used to indicate the location of objects and their relationships. Field work is carried out when it is not possible to interpret the objects on the spot in office conditions directly or through supplementary signs [4].

In order to create large-scale agricultural maps, it is necessary to know all agricultural objects and their characteristics in order to visually interpret satellite images. Due to the fact that normative documents on the visual interpretation of

images have not been developed in our republic, it is necessary to use "Инструкция по дешифрированию аэрофотоснимков и фотопланов в масштабах 1:10 000 и 1:25 000 для целей землеустройства государственного учета земель и земельного кадастра" [3] will come. According to it, the following are the interpretation objects for creating agricultural maps: boundaries of administrative units, boundaries of different farms (farms and peasant farms), land use boundaries, rural settlements, communication routes, hydrography and hydrotechnical structures, agricultural land, forest and shrublands, etc.

The process of visual interpretation is carried out in the following main stages: preparatory stage, image enhancement stage, in office interpretation and in field interpretation (Fig. 1).

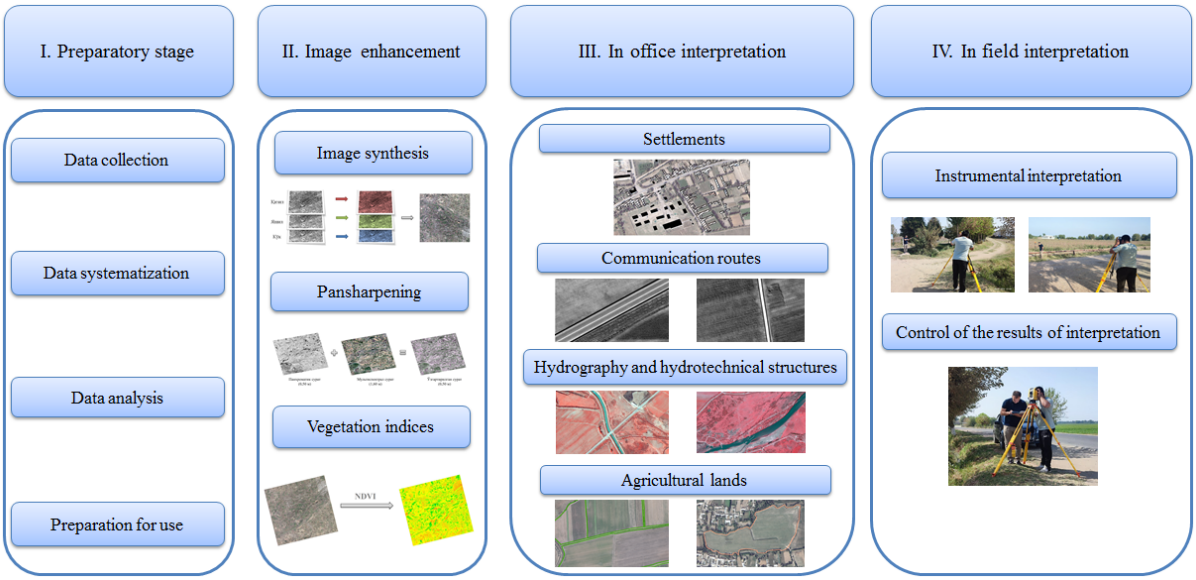

Fig. 1. Technological scheme of visual interpretation of agricultural objects

The preparatory stage includes the processes of collecting, systematizing, analyzing, and preparing for use of legal, cartographic, engineering and economic data and materials necessary for the territory of the object.

Digital aerial images can be enhanced by changing their pixel brightness and spectral characteristics. This, in turn, can facilitate the visual interpretation of images in office conditions. Synthesis of images taken in different spectral

ranges (band combination), image fusion (pansharpening) and application of different indices (such as NDVI) are performed in order at this stage.

At the stage in office interpretation of satellite images for the preparation of large-scale agricultural maps, all agricultural objects on the site of the image are interpreted according to direct and complementary signs, as well as using auxiliary materials. Interpretation is carried out in the GIS environment, using a pre-prepared orthorectified image. In this case, interpretation is carried out in the following stages: identification, familiarization and interpretation. Simultaneously with the interpretation, all the objects in the place are digitized.

Objects that cannot be reliably interpreted in office conditions are clarified and interpreted in field. Similarly, in field interpretation, the changes that occurred in the place due to the passage of time between the photography and interpretation processes are also interpreted in an instrumental way.

In recent years, the direct digital acquisition of remote sensing data, the expansion of the capabilities of software for data processing, including GIS software, led to the development of methods and algorithms which allows to partially or fully automate the process of their analysis. Currently, in practice, classification is used as the most common method of analyzing remote sensing data [4, 2].

Classification of satellite images refers to the process of determining whether each pixel in digital images belongs to one or another type of spatial objects based on certain statistical criteria [6]. In the automatic classification of images, the spectral brightness of pixels is based on a statistical criterion. In this case, the images are automatically divided into groups according to the spectral brightness of the pixels in them, that is, according to their spectral characteristics. Pixels with the same or close spectral brightness values are grouped into single groups.

Informational or spectral classes are used to classify aerial and satellite images. Informational classes mean objects in a place that need to be determined

on the basis of images, that is, various land categories, buildings and hydrographic objects. Spectral classes include a group of pixels that have almost the same brightness in a certain spectral range.

According to classification, supervised and unsupervised methods are distinguished [4, 2].

The essence of the supervised classification is that the operator selects several reference sections belonging to certain informational classes from the image and uses the brightness value of the pixels in them as a sample. Later, by comparing the brightness value of all the remaining pixels in the image with the value of the pixels in the reference plots, it is determined whether they belong to one or another class. Supervised classification can be performed using algorithms such as minimum distance, parallelepipeds, or maximum likelihood.

In unsupervised classification, pixels with similar spectral value are automatically divided into arrays or clusters, that is, cluster analysis is performed. In this case, the classification is carried out by spectral classes. Then the operator analyzes the description of spectral classes (clusters) and determines whether they belong to one or another informative class. Various algorithms can also be used for performing unsupervised classification. Examples of these are K-means and ISODATA algorithms.

The following figure shows the technological scheme of classification of agricultural objects in supervised and unsupervised methods (Fig. 2).

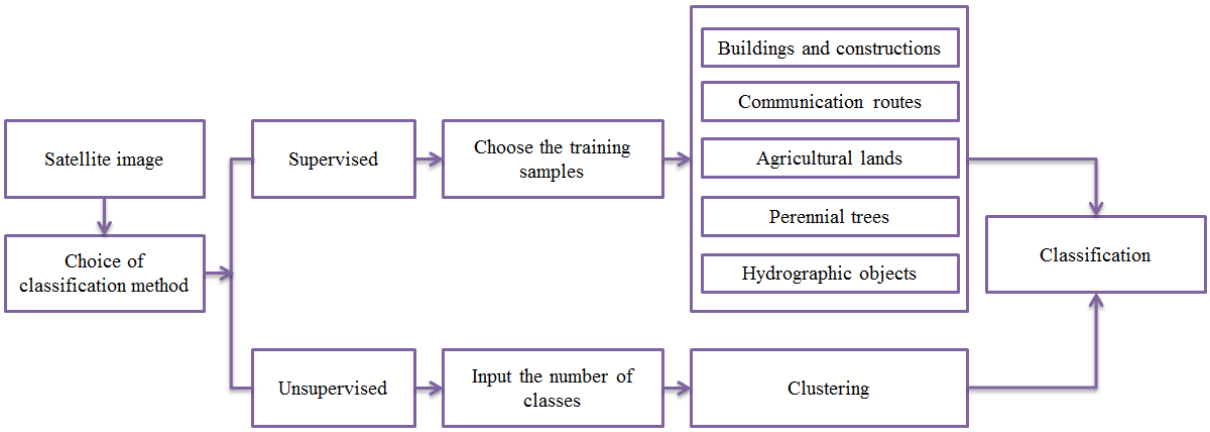

Fig. 2. Technological scheme of classification satellite image

It should be noted that classification of satellite images in supervised and unsupervised methods does not provide sufficient accuracy. This is due to the fact that these methods are based on pixel analysis, in which the images are analyzed only by the spectral characteristics of individual pixels, and on the contrary, the characteristics of objects such as geometric shape, size and texture are not taken into account. This, in turn, can lead to incorrect classification of pixels with spectral values close to each other, but belonging to different informational classes. Especially images with high spatial resolution cause inconvenience in analysis. Therefore, it is desirable to use object-based methods in the automatic analysis of space images with high spatial resolution.

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