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Special features of automated decoding of farmland satellite images (on the example of Kipti territorial community)

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SUMMARY

The paper presents the results of evaluation of various methodologies of automated land decryption and evaluates the advantages and disadvantages of each of them. The use of methods of comparative classification made it possible to identify with high reliability the types of agricultural land: arable land, perennials, fallows, hayfields and pastures. The obtained results allowed to increase the reliability of automated identification of agricultural lands and to establish trends in their quality. It is proposed to use the presented approach to assess the condition of agricultural lands at the level of united territorial communities.
Introduction

Agriculture is one of the most promising industries for the use of Earth Remote Sensing (ERS) data to enhance the intensification of livestock and especially crop production. Crops are perfectly reflected in space images, they are not hidden, single-tier, easy to decode by texture and by spectral characteristics.

Modern ERS data, first and foremost, have the technical characteristics that enable it to solve the complex tasks of crop management and insurance, including field border mapping, sowing and harvesting campaigns monitoring, land use analysis, assessment of phytosanitary status and crop productivity (Lysenko, V., Opryshko, O., Komarchuk, D., Pasichnyk, N., Zaets, N., Dudnyk, A., 2017), (Estel S., Kuemmerle T., Alcantara C., Levers C., Prischepov A., Hostert P., 2015), (Trofymenko P.I., Trofimenko N.V., Veremeenko S.I., Furmanets O.A., 2018).

ERS data enable clients to obtain up-to-date information on the structure, condition and characteristics of agricultural land and other agricultural industry assets, as well as the status and development of crops. They also allow to solve more complex analytical tasks, such as yield forecasting and the calculation of optimal fertilizer doses (Lysenko, V., Shvorov, S., Opryshko, O., Pasichnyk, N., Komarchuk, D., 2018), (Popov M.A., 2007). For monitoring and analysis of agricultural land, it is convenient on the basis of satellite images to use data that can help to define not only types of crops, but also the degree of contamination, the state of yield, the exact boundaries of fields, the area of crops and so on.

The purpose of the paper is to analyze the features of performing automated decoding in ENVI software using three methods of automated decoding. For the purpose of automated decoding of agricultural lands, the territory of the Kiptivska united territorial community in Kozelets district of Chernihiv region was selected (Samsonova V.P., Kondrashkina M.I., Krotov D.G., Chichiyeva O.A., 2015).

The area is mostly plain with small hills and hollows. There are also wetlands, lakes and large wooded areas on the territory of this community. 86% of the area is covered by black earth soils and partly by sand. Meadow and saline soils are very common. Wetlands are occupied by marshy and peat-bog soils. Most of the territory is under arable land, but the part of the land is occupied by meadows that make up the main pastures and hayfields. In addition to natural vegetation, large areas are occupied by fields where crops are grown (cereals, fodder, beets, sunflowers, corn).

The process of recognizing objects, their properties, the relationship of their images in the picture is called decoding, which might be either field and cameral. The cameral is divided into visual and automated. Visual decoding is performed on the eye; the performer decodes what he/she sees in the picture. Automated decoding is performed by the executor using software complexes with special algorithms. Automated decoding is founded on several methods that allow you to group objects by decoding features.

When using multispectral images, the color conversion method is often used. When an image in panchromatic mode of a single channel of multi-spectral image is displayed on the screen, it will be grayed out. To obtain color image in multispectral mode, three channels of multispectral image are used - R (red), G (green), B (blue).

Methods of investigation

In order to perform the automated decoding of the above-mentioned territory, actual satellite images of the territory of the Kipti United Territorial Community (UTC) were downloaded from the Landsat portal. With the ENVI software, using the color conversion method and specifying different combinations of Landsat spectral data channels, it was determined the degree of vegetation of crops (Fig. 1).
Results of investigations

The planted acreage in the satellite images is indicated in red and light red. Fields with a separate type of crops are marked in light-red, unlike the dark-red. Smaller objects of forest areas are highlighted in a darker red color. The mowed hayfields in August are shown in gray and hydrographic objects: lakes, rivers, ponds are shown in black. Shades of dark red in the satellite images characterize the high content of plant chlorophyll, which means a high level of vegetation. Intensive vegetation was observed in such territories. The black color in the picture shows the area with no vegetation, this could be caused by the lack of vegetation in this area or the vegetation was too dense or rare (Samsonova V.P., Kondrashkina M.I., Krotov D.G., Chichiyeva O.A., 2015).

Another working method of automated decoding used in this study is index images. The brightness value of each pixel of such an image is determined by arithmetic operations over the brightness values of that pixel from different image channels. For agricultural purposes, such indices as NDVI, MCARI, MATVI2 and others are calculated using the ENVI automated decoding software. Using a picture without color processing (Fig. 2), the borders of crops are clearly distinguished, since the areas of crops differ greatly in terms of pixel brightness (Lysenko, V., Shvorov, S., Opryshko, O., Pasichnyk, N., Komarchuk, D., 2018).

In the transformed image (Fig. 2), the territories obtained by calculation of the NDVI vegetation index are highlighted in different colors. Green shows thick and high vegetation, yellow marks fields with vegetation and red indicates open soils (bare arable land).

The classification method is based on the process of automated division of all pixels of the image into groups (classes) using cluster analysis. There is a classification without learning and a classification with learning (Lysenko, V., Opryshko, O., Komarchuk, D., Pasichnyk, N., Zaets, N., Dudnyk, A., 2017), (Popov M.A., 2007).

Classification without learning - it is the process when pixel distribution of an image occurs automatically, based on an analysis of the statistical distribution of pixel brightness. Classification with learning is a process when the brightness of each pixel is compared with the standards, and as a result, each pixel belongs to the most appropriate class of objects. Classification without learning is done in two ways, in which you do not need to build areas of interest. Selecting either ISODATA or K-means, the images are automatically divided into classes that can be colored in the necessary colors.

Classification methods without learning allow to divide not only natural objects such as forests, lakes, meadows, but also agricultural land into separate species. Knowing the vegetation period of crops, it is possible to determine the types of crops that grow in the areas of crops, you can also determine the area of crops of certain types of crops and identify their boundaries. Classification with learning is performed in different ways: the method of the spectral angle, minimum distance, parallelepipeds, maximum likelihood, Mahalanobis distance and binary coding (Samsonova V.P., Kondrashkina M.I., Krotov D.G., Chichiyeva O.A, 2015).
First the minimum distance method was selected (Fig. 3). The following was the maximum likelihood method (Fig. 4). The result was similar to the previous one, but most of the plots turned purple.

![Figure 3. Using of classification with minimum distance method](image1)

![Figure 4. Using of classification with maximum likelihood method](image2)

Next we used Mahalanobis distance method (Fig. 5). This method, unlike the previous ones, distinguished areas of blue color as one class, which marked the acreage with the same type of crops. The Mahalanobis distance method allows you to determine the exact boundaries of land.

![Figure 5. Use of classification with Mahalanobis distance method](image3)

The next step was to use the most common classifications without learning - K-Means and ISODATA. The main difference between K-Means algorithms and ISODATA lies in the fact that at the stage of initialization of the ISODATA algorithm there is a pixel distribution, and in the algorithm K-Means there is a distribution of values of mathematical expectations. It was by these two algorithms that the classification was performed (Figs. 6, 7) (Lysenko, V., Shvorov, S., Opryshko, O., Pasichnyk, N., Komarchuk, D., 2018).

![Figure 6. Use of classification without learning - K-Means](image4)

![Figure 7. Use of classification without learning - ISODATA](image5)
By analysis of the two images made with different methods of classification without learning, it’s seen that in this case, the ISODATA classification has much clearer borders. After the automated decoding of the ISODATA and K-means methods of the classification without learning, it is necessary to proceed to the decoding implementation with classification method without learning. The created areas of interest were divided into four classes, which were responsible for a particular color in the satellite image (Samsonova V.P., Kondrashkina M.I., Krotov D.G., Chichiyeva O.A., 2015).

Recommendations and conclusions

Thus, summarizing the study, we can draw the following conclusions:

- the method of joint processing of satellite images in three or more ways allows to increase the accuracy of automated processing;
- the use of the technique of classification of the images dynamics over time makes it possible to identify agricultural lands that are prone to the processes of overgrown trees and shrubs;
- the use of space photographs allows you to form a training sample of agricultural land;
- it is advisable to use this methodology to assess the state of agricultural land at the level of united territorial communities;
- the use of comparative classification techniques makes it possible to recognize with high accuracy the types of agricultural land: arable land, perennial crops, fallow fields, hayfields and pastures.

References


