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COMPUTER TECHNOLOGY FOR SATELLITE IMAGERY PROCESSING IN NATURE MANAGEMENT PROBLEM SOLVING USING LINEAMENT ANALYSIS

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Abstract. This study focuses on analyzing the techniques used to highlight lineaments in images. Various mask algorithms, including the widely used optimal Kenny detector, were employed to identify brightness boundaries. Additionally, several quality criteria were developed to assess the accuracy of boundary selection. Based on the results of the analysis, conclusions were drawn regarding the effectiveness of different pre-processing methods for space images, along with recommendations to streamline data processing and analysis and enhance the reliability of results. Our analysis of image processing methods for selecting brightness boundaries revealed that the most effective approach involves applying filters to the source images to increase the number of selected boundaries while maintaining their integrity and length.

Keywords: image processing, space images, brightness limits, high-frequency filters, lineament analysis.

Introduction. The development of the hardware and methodological basis of satellite surveys results in a higher role of space-based methods of studying the Earth's surface. In the practice of Earth sciences, the specific weight of multi- and hyperspectral imaging is constantly increasing, which makes the issue of developing new methods of space data processing and analysis urgent. Methods of lineament image analysis are increasingly used to solve nature management problems. They are based on the selection and further analysis of lineaments - linear elements of a space image. Lineaments are considered to be fault structures of the Earth's crust, and their study makes it possible to clarify the geological structure of the territories for solving various geological, ecological and landscape problems.

There are many approaches for automatically extracting lineaments from images. Most often in practice, the one that consists of the preliminary determination of the limits of the brightness of the picture with the subsequent selection of lineaments by automatic and semi-automatic methods is used. For highlighting brightness boundaries, including the optimal Kenny detector used, masking algorithms [1].

Image pre-processing is an important step for effective lineament detection. Traditionally, contrast, brightness correction, and space image histogram equalization methods are used for image processing. However, in the theory of digital image processing, some methods have not been used in lineament analysis, and their effectiveness has not been studied. This work is devoted to the evaluation of these image-processing methods.

The objective of this study is to determine the optimal techniques for processing space images to address nature management issues through the application of lineament analysis methods.

Methodology. The experiments were conducted using the following methodology:

1. Image processing methods were implemented in the Python environment.

2. In the GIS RAPID environment, brightness boundaries were highlighted using Kenny's method. [2, 3].

3. Processing of maps of luminance boundaries was performed and we obtained maps of spatial concentration of luminance boundaries.

4. In the RAPID GIS module, for each received map of the concentration of brightness boundaries, an indicator characterizing the character of the selected brightness boundaries was calculated - the dispersion of the values of the histogram, constructed by the density values.

5. An evaluation of the accuracy of brightness boundary detection was performed [4]. The assessment was based on the following metrics: *N*, which represents the number of individual (non-zero) pixels corresponding to the brightness boundary in the binary image. This metric reflects the total number of selected boundaries. A higher N value indicates more detailed boundaries.

$$F = K/N, \qquad (1)$$

where *K* is the number of continuous fragments of image boundaries. This indicator characterizes the degree of border fragmentation. The lower it is, the more precisely the boundaries are selected. It should be noted that an increase in *N* usually leads to an undesirable increase in *F*.

The values of indicators N and F were automatically calculated by the corresponding GIS RAPID module.

6. Steps 1-5 were performed for all images obtained using different methods of processing the input image.

7. Indicators N and F were arranged in ascending order and ranked from 1 (the lowest value) to 10 (the highest value) according to the serial number obtained. According to the results of the ranking of the N and F indicators, an analysis of the

studied methods was carried out. They became the basis for formulating conclusions and recommendations regarding the application of the researched methods in the procedures of lineament analysis.

Calculations showed that all the investigated characteristics increase the value of the *N* indicator compared to the input, unprocessed, space image. This means that using any of the methods allows you to increase the number of brightness limits compared to the input. This is evidenced by the fact that the application of any method leads to an increase in the dispersion of the histogram values of the processed image compared to the input one.

Conclusions. Computer technology of process and analyze satellite image for solving nature management problems using lineament analysis was proposed in this work. It allows processing and analyzing images processed by various methods based on the GIS RAPID and Python systems; implementation of several image processing methods, and analysis of image processing methods in terms of the effectiveness of their application for solving the problem of highlighting brightness boundaries. The conducted studies showed the best results and can be obtained by applying filters to the source images that provide an increase in the number of selected brightness boundaries while simultaneously increasing their integrity and length. It allows a reduction of the time required to solve nature management problems by the methods of lineament analysis, and even increases the reliability of the obtained results.

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