Objects selection and recognition during remote sensing images digital processing by means of LabVIEW

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Abstract. The article discusses the possibility of using the image processing module of the LabVIEW modeling system from National Instruments for the optical aerial and satellite images digital processing. The objects recognition and selection in the images is quite time-consuming process and requires a significant time investment with the involvement of highly qualified experts. In order to automate the object recognition process, the virtual instruments have been developed for converting multi-zone images into a pseudo-color image, as well as for decoding color and pseudo-color images. A method of identifying objects belonging to the specified classes based on replacing a color image with a grayscale and its subsequent binarization is proposed. Based on this method, the virtual instruments have been developed to automate the process of selecting objects and determining their geometric characteristics.

Introduction
The processing of images obtained by the remote sensing methods for scientific and national ownership purposes is an urgent modern problem [1-2]. The remote sensing methods are currently widely used to study the Earth surface and the processes occurring on it. Such sounding is performed with the involvement of air and spacecrafts. The surface surveying is performed both in the optical range by personnel digital and film cameras, as well as by electronic scanning systems, and in the radio frequency region using radars. Depending on the spectral resolution, the optical imaging equipment is divided into panchromatic, performing imaging in the entire visible spectrum and multispectral, obtaining the multi-zone images while simultaneously shooting the same Earth area in different spectral channels [3]. Remote sensing images are used in geodesy, construction, to create databases of industry-wide geographic information systems (GIS). These data are used in the design of large engineering objects (roads, pipelines, bridges, tunnels, dams, etc.) for environmental monitoring, mineral exploration, weather forecasts, and other areas [4].

Problem statement
The objects’ recognition and selection in images (their interpretation and vectorization) is a rather laborious process and requires a considerable amount of time with the involvement of highly qualified experts [5]. The task can be simplified by applying special digital processing of the obtained images in order to automate both the process of selecting objects belonging to specified classes and the process of recognizing objects. In this paper we propose to use the LabVIEW [6] modeling system of the National Instruments Corporation to automate the recognition and selection of objects when processing remote sensing images. LabVIEW is a special software module Vision Development
Module (VDM), which includes the Vision Assistant environment, as well as an extensive set of functions and additional utilities, is designed for digital image processing and analysis [7–9]. Software development in LabVIEW is done by creating virtual instruments using a graphical programming language.

Solving the color images objects recognition problem
The Color Classification Training Interface utility of the VDM LabVIEW software module [7] was used to recognize objects in color images. The specially organized stage of classifier training allowed to create classes of objects based on the reference color images of the object fragments (reference textures) of each class. Further, the virtual device Recognition.vi was developed to automate the recognition of unknown objects with the definition of the assessment of the correctness of the recognition carried out, which involved the Classifier.clf file obtained during training. In Figure 1 the block diagram of the virtual device Recognition.vi is shown. The front panel of the device is used to display the original color image. When the device is started, the front panel displays the class label and the assessment of the correctness of the recognition performed for the unknown fragments marked by the operator.

![Block diagram of the virtual device Recognition.vi](image)

Figure 1. Recognition.vi virtual instrument block diagram

Solving the multispectral grayscale images objects recognition problem
To simplify the image decryption problem solution, multizone shooting is used. In this case, each zonal halftone image is painted in a certain color and the resulting images are mixed, forming a pseudo-color image [5]. In a pseudo-color image the brightness contrasts inherent in objects of different classes are enhanced by color contrasts.

To obtain a pseudo-color image MZ.png when shooting in four spectral ranges, it was developed using the Visio Assistant programming environment, the script MZ.vascr, and on its basis the virtual device Multizone.vi was created (Figure 2).
Figure 2. Multizone.vi virtual instrument block diagram

A logical operation “AND” with a constant is used for coloring MZ-1.png, MZ-2.png, MZ-3.png, and MZ-4.png zonal images in pseudo-colors. And a logical operation “NOT EXCLUSIVE OR” is used to mix the pseudo-color images into a single image.

Multi-zone shooting object recognition can be performed by the Recognition.vi virtual instrument using the corresponding MZ Classifier.clf pseudo-color images classifier file.

Solving the color & pseudo-color images objects selection problem

To highlight the objects of a given class on color (pseudo-color) images, threshold processing is usually used with three thresholds (known brightness ranges) set separately for the red, green and blue color components of the image [10-13]. However, this method can be successfully applied only to the objects’ selection characterized by uniform brightness and color. Objects in remote sensing images are usually characterized by heterogeneity in brightness and color, so the use of three thresholds is unacceptable.

This task can be solved in two stages. At the first stage, the original color (pseudo-color) image is converted to a grayscale with the assignment to objects of a particular class of a certain brightness value. Then the threshold processing of the halftone image is performed with the selection of objects of any class. To solve the problem of converting a color image into a halftone with the selection of objects of specified classes, the virtual device Selection.vi was developed (Figure 3), in which the corresponding classifier classifier.clf file is used to automate object recognition.
A rural area color aerial photograph fragment results’ transformation example (Figure 4) into a halftone image with the selection of objects belonging to the classes Field, Grass, Trees, Building is shown in Figure 5.

Figure 3. Selection.vi virtual instrument block diagram

Figure 4. The rural areas aerial colored photograph fragment

Figure 5. Grayscale image after the photograph fragment processing
BIN.vascr script and on its basis the virtual device BIN.vi was created in order to select the given class objects on a grayscale image using the Visio Assistant programming environment (Figure 6). This device allows to perform single-threshold processing and to obtain a binary image of any class objects with these objects’ geometric characteristics definition (area, coordinates of a rectangular frame bounding an object, perimeter).

Figure 6. Bin.vi virtual instrument block diagram

Summary
The article discusses the recognition and selection problem of the objects recorded on optical aviation and space images of remote sensing of the Earth. Traditional methods of decoding and vectorization are quite time-consuming and require a considerable amount of time with the involvement of highly qualified experts. To automate the objects recognition and selection processes the use of virtual instruments developed using the image processing module of the LabVIEW modeling system from National Instruments was proposed.

In order to automate the object recognition process, two virtual devices have been developed: a device for converting multi-zone images into a pseudo-color image and a device for decoding color and pseudo-color images.

The method of identifying objects belonging to specified classes based on replacing a color image with a grayscale and its subsequent binarization is proposed. Based on this method, a virtual device for converting a color (pseudo-color) image into a halftone with the selection of objects of different classes and an instrument for highlighting objects of a particular class on the halftone image with determining the geometric characteristics of objects was developed to automate the objects selecting process.

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