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**APPLICATION OF ALGORITHM FOR RADAR IMAGE PROCESSING
IN THIRD-PARTY SOFTWARE****YULIA BOGOMOLOVA, VALERY CHERTKOV**
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The article presents the review and comparative analysis of the software for radar image processing. The algorithm for selecting the area of a certain height based on the determination of the color range on the radar image is developed. We study how to apply the given algorithm in the software of third-party vendors in the form of function located in the dynamic link library.

Space radar imagery data differ significantly from the data obtained from space in the optical range as when shooting the amplitude and the phase of the signal are registered. Specialized software is required to work with radar images (RI) of primary processing levels. Currently, there are commercial and free software applications specifically designed to work with radar data. For other programs there are special modules that allow processing polarimetric data (such as Envisat, ALOS/PALSAR, Radarsat-2, TerraSAR-X and etc). They allow carrying out image synthesis from complex images Single Look Complex Image (SLC), calibration, calculation of different polarimetric parameters, coherency and other parameters. Such software includes the following programs: ENVI with the embeddable SARscape module; GAMMA Software; Geomatica 2012; ScanEx Image Processor; NEST; PolSARPro; DORIS.

The review of the software for radar image processing. We conducted a literature review and selected four commercial programs and four free programs described as the best representatives of the class. The given software has modular structure that enables functionality extension. Practically all of the programs have a polarimetry module which can process radar images received in different polarizable modes, that allows generating a full polarizable matrix.

SARscape (ENVI environment) allows complex processing of radar data. This building block software supports modern radar data. A complex of multifunction modules allows processing of data of the radar shooting executed by a radar with the synthesized aperture (SAR). Today SARscape takes the leading position among the software products intended to process and analyze radar data. SARscape for ENVI provides the maximum support to the existing radar sensors: ENVISAT ASAR, Radarsat-1,2, TerraSAR-X/tanDEM-X and the group of CosmoSkyMed 1-4 satellites.

SARscape standard configuration allows the following operations with radar images: focus, import, a division of comprehensive data into the amplitude and phase, automatic snapshot of one and the same territory for different dates, incoherent accumulation, filtering of speckle noise on single images and multi-temporal series of images [1].

GAMMA is a modular program for interferometric SAR data processing. GAMMA software supports multicore processors, which increases the speed of calculation depending on the number of CPU cores. Geocoding of radar data is available as part of a separate module GEO. The program is written in the ANSI C language which was selected for fast and effective processing of big data sets. Modern algorithms are used in the program for exact and fast processing on personal computers with the following operating systems: Linux (32 and 64-bit), Windows 7 (32 and 64-bit), Apple OSX 10.6-10.7 (Snow-leopard, Lion) [2]

The program contains a tool kit to use the time response and spatial characteristics received from certain local reflectors for the purpose of making dynamics cards of deformation and change of heights and the relative atmospheric time delays.

Geomatica 2012 allows all levels of processing of space and aero photos. Geomatica consists of a set of tools for the remote sensing of the Earth surface, digital photogrammetry, the spatial analysis, mosaics and

automation. One of the best modules of this program is the photogrammetric OrthoEngine module. In Geomatica there is no traditional division into remote sensing, photogrammetry, cartography. Geomatica 2012 uses the full volume of the user computing resources for the maximum productivity. [3]

Geomatica 2012 uses the exclusive GDB Technology for direct read and write of raster data, vectors and other information from the extensive list of the supported formats that provides rapid and direct access to data. The list of the supported formats permanently extends.

ScanEx IMAGE Processor. This application consists of a basic configuration and connected modules. The modular structure serves for the convenience of users: it is always important to have a choice. You can acquire only that feature set which is necessary for your research or operations. The program has ample functional capabilities of radar image processing: filtering a speckle noise, means for conversion between formats of representation of values of brightness (energy or amplitude), a functionality for computation of textural characteristics of the image. In addition, there are tools for working with complex data (SLC) such as georeferencing, phase retrieval and computation interferogrammy [4].

PolSARPro. This software package is extended by European space agency (ESA) free of charge. PolSARPro is a tool for polarimetric SAR processing. PolSARPro does not allow terrain correction, but suggests using connection to ASF's Ready cards. The module of polarimetric SAR processing allows using multistream sets of the polarized SAR data (Envisat ASAR, PALSAR, ALOS-2 PALSAR, COSMO-SkyMed, RADARSAT-2, RISAT, TerraSAR-X and Tandem-X). It is necessary to mark that there are a lot of manuals and documentation on how to operate this software which brings this product to the first place among free of charge distributed programs of this class. All the elements of the PolSARpro project are extended by ESA free of charge, including the source code [5].

Next ESA SAR Toolbox. NEST (Next ESA SAR Toolbox) is the product developed by the specialists of the Canadian firm of Array Systems Computing Inc firm. by the request of the European space agency. It includes the module for viewing, post-processing and the analysis of the radar space pictures received by the SAR equipment from the satellites of ESA agency and other satellites having this type of sensors. NEST is a system with open codes that allows creating new applications for viewing and post-processing of SAR-data in Java API interfaces.

DORIS. Delft object-oriented radar interferometric software is the packet for radar image processing (starting with Level 1) developed at Delft University of Technology, DUT. It is realized on C ++, works under basic operation systems (under Windows — by means of Cygwin). It uses GMT utilities (Generic Mapping Tools) for visualization and it uses the snaphu program for restoration of a phase of the interferogram. It is necessary to mark that this product comprises third-party programs which form a single complex system.

Comparative analysis of the software. An area of great interest to us is free software products with open source codes such as Next ESA SAR Toolbox (NEST), PolSARPro, DORIS. In our research we deal with PolSARPro. It is written in C/C ++ and allows the connection of alternative third-party libraries which contain algorithms for radar image processing. PolSARpro has a convenient, clear graphic interface. The software environment is flexible and is available for a wide range of users - from beginners to experts.

Implementation of the algorithm for image processing. The program code was written in MATLAB environment. After verification the independent library was built in the third-party software by means of Matlab Compiler which allows converting Matlab M-files automatically in C and C ++ to create independent software products [6]. In the developed algorithm the separation of the area of a certain height based on the determination of the color range on the radar image is realised. The radar image received from the radar with the synthesized aperture was accepted as the source image for algorithm testing. (figure 1).

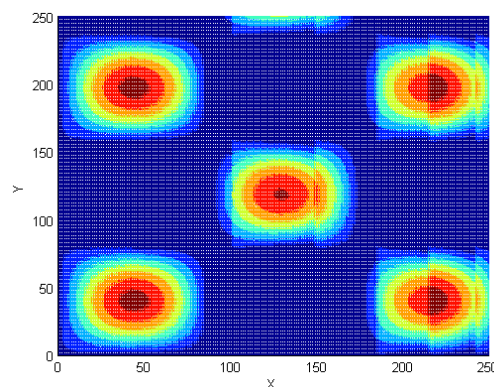


Fig. 1. The Source image

The process of the separation of the area of a certain color range consists of four main stages:

1. Reading of the source image and its visualization are executed by commands:

```
I=imread ('inputfig.png');
figure, imshow(I);
```

2. The selection of the area corresponding to a specific color range. To solve the task, we choose the orange color which has the height of about 5 m (see fig. 1). Orange and its close color shades correspond to RGB values (185.. 225, 245, 255 ... 20 ... 60). To allocate for each channel individually, we use the built-in MATLAB function `roicolor`. Function `BW = roicolor (S, low, high)` puts the result of binarization of half-tone image or the palette image `S` in binary image `BW`. Pictures `BW` and `S` have the same size. Pixel of binary image `VW (r, c)` is assigned the value of 1 if the brightness of the pixel `S (r, c)` of the original half-tone or index `S (r, c)` of the palette image belongs to a range of [low, high]. Otherwise, `BW (r, c)` is assigned the value of 0.

```
BWR=roicolor(I(:, :, 1), 185, 225);
```

```
BWG=roicolor(I(:, :, 2), 245, 255);
```

```
BWB=roicolor(I(:, :, 3), 20, 60);
```

The results of the execution of the `roicolor` function for each channel are provided in figure 2.

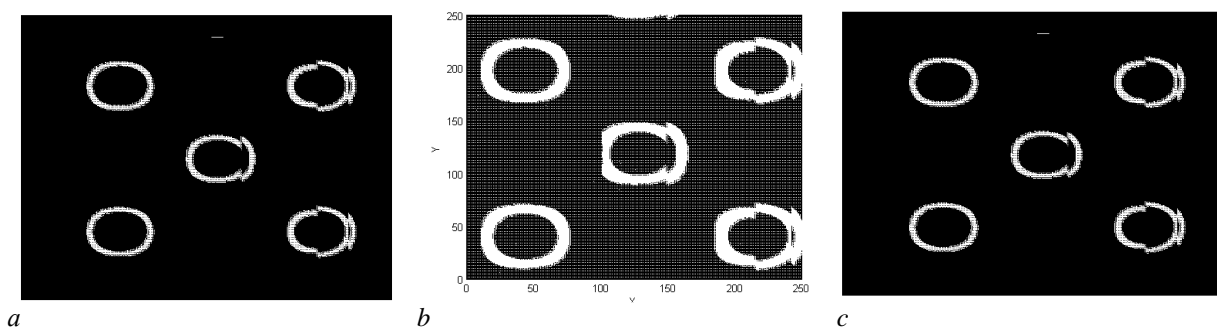


Fig. 2. Results of execution of the `roicolor` function for each RGB channel of the image:
a – red channel; *b* – green channel; *c* – blue channel

3. A stage of combining of channels for the formation of the single area of separation. The logical function `And` for combining all channels is used. If the pixel is assigned the value of 1 in all RGB layers it will accept the value of 1 as a result. In all other cases it will accept the resultant value of zero.

```
BW=(BWR & BWG & BWB);
```

The result of processing is provided in figure 3a.

4. Separation of boundaries. For delimitation of objects of the image it is possible to use the edge function. As one of criteria for determination of the edge sharp overfall of intensivnost of pixels of the image is used. We will mark that some methods of separation of boundaries, depending on the features, more select vertical, horizontal or all boundaries equally.

One of the most effective methods of separation of boundaries is Canny's method. It differs from other methods in that in case of delimitation it uses two thresholds (for feeble and strong boundaries). Feeble boundaries are marked in the resultant image only when they are connected to the strong. For noisy images this method provides the best detection of boundaries in comparison with remaining methods, but requires significantly bigger time.

```
b = edge (BW, 'canny', 0.15, 2);
```

The result of processing is given by the edge function in figure 3b.

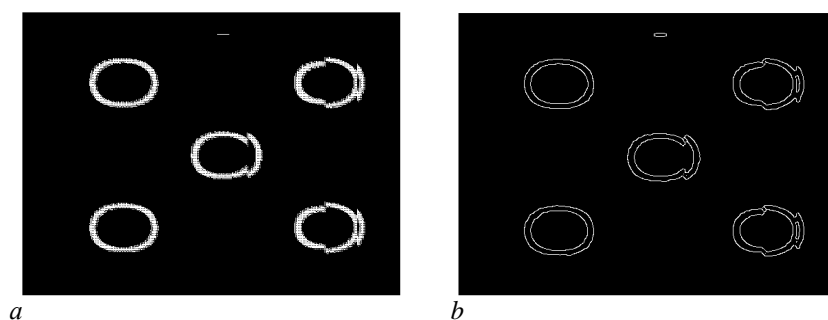


Fig. 3. Result of processing
a – associations of layers of RGB using a logical function `And`; *b* – separation of area of a certain color

ITC, Electronics, Programming

Full processing algorithm in MATLAB to highlight the area of a certain color range as a separate function has the form:

```
function b = myimage (I)
BWR = roicolor (I (:,:, 1), 185, 225);
BWG = roicolor (I (:,:, 2), 245, 255);
BWB = roicolor (I (:,:, 3), 20, 60);
BW = (BWR & BWG & BWB);
b = edge (BW 'canny' 0.15, 2);
end
```

As an argument at the entrance the function uses a three-dimensional matrix of the source image, and the output of the function is a three-dimensional matrix result.

To create a dynamic library from the given function we apply MATLAB Coder tool that generates standalone C or C++ code, static or dynamic library from MATLAB code. The generated code is easy to read by programmers and it is platform independent. In the process of creating a dynamic library all data types of used variables were identified. On completion of the MATLAB Coder module standalone Si code and shared library with all uppercase files that are required to connect the library to the third-party software were generated.

Conclusion. The comparative analysis of the software for radar image processing is made. To implement the third-party algorithm for image processing, the software product PolSARPro is chosen. PolSARPro is a free software product with open source code. The algorithm for selecting the area of a certain height based on the determination of the color range on the radar image is developed. By means of MATLAB Coder *the algorithm* was converted into dynamic link library in the form of separate function.

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DEVELOPMENT OF TRAINING APPLICATION USING GIS ENVIRONMENT

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This paper describes an application-quiz used for geographical training that was developed using GIS environment and Visual Basic for Applications. It may be useful for studying geography and collateral subjects.

Nowadays, geoinformational systems with its diversity of functions and wide range of opportunities may be used not only for digital mapping, but also as training tools.

In the process of our work, we created a training application, some kind of game. The goal of this game is to guess district of the Republic of Belarus by its border, location of major settlements, places of interest and additional information.

The application was developed on the basis of software ESRI ArcGIS 9.3 and programming language Visual Basic for Applications. The dialogue is carried out through userform (fig. 1).

The application is run by the button on the toolbar, that is macro attached to it. After that randomly chosen district is showed on the map extent (fig. 1).

The player's task is to guess as many districts as he can and take as many points as he can. The quiz has three levels. The first level offers you to guess the district according to the layers of rivers, lakes, its border and the borders of the nearby districts. The maximum number of points you can get at the first level is 10. On the