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J21402-001

Beskid P.P., Shishkin A.D., Chernetsova E.A.

INHOMOGENEITIES IDENTIFICATION OF WATER SURFACE BASED RADAR IMAGES

Russian State Hydrometeorological University

Abstract. In order to solve the problem of environmental monitoring of the sea surface and the technique of processing algorithm of radar images obtained by satellite. Focuses on solving the problem of distinguishing oil spills and slicks wind. An algorithm that is implemented based on neural networks and the results of its simulation.

SEA SURFACE, RADAR IMAGES, SEA SURFACE MONITORING, CHARACTERISTICS OF HETEROGENITY, CLASSIFICATION ALGORITHM

Introduction

Problems in the study of the seas and oceans, sustainable use of its resources are currently of great importance. From this point of view , of particular importance remote methods research on marine and coastal waters , based on the analysis of the structure of signals , which are formed as a result of radiation or reflection of electromagnetic waves by natural and artificial entities. Satellite data are presented in the form of radar images (RI) , the processing of which reveals the water surface is artificial or man-made anomalies . The emergence and development of hazards can be triggered by various causes. Especially dangerous is oil port , pipeline systems and sea routes for oil tankers . To reduce risk and improve environmental safety , it is important to determine the oil spill in the early stages of their appearance [1].

Typically, the data obtained by radar , after preprocessing is recorded in the form of an array in which each element carries information about the color or monochrome intensity of each pixel representing the image of the observed surface. Direct use of this form of data representation for current monitoring has the significant disadvantage that the spatial characteristics of the objects depicted (anomalies) it explicitly granted. It is therefore necessary secondary processing radar data , aimed at identifying the spatial distribution of objects. Determination of spatial features of objects is processed pixel array methods that allow you to either identify the contours of objects , or to determine the characteristics of an image with the same intensity pixels . Identifying the contours of objects made with the help of threshold gradient or Laplacian values [2]. Methods to identify the contours of objects used in filtration problems , image compression, and include a description of the image in terms of the coefficients of the discrete cosine transform [3] , Fourier transform [4] , wavelet transform [5]. If we solve the problem of image classification of objects (for example, in monitoring the sea surface) , it is necessary for the separation of the image area having the same characteristics . Figure 1 shows examples of radar images of two regions .

Segmentation of the image in this case is based on a hierarchical clustering pixels where a pixel is compared with its spatial " neighbors" is attributed to a particular segment or by homogeneity on the basis of the statistical similarity metric to determine which can be used, for example , a Markov random field method [6] or deformable model [7] .

a) b)

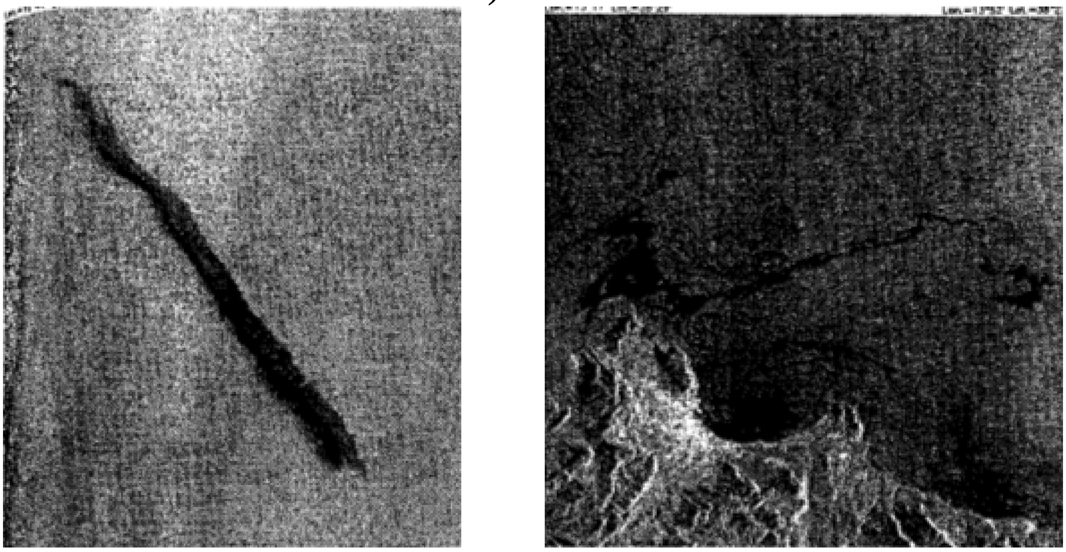

Fig. 1. The sea surface radar image (grayscale): a) oil spill, b) wind slick

When using Markov random fields original array of image pixels is considered realizations of the Markov random field distribution , fixing the spatial context . Image segmentation in this case consists in assigning the pixel level so as to form the area , based on a probabilistic model . Using the method of Markov random fields , therefore requiring precise knowledge of a priori probability density model of the image and the large amount of calculation. Method deformable models , otherwise called "snakes" means that area in the image space to move under the influence of internal forces (determined by the areas) and the external forces (imposed by the data set) .

So how to solve the problem of monitoring the sea surface a priori information about the distribution of inhomogeneities are usually available, you must choose a criterion of homogeneity of pixels in the radar image, which would allow to produce image segmentation excluding probability characteristics . If we accept the assumption that heterogeneity (to see) and background (the sea surface) have different pixel intensity values , the radar image segmentation is possible, first, to use a monochrome (not color) information, and secondly, to use the method threshold , which advantages are:

- Easy to calculate the minimum histogram " shades of gray ";
- The ability to automate image segmentation .

The presence of oil slicks on the sea surface reduces small waves due to the increasing viscosity of the upper layer and significantly reduces the energy backscatter signal , so the radar picture appear darker areas . However, the image obtained by radar can also arise blackout caused by the presence of local low-speed winds over the sea surface or the presence of natural sea slicks , but oil slicks on the radar image showing large discontinuities in comparison with the background color , mainly due to its viscosity.

1.Metod of implementation of radar image segmentation

Image segmentation , which is a two-dimensional array of pixel intensity values in terms of " shades of gray " is proposed to conduct the homogeneity of pixels by the assumption that the image is present object (s) are darker than the background . Therefore, the color image portion of the sea surface must be represented in the form of an array of monochrome , and, if necessary , perform filtering.

Filtering is a method of changing or improving the image. For example , in the case shown in Fig . 1 , you want to filter to increase the contrast of the image and the background of the oil stains . Image filtering is an operation performed on the neighboring elements in which each pixel value of the filtered image is determined by applying a function to the values of pixels adjacent to the data. When linear filtering pixel intensity value of the filtered image is a linear combination of values of the intensities of pixels neighboring the original image (for example, when using the convolution operation) . When nonlinear filtering pixel intensity value of the filtered image is non-linear combination of pixel intensity values of the neighboring original image (for example, when using the function calculates the standard deviation of the intensity values of pixels - neighbors). Figure 2 shows how to filter a sliding neighborhood applied to the image presented in the form of a matrix size of 6x5 pixel intensity (of 30 pixels) . Neighborhood region has a size of 2x3 pixel (of 6 pixels).

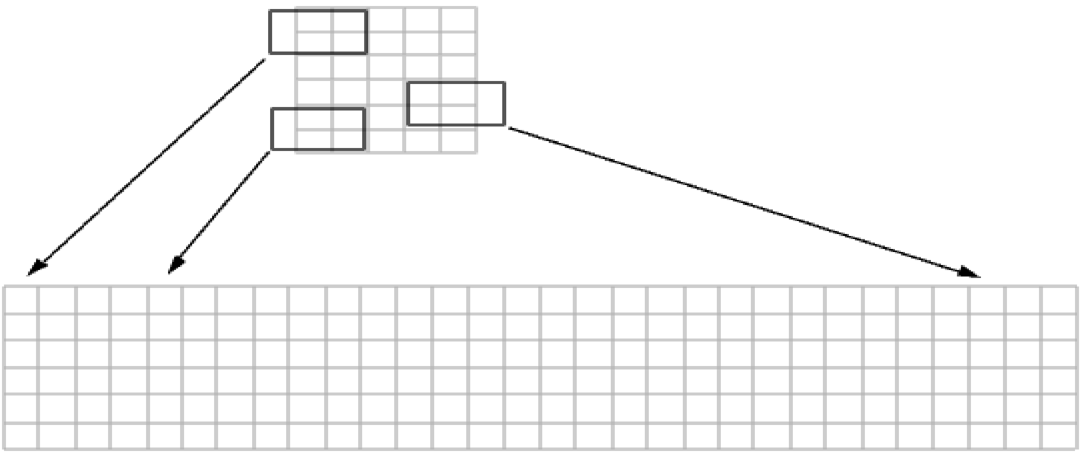

Fig.2.Filtering method of a sliding neighborhood

Since the computing operations are carried out easily and quickly on the data having the form of columns (rows) , not rectangles program creates a temporary matrix for each neighborhood size 6x30 , which is then processed using a linear or non-linear functions depending on the type of filtration. To determine the boundaries of dark objects selected darkest pixels as a starting point and then built up the area around them , defining the boundaries spots while adjacent pixels do not have shades of gray values greater than the threshold [8]. Analysis of radar images begins with determining the boundaries of a dark subject. It analyzes the estimated surface and a histogram in which the axis of abscissa of gray level intensity of the image , and the ordinate - number of pixels. Local minimum of the histogram is used as a threshold in automated image segmentation .

However, the software implementation of this technique it was found that the algorithm is implemented it "hard decisions " can not ignore the pixels , which undoubtedly belong to the field inhomogeneity , but the intensity of which was slightly greater than a predetermined threshold (region in Fig .3 , Dedicated rectangle) .

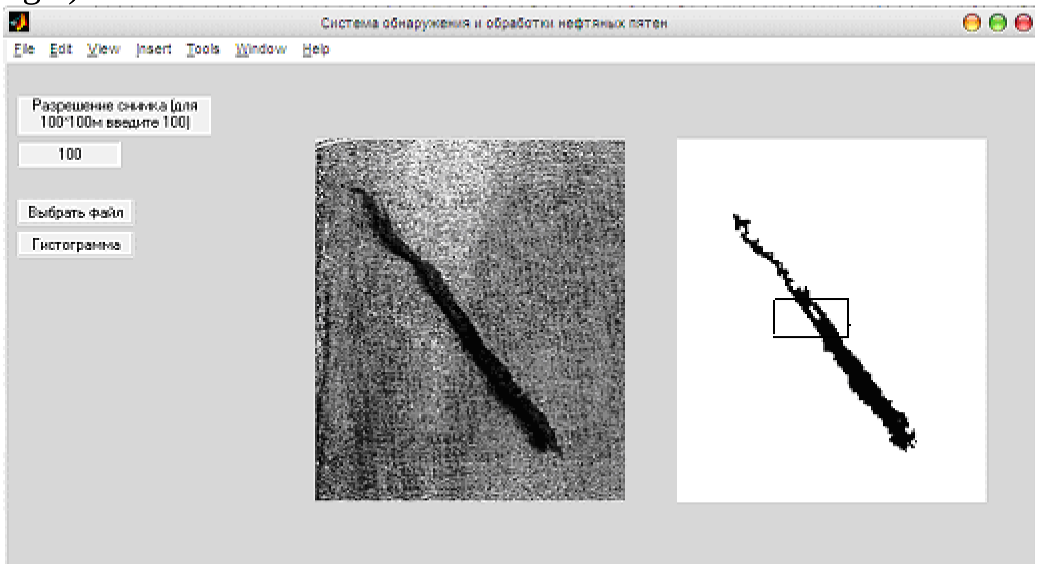

Fig. 3. Program window of automated image segmentation

To implement the algorithm of "soft decision " we introduce the concept of "relative fuzzy connectedness " pixels [9]. Consider a two-dimensional image represented in Figure 4 and consists of two regions corresponding to the object O1 and O2 background .

We define the ratio of each pair of connected pixels as the value of some criteria in terms of space and intensity. Moreover, for each route linking , for example, points O1 and O2 in Fig. 4 will be calculated its value relative fuzzy connectedness criterion by which to judge the " force connection" two points of the image on one or another way. For example , in Fig . 4 rso1 path between points O1 and O2 has the greatest virtue of the relative fuzzy connectedness. The basic idea of methods for determining "relative fuzzy connectedness " is to stand with the hard threshold to the image, for example, O1, find two reference points within the site and outside it (eg , O1 and O2) . Then , according to some criterion defining the relative value of fuzzy connectedness other image pixels with these two reference points , use it in determining what accessories pixels or another object.

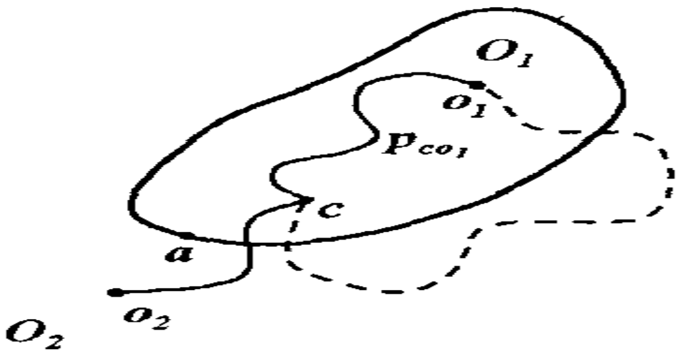

Fig. 4. Illustration of the basic concepts of "relative fuzzy connectedness" image pixels

For example, a point in Figure 4 will belong to the object O1 , because strength of its connectivity with the point O1 is greater than the force of fuzzy connectedness with the point O2 . Such a pixel as a boundary point and Fig. 4 , will be captured that area , fuzzy connectedness strength with which it will be more. The main difficulty in applying this technique is the choice of criterion of relative fuzzy connectedness. We first consider the principles of the function , which is a criterion of relative fuzzy connectedness intensity (A) of the two pixels (P1 and P2) . To assess the value of connectivity , you can choose the squared difference of the intensities of two pixels , weighted value , the inverse variance σ^2, the intensity values determined for the pixels in a neighborhood reference point $\frac{(A(P_1)-A(P_2))^2}{\sigma^2}$, as a quadratic function has the property of "mask" small values of the argument and excrete large values of the argument. However, I would like to change the speed test was the same for the whole range of arguments. Among the family of exponential functions highlights the exponential function whose derivative is equal to the value of the function itself. Therefore can be modified test function: $\exp\frac{(A(P_1-A(P_2))^2}{\sigma^2}$.

Since it is necessary to set some boundaries that define full connectivity and the lack of connectivity, we would like to test function takes the value 1 when fully connected pixels and 0 for no connection. This requirement will be responsible function of the form

$$f_A(P_1,P_2)=\frac{1}{\exp\frac{(A(P_1)-A(P_2))^2}{\sigma^2}}, \tag{1}$$

and which is chosen as the criterion of the relative intensities of the two fuzzy connectedness pixels.
To determine the criterion of relative fuzzy connectedness of two pixels $P_1(x_1;y_1)$ and $P_2(x_2;y_2)$, defined by their coordinates on the x and y to modify the criterion (1):

$$f_{x,y}(P_1,P_2)=\frac{1}{\exp\frac{R^2}{\sigma_{cp}{}^2}}, \tag{2}$$

where $R=\sqrt{(x_2-x_1)^2+(y_2-y_1)^2}$ - the distance between two pixels, given with its coordinates, σ_{cp}^2 - the average value of the variance calculated for the matrix coordinates of the compared pixels $\begin{bmatrix} x_1 & x_2 \\ y_1 & y_2 \end{bmatrix}$.

When fully connected two pixels in terms of intensity and spatial location relative value of the criterion of fuzzy connectedness is $f_A(P_1,P_2)+f_{x,y}(P_1,P_2)$=2. In the absence of connectivity $f_A(P_1,P_2)+f_{x,y}(P_1,P_2)$=0.

The proposed method of determining the relative fuzzy connectedness image pixels allows to adapt the threshold and increase the effectiveness of automated image segmentation.

2. Calculation metod of characteristics of the sea surface irregularities identified in the radar image

After the image segmentation , it is necessary to calculate the parameters of irregularities on the sea surface , which are then used to classify objects. These parameters should describe the object geometry (length and shape) and its physical behavior (backscatter intensity of pixels belonging to the object and the background , and in relation to the area that surrounds the object) .

Parameters satisfying the above conditions are:

1) The size of a region on which an object is A km^2.

2) Perimeter P - length of object boundaries , km .

A calculation of the parameter is to multiply the number of pixels belonging to a dark object on the area of one pixel , with image resolution set by the operator . Perimeter images are also directly related to the size of one pixel . 3) Difficulty defined as

$$C = \frac{P}{2\sqrt{\pi 4}}. \quad (3)$$

This option usually takes small numerical values for areas with simple geometry and large values for complex geometric regions.

4) Length *S*. This parameter is obtained using principal component analysis [10] of the vectors whose components are the coordinates of pixels belonging to an object. if λ_1 and λ_2 are the two eigenvalues associated with the calculated covariance matrix and $\lambda_1 > \lambda_2$, length value is

$$S = \frac{100\lambda_2}{\lambda_1 + \lambda_2}. \quad (4)$$

We explain the algorithm for calculating the length of S dark subject. For this we consider the image spot on the surface in terms of the coordinates of pixels shown in Fig. 5. Coordinates of pixels belonging to the spot, are a two-dimensional vector:

a=[2 2;3 3;4 3;4 4;5 4;5 5;6 5;6 6;7 6;7 7].

We calculate the covariance matrix b of vector *a*: *b=cov(a)*.

We calculate the vector c of eigenvalues of the covariance matrix *b*: *c=eig(b)*;

	Координата x								
Координата y	1,1	1,2	1,3	1,4	1,5	1,6	1,7	1,8	1,9
	2,1	2,2	2,3	2,4	2,5	2,6	2,7	2,8	2,9
	3,1	3,2	3,3	3,4	3,5	3,6	3,7	3,8	3,9
	4,1	4,2	4,3	4,4	4,5	4,6	4,7	4,8	4,9
	5,1	5,2	5,3	5,4	5,5	5,6	5,7	5,8	5,9
	6,1	6,2	6,3	6,4	6,5	6,6	6,7	6,8	6,9
	7,1	7,2	7,3	7,4	7,5	7,6	7,7	7,8	7,9
	8,1	8,2	8,3	8,4	8,5	8,6	8,7	8,8	8,9
	9,1	9,2	9,3	9,4	9,5	9,6	9,7	9,8	9,9

Fig 5. The long and thin spot on the surface in terms of the coordinates of pixels

We obtain the following values of the eigenvalues:

c = 0,1298 – value of the eigenvalue λ_2,

c =5,1369 – value of the eigenvalue λ_1.

We calculate the length via formula (4):

S=100*0,1298/(0,1298+5,1369)= 2,4645.

Fig. 6 shows a dark object, which tends to form a larger circle. Coordinates of pixels belonging to the spot, are two-dimensional vector *a1*:

a1=[2 2;2 3;2 4;2 5; 3 2;3 3;3 4;3 5;4 2;4 3;4 4;4 5;4 6;4 7;4 8;5 2;5 3;5 4;5 5;5 6;5 7;5 8;6 4;6 5;6 6;6 7;6 8;7 6;7 7;7 8].

We calculate the covariance matrix of two-dimensional vector *a1*: *b1=cov*(*a1*).

We obtain the following values of the eigenvalues of the covariance matrix *b1*:

c1=1,3269 – value of the eigenvalue λ_2,

c1 =4,8950 – value of the eigenvalue λ_1.

We calculate the length of the second dark object on the plane:

*S*1=100*1,3269/(1,3269+4,895) = 21,3263.

	Координата x								
	1,1	1,2	1,3	1,4	1,5	1,6	1,7	1,8	1,9
	2,1	2,2	2,3	2,4	2,5	2,6	2,7	2,8	2,9
	3,1	3,2	3,3	3,4	3,5	3,6	3,7	3,8	3,9
	4,1	4,2	4,3	4,4	4,5	4,6	4,7	4,8	4,9
Координата y	5,1	5,2	5,3	5,4	5,5	5,6	5,7	5,8	5,9
	6,1	6,2	6,3	6,4	6,5	6,6	6,7	6,8	6,9
	7,1	7,2	7,3	7,4	7,5	7,6	7,7	7,8	7,9
	8,1	8,2	8,3	8,4	8,5	8,6	8,7	8,8	8,9
	9,1	9,2	9,3	9,4	9,5	9,6	9,7	9,8	9,9

Fig. 6. Dark object, tending to form a circle in terms of pixels

Comparing *S* = 2,4645 and *S*1= 21,3263, we see, that the numerical value *S* is small for long and thin objects and is large for objects whose shape is close to a circle.

5) The standard deviation of the object - standard deviation (in dB) of the intensity values of pixels belonging to a dark object.

6) The standard deviation for the background - standard deviation (in dB) of the intensity values of pixels belonging to the area surrounding the dark.

7) Maximum contrast - the difference between the average value of pixel intensity of the background and thus a small value of pixel intensity of the object is dark dB .

8) Average contrast - the difference between the average value of pixel intensity of the background and the average pixel intensity value of the dark object dB.

9) The maximum gradient - maximum gradient boundary "background object " dB.

10) The average gradient - average gradient boundary "background object " dB.

11) The standard deviation of the gradient - the standard deviation in dB values the boundary gradient.

3. Classification and identification algoritm of radar data anomalies developed on the basis of experimental data

In order to approve the proposed methodology has been developed classification algorithm based on neural networks [11]. The scheme of classification algorithm based on radar data anomalies these experimental studies is shown in Figure 7 .

As processed radar images were taken in Figure 1 , b . In the course of the experiments showed that for the detection of oil spills is sufficient resolution 100x100m . Automated processing of the radar picture starts with defining the boundaries of a dark subject. It analyzes the estimated surface and a histogram in which the axis of abscissa of gray level intensity of the image , and the ordinate - number of pixels. A typical form of such a histogram is shown in Figure 8 .

The image histogram of the oil slick has two peaks , the smaller of which is concentrated in the area of the average value of the scattering of a dark object to focus more on the middle value of the background. Local minimum between the peaks used for the fragmentation of the image.

RI for classified means of ground control were calculated boundary values of all 11 parameters for oil spills and slicks wind , which later were used during the training phase of the neural network . Found that oil spills are less complex and more subtle form than wind slicks . Average values of the gradient along the borders of the oil slick is higher than that of wind slicks , which are usually more extended than oil spills .

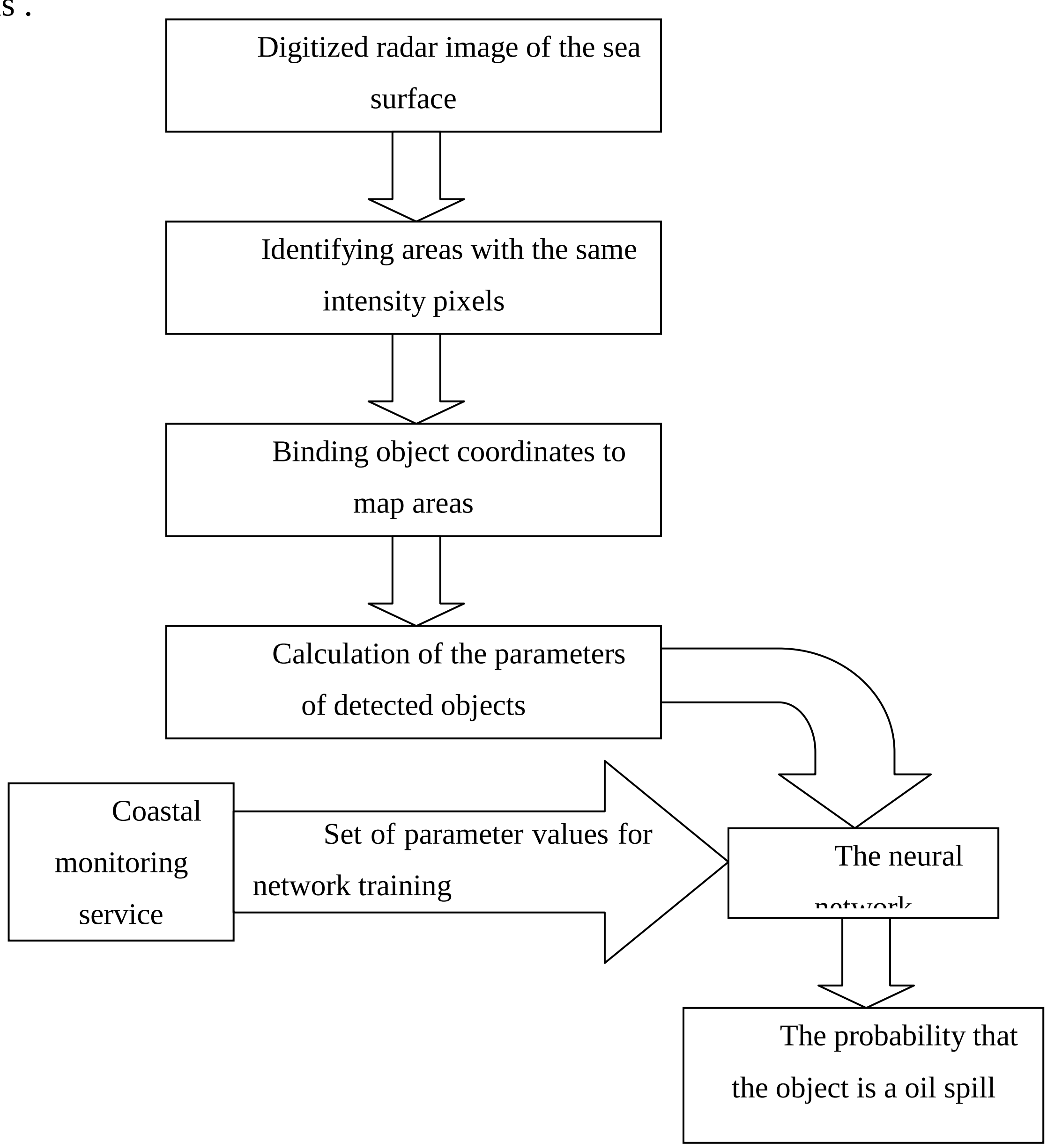

Fig.7. Classification algoritm

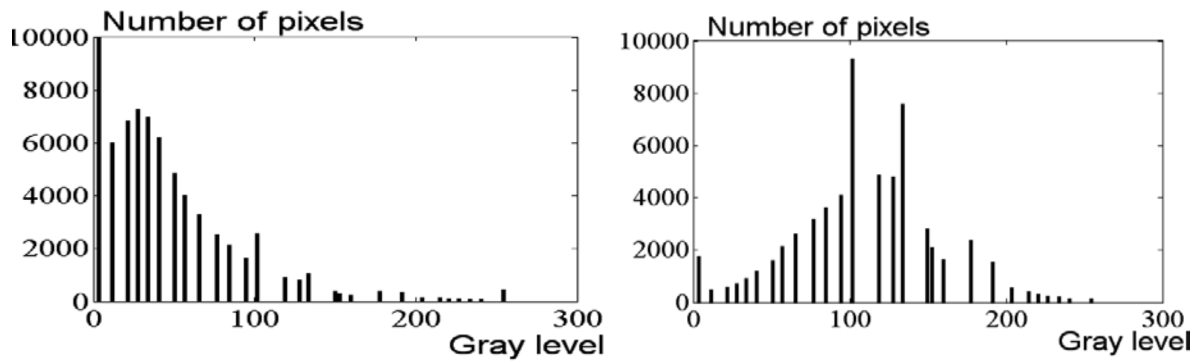

Fig 8. Histograms: a) histogram of the oil slick, b) histogram of natural slicks

Program window, creating and training neural network method of steepest descent, is shown in Fig. 9.

The neural network training was carried out using back-propagation algorithm, which uses a gradient search technique and iteratively selects the weights in the network to minimize the error function on the mean square between the desired and the actual output value. Iteration stops when no significant change in the value of the overall error. Thus, learning the network is reduced to solving the optimization of functional errors gradient method.

Input received at step for finding the parameters of a dark object, manually entered into the appropriate cells, next to which is written the range of variation of parameters corresponding to the image of the oil slick. Networks are used for training the parameters randomly selected from the database of images of the oil slick and the data bank of wind slicks. Result of the program is the probability that a dark object in the radar picture to oil stains.

a) b)

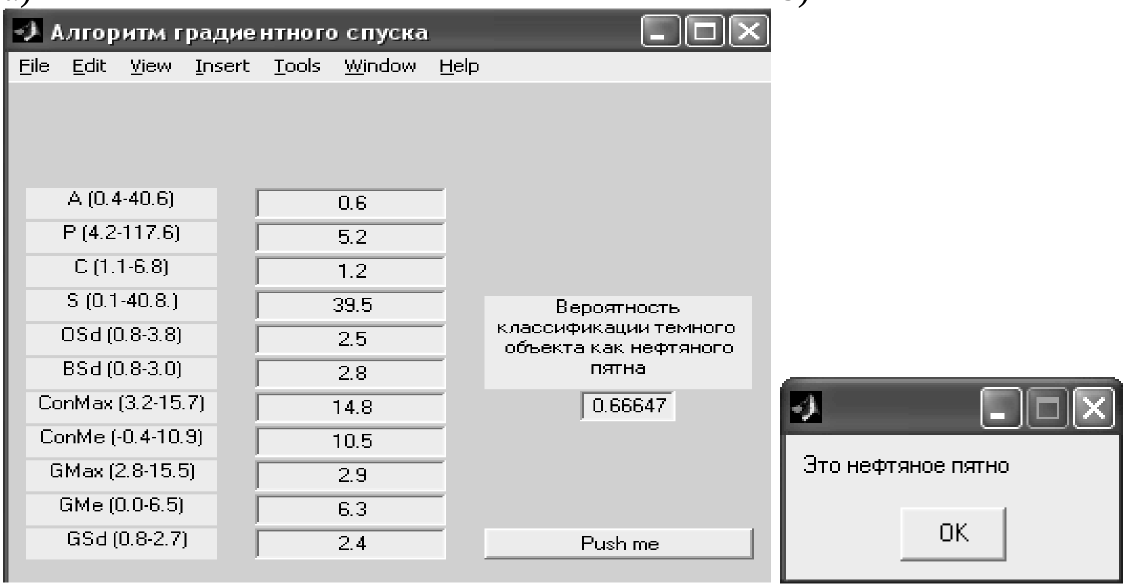

Fig. 9. Program interface implementing a neural network:
a) input image parameters, b) classification result

Conclusion

A method for processing of radar data is proposed and a classification algorithm based on neural networks is developed. A scheme of classification algorithm, based on the data allows the experimental data. As processed radar images were taken the real marine anomalies slicks and oil stains. In the course of the experiments showed that for the detection of oil spills is sufficient resolution of 100 x 100 m

Literature

1. Бескид П.П., Шишкин А.Д. Об опыте проведения мониторинга состояния морской поверхности радиолокационными средствами. Безопасность жизнедеятельности.-№2, 2011, С. 20-24.

2. J.Canny A computational approach to edge detection.- IEEE Trans. Pattern Anal. Machine Intell., vol. PAMI-8, pp.679-698, Nov.1986.

3. H.S.Chang and K.Kang A compressed domain scheme for classifying block edge patterns – IEEE Trans. Image Process., vol.14, no.2, pp.145-151, Feb.2005.

4. A.Moody, D.M. Johnson Land-surface phonologies from AVHRR using the discrete Fourier transform – Remote Sens. Environ., vol.75,pp.305-323,2001.

5. Xu Y., Weaver J.B., Healy D.M. Wavelet transform domain filters: A spatially selective noise filtration technique, IEE Trans. Image Process., vol.3, no. 6, pp.747-757, Nov.1994.

6. C. Bouman Markov random fields and stochastic image models.- IEEE Int. Conf. Image Processing, Oct.1995, pp.23-25.

7. C. Xu, D.L. Pham, J.L.Prince Image segmentation using deformable models, in Handbook of Medical Imaging, Bellingham, WA:SPIE, 2000, vol.2, ch.3.

8. Q.Hu, Z.Hou, W.L.Nowinski Supervised Range-Constrained Thresholding, IEEE Trans. Image Process., vol.15, no.1, pp.228-240, Jan. 2006.

9. Глинский В.В., Ионин В.Г. Статистический анализ.- М.: Инфра-М, 2002.-323 с.

10. Udupa et al. Relative connectedness and object definition: Theory, algorithms and application in Image.- IEEE Trans. on Pattern Anal. and Machine Intell., vol.24, No.11, Nov.2001

11. Нейрокомпьютеры в системах обработки изображений. - Под ред. А.И. Галушкина.-М.: Радиотехника, 2003.-192 с.

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PROSPECTS OF DEVELOPMENT OF UKRAINIAN NATIONAL GEODETIC FRAME

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Summary. *Prospects of development of Ukrainian National Geodetic Frame are examined in the research. To improve the accuracy of the research different methods and approaches of investigation were examined. We analyzed and chose the best method to solve a set problem.*

Key words: *gravimetric method, SGFU, fundamental geodetic frame, world wild geodetic system.*

Introduction. Prior tasks which should be solved to introduce Ukrainian Geodetic Reference Frame and upgrade the SGFU are:

- create a Fundamental Geodetic Frame, while a part of its points will be permanent stations of the world and European frames;
- tie the points of the 1^{st} and 2^{nd} categories of the SGF with the points of the Fundamental Geodetic Frame;
- estimate accuracy of the SGF and calculate accurate settings of connection between state coordinate system and European and international systems;
- upgrade state gravimetric frame;
- construct a model of geoid of subdecimetre accuracy for the territory of Ukraine;
- introduce Geodetic Reference Frame for the territory of Ukraine.

Setting a problem. A new structure of the State Geodetic Frame is based upon the usage of modern satellite and radionavigation systems and will be constructed according to the resolution passed by the Cabinet of Ministers of Ukraine #844 from 8 June 1998 “General issues of creating State Geodetic Frame”. This structure also provides frames developing of higher level of accuracy, which are closely related between each other in a certain hierarchy according to the principle of transition from the general to the partial.

Fundamental Geodetic Frame (FGF) should be the main link in the whole structure of coordinate providing the territory of the country. The main functions of the frame are:

- setting and operative reproduction of the world wild geocentric coordinate system;
- removing possible misrepresentations of SGF and extensive frames within regional and global scales;
- experimental revelation and calculation of deforming influence of geodynamical processes on stability of the coordinate system (so-called reducing to a common epoch);
- metrological providing of long-term production activity (calibration and certification of future space and other systems of high accuracy).

Statement about the material of the research. In accordance with the destination of FGF, its stations should be evenly situated within the whole territory of the country on each 200-300 km. There should be about 15-20 stations. Mutual situation of joint stations should be determined according to the relative error as 1·10-8. Such errors may have place in geocentric position vectors of the stations. It's necessary to carry out complete recycle inspections in FGF each 4-6 years. [1]

Technical equipment of work connected with creation FGF should provide not only determination of joint stations' situation of high accuracy but their connection with the Earth centre of mass. If we want the work in each following cycle not to become a new science and technical problem which would require excessive material means and efforts but be done within the scope of the common project according to the previously well-tested scheme during limited terms, a part FGF's stations (about 8-10) should work as constantly operating observatories. Such a number of specially equipped observatories where a complex of satellite, astronomic and geodetic, gravimetric and geophysical observations are made, will allow us both, to provide a constant reproduction of world wide geodetic coordinate system, and reduce the results of the observations and coordinate estimations within the entire epoch taking into account the relativistic effects, tidal and other movements of the Earth crust.

Having analyzed possible variants of the usage of satellite radionavigation systems for coordinate supply of the country, we came to conclusion that nowadays, taking into account all the above accurate, organizational and technical conditions, the most optimal method is to build a geodetic frame of stations of single accuracy with average distance between each station not overcoming 20-30 km for the astronomic and geodetic frame of the 1st category, that is to re-estimate the existing stations of AGF of the 1st and 2nd categories (5 905 stations). [2]

The principal function of the AGF-1 is to distribute world wild geocentric and coordinate system within the territory of the country and to determine accurate features of the joint orientation of world wild and reference coordinate system; to provide integration of planned and high-altitude geodetic frameworks into a single system.

Creating a basis for high accurate estimation of the geoid's heights within the territory of the country is the second important function of the AGM-1. Stations of the AGF-1 should be included into the state frame of high accurate leveling or connected with it but the average square errors of estimation the excesses between joint stations shouldn't exceed ± 0,05 m. The heights of the geoid which were estimated from the satellite observations and leveling data in the stations of the AGF-1 can be interpolated later with the help of the existing gravimetric extraction on any intermediate station, what will make it possible to build a high accurate map of the geiod's heights within the territory of the country.

Close connection between FGF and AGF-1 with the existing state geodetic frame is realized with the help of SGF binding to the stations of FGF and AGF-1 and matching the stations of these frames. All this ensure estimation of single features of connection the world wild geocentric and coordinate system with the reference geodetic system and, if it's needed it will provide an accurate connection while using local coordinate systems and sets of local features.

As the result of data processing of all performed observation sessions we will have spatial rectangular coordinates of AGF-1 in the coordinate system of FGF stations which matches with the world wild system on the centimetre level. [1]

Satellite methods of estimation planned coordinates in 80-90th of XX century allowed to deny the necessity of estimation the target geodetic dates in the only target station. Also these dates estimate orientation of the indicating ellipsoid for the reference coordinate system. Nowadays we have the same problem with the usage of level posts setting per se regional systems of heights. Development of methods for estimation coordinates, taking as the basis the usage of satellite and radio-navigation systems and gravimetric estimations at the same time, allows to come up at a new level of quality to the problem of setting the entire system of heights. [3]

Nowadays the most accuracy in estimation the heights of the geoid is achieved due to the complex method which consists in estimation the influence of the gravity anomalies in remote areas according to the features of planetary gravitational field model of the Earth, and according to the integral formulas with using detailed gravimetric information in central area. Nowadays the accuracy of estimation the absolute heights of the geoid within the territory of Ukraine is characterized by an average standard error up to 1 m but there may be systemic errors of regional character up to 2 m. Further accuracy raising of estimation the geoid’s heights is connected with the necessity of accuracy raising of estimation the features of planetary gravitational models, theory and methods development of estimation the perturbing potential. All these allow to estimate heights of the geoid with the average standard error about 0,01 m. First of all, the way out of this problem is connected with taking into account the Earth ellipsoid and peculiarities of the relief influence in accordance with the Molodenskyi’s theory. [4]

Modern gravitational field models of the Earth obtained in Russia and in the USA are high level detailed and accurate in representing geopotential. These models are EGM-96 (USA) and HAJ-97 (Russia). According to the detail level they meet spreading of the geopotential into a raw according to spherical functions up to 360th degree. It became possible thanks to the joint processing the satellite orbital and altimeter data and data from the land and marine gravimetric estimations.

Deviation of the real sea surface from the level-sensitive one is estimated with the greatest reliability and details by the same gravitational models. So it is impossible to considerably precise the planetary component by altimeter data. We should rely on completely new satellite methods. The most prospective method is the one of satellite radioendometrium.

Conclusion. To raise the accuracy of estimation the features of the Earth geopotential we need to use more actively the gravimetric method. Accuracy of the modern ballistic gravimeters equals ± 5 mcGal. Thanks to estimations with such gravimeters we can get a frame of fundamental gravimetric stations. A gravimetric frame of the 1st category was built of pendulum devices in Ukraine. It consists of about 60 stations. Errors of estimation the gravity increase in these stations equal ± 3-4 mcGal. If to tie detailed gravimetric surveys to the gravimetric frame at the same level of accuracy (e.g. on a scale 1:200 000 which covers all the territory of Ukraine, or if possible on a scale 1:50 000 which covers considerable territory of Ukraine), we will be able to estimate heights of the geoid with deviation ± 5-10 cm. Thus we have all real and objective circumstances to solve the above problems with a great success. [1]

Literature:

1. Бондар А. Л., Заєць І. М., Кучер О. В. Стан та основні напрями розвитку Державної геодезичної мережі України // Вісн. геодез. та картогр. -2001. - №3. - С. 17-23.
2. Заєць І. М. Про трансформування плоских прямокутних координат в геодезичних мережах. // Вісник геодезії та картографії. -2004. - №1. –С. 16-20.
3. Кучер О.В., Заєць І.М., Стопхай Ю. А., Ренкевич О.В. Перетворення координат із державної геодезичної системи у світову систему WGS-84 // Вісник геодезії та картографії. -2002. - №3. –С. 8-14.
4. Кучер О., Лепетюк Б, Ренкевич О., Заєць І.. Науково-технічне забезпечення впровадження референцної системи координат для території України // Сучасні досягнення геодезичної науки та виробництва: Зб. Наук. Пр. – Львів: Ліга-Прес. – 2003. – С. 23-31.