

GIMS TECHNOLOGY IN ENVIRONMENTAL MONITORING OF MARINE ECOSYSTEMS

F.A. Mkrtchyan, V.F. Krapivin

*V.A. Kotelnikov Institute of Radioengineering and
Electronics, RAS, Russia*

ABSTRACT

The basic scheme of collection and processing of the information in geoinformation monitoring system(GIMS) recognizes that effective monitoring researched object is possible at complex use of methods of simulation modeling, collection and processing of the information. From the position of system analysis, the system of collection and processing of the information in geoinformation monitoring represents the structure uniting the computers of various classes, databases and the advanced problem-oriented software. Creation of such system demands the development of formalized description of the information flows and unique methodology of its processing. Marine ecosystems are one of the important objects of geoinformational monitoring. In this paper presented, a remote monitoring system for detecting anomalies on the sea surface is considered. Its block diagram is analyzed, which consists of a Holder, Resolver and Searcher. As an informative sign of waiting for the detection of anomalies on the sea surface, a model of the "spotting" of the surveyed surface was developed on the basis of empirical data. The experimental verification of the effectiveness of the algorithms considered is based on data from the Kosmos-1500 satellite for the Arctic regions

INTRODUCTION

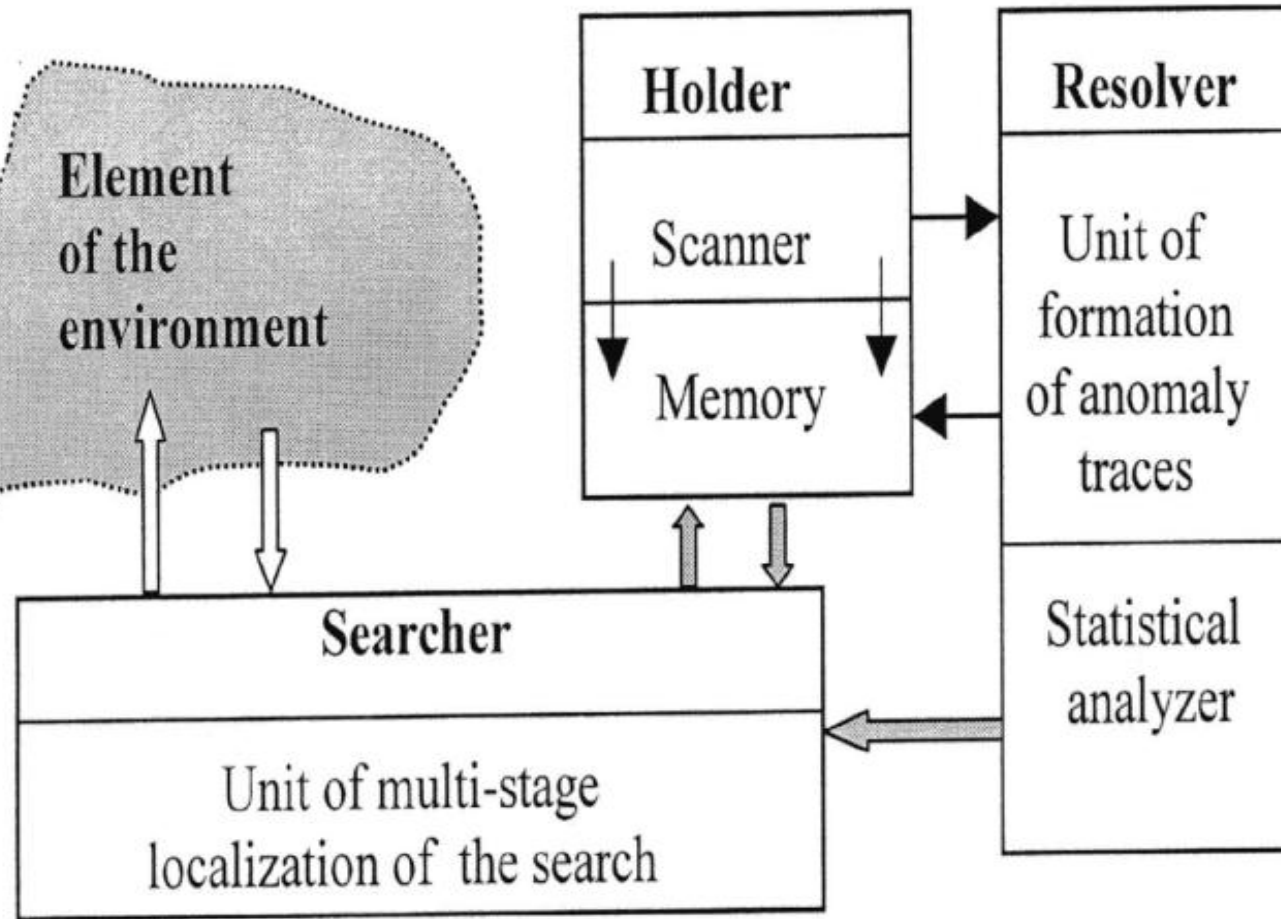
This paper is directed to the widening of cumulative experience in the development of effective and reliable information-modeling technologies for the equipping of microwave and optical monitoring of hydrological systems having different spatial scales. The problem urgency is caused by the necessity of perfecting the existing information technologies including Geospatial Information Systems (GIS) in the direction of broadening their functions and optimization of instrumental tools for hydrological monitoring with the orientation on the detection of extreme hydrological processes.

GIMS - technology develops GIS technology towards the realization of the formula:

$$\mathbf{GIMS = GIS + model.}$$

In other words, the functions of GIS enlivened by the introduction of a new grid - time scale. The result is a forecasting tool and, therefore, may carry out a dynamic integration of environmental information.

BLOCK DIAGRAM GIMS OF SEARCH OF ANOMALIES ON A SEA SURFACE.



The limited hardware, memory and performance onboard computing device dictates the division of the monitoring system into three subsystems . Holder, Resolver and Searcher. Recent divided into sub - units whose functions are as follows:

- 1) periodic viewing elements earth's surface;
- 2) fixation suspicious elements in the memory;
- 3) the formation of traces of suspicious elements moving anomalies;
- 4) Data accumulation time on fixed elements of the earth surface for the purpose of statistical analysis for deciding the nature of the signal or noise recorded suspicious elements;
- 5) multi-stage procedure, the localization of search anomalies.

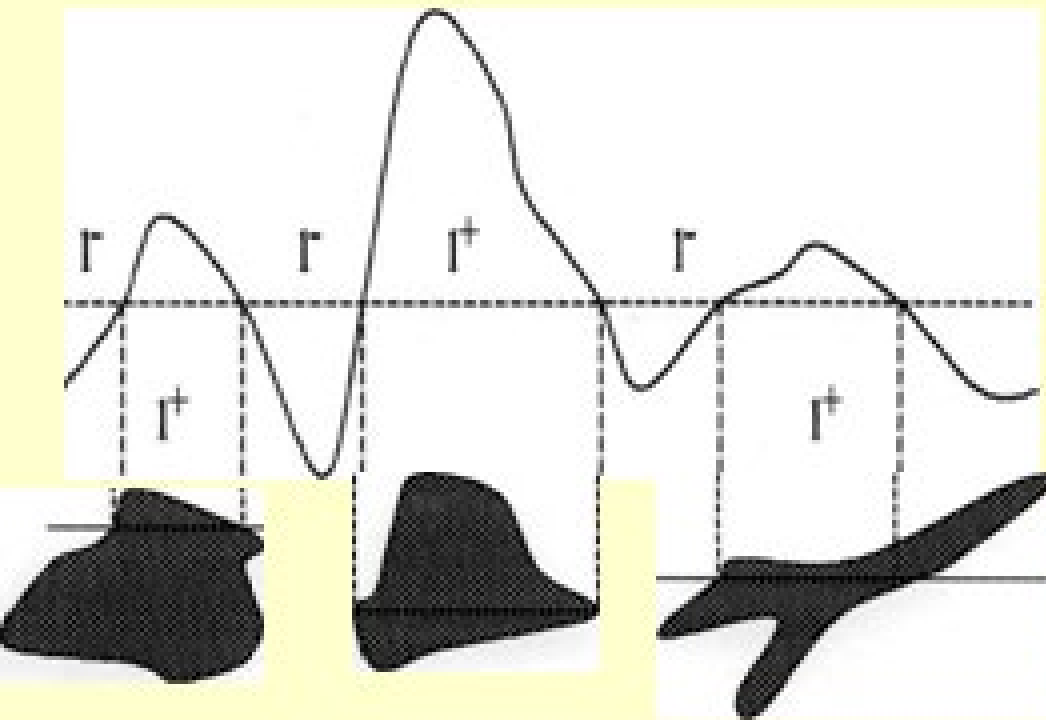
ABOUT METHODS OF CLASSIFICATION

At present time there are many methods of recognition which are caused appreciably by variety of statements of concrete tasks. The problem of recognition consists in the division of some group of objects into the classes at the base of certain requirements. The objects having general properties are related to one class. An initial data for the solution of a recognition problem are results of some observations or the direct measurements, that are named initial attributes.

Method of taxonomy (clustering) is one of the important methods of recognition and classification of images.

Kings method is one of well-known methods of taxonomy, which gives good results in those cases, when the quantity of the available information in assumed clusters is moderate. According to this method the distance between groups of points in space of attributes is defined as distance between centers of masses of these groups. Clustering in this case is based on the assumption that sites of the increased density in space of attributes correspond to similar situations.

MODEL OF SPOTTINES



Statistical model of spottiness for investigated space is one of models for this image. The method of the thresholds determination in the most obvious and simple way for spots definition. In this case that part of space belongs to area of spots, on which the parameter of environment measured within the chosen channel exceeds value (t^*) or, on the contrary, does not exceed value (t) a threshold.

SOFTWARE

The list of software items of the simulation system of classification of the phenomena on a terrestrial surface is given in Table. An important point of algorithms and the software of system is the possibility of spatial interpolation and data restoration using remote and in-situ measurements.

One of main aspects of the practical importance of developed system is qualitative interpretation and visualization of results of remote measurements. For primary processing of remote measurements it is useful to apply an overage-connecting method of cluster analysis to detect the specific informational zones. That method is effective under small volumes of sampling. Two variants of this approach are realized to be distinguished by the organization form of algorithms and indeu spaces.

SOFTWARE MODULES	THE FUNCTIONAL CHARACTERISTIC AN SOFTWARE
REICM	Reduction of the experimental information in a computer memory
DRHIM	Data reconstruction by means of the harmonics interpolation method
SIDSM	Spatial interpolation of the data by means of a spline method
DRMOT	A method of optimal interpolation
CASRS	Cluster analysis focused on sings space of remote sensors
CALRS	Cluster analysis focused on the account of local reading of sensors
RSC	Research of spottiness characteristics
RRADA	Realization of recognition algorithm by a method of the discriminant analysis
CSAIRM	Sorting and accumulation of the in-situ and remote measurements
CMS	Computer mapping of the spots

APPLICATION

Analysis of statistical characteristics of “spottiness” for three types of areas of Arctic oceans was conducted. These statistical characteristics were determined for the most informative thresholds. At that time statistical characteristics of "spottiness" for the same areas, selected using criteria of minimal value of coefficient of correlation for joint sample of positive and negative spots.

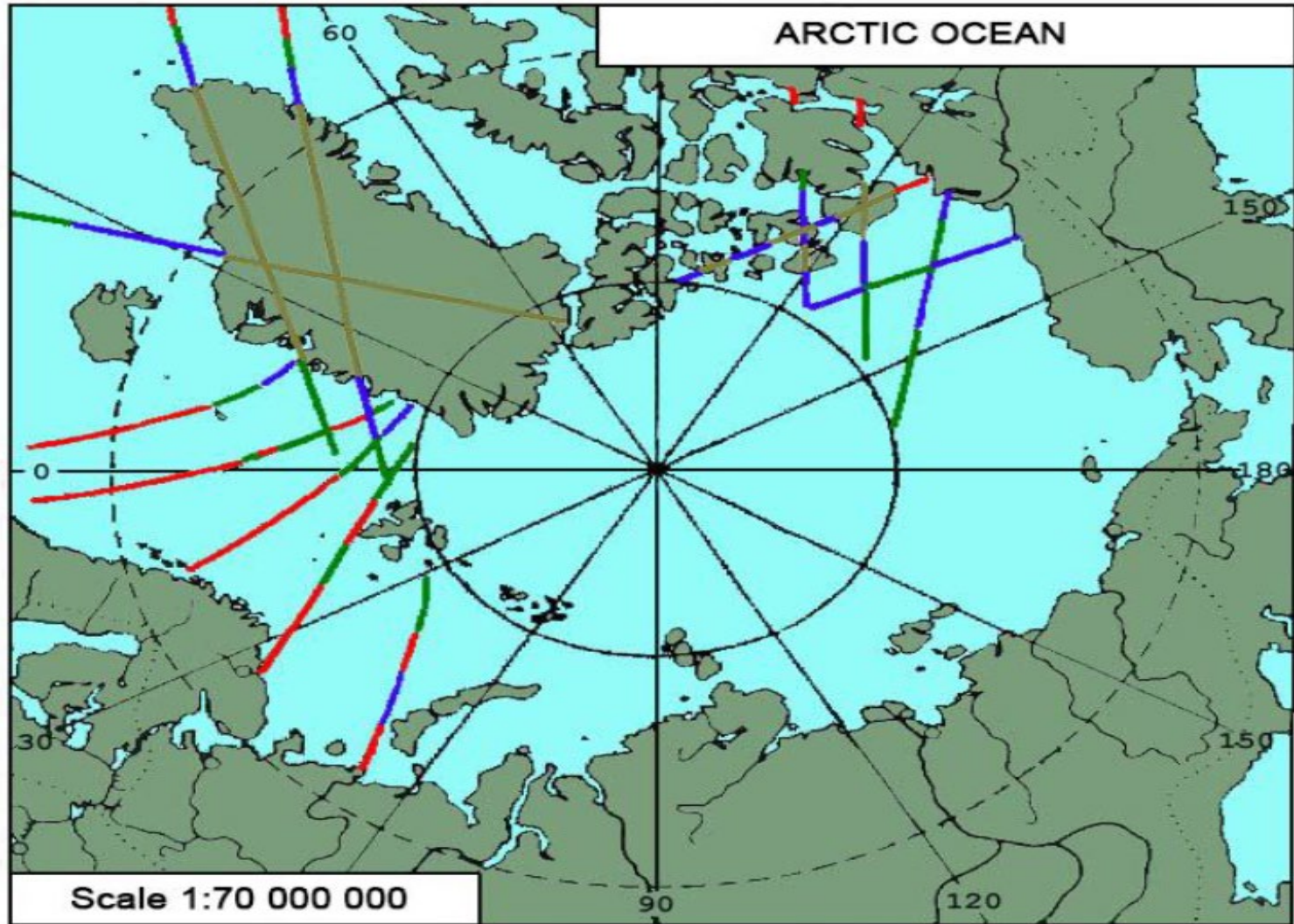
Statistical characteristics of the "spots" brightness temperature of the sea surface (the Barents Sea) according to satellite "Cosmos-1500" (8-9 February 1984) channel $\lambda_1 = 0.8$ cm

Threshold	N	W	D	MIN	MA X	A	Θ	ρ	
160	1 ⁺	28	21.3	220.5	1	106	1.87	5.6	0.168
	1 ⁻	27	12.6	15.5	1	31	2.2	3.2	
180	1 ⁺	36	18.3	125.2	1	80	3.02	14.3	0.054
	1 ⁻	35	16.2	26.8	1	26	2.3	4.8	
200	1 ⁺	32	24.6	145.4	1	96	5.1	12.6	0.18
	1 ⁻	32	22.4	89.8	1	80	4.2	9.4	
220	1 ⁺	24	9.8	194.8	1	83	4.3	10.05	0.26
	1 ⁻	24	25.4	210.2	1	64	3.2	6.3	

Statistical characteristics of the "spots" brightness temperature of the sea surface (area of the Beaufort Sea), according to the satellite "Cosmos-1500" (8-9 February 1984) channel $\lambda_1 = 0.8$ cm

Threshold	N	W	D	MIN	MAX	A	Ξ	ρ	
200	1 ⁺	9	38	165	1	110	1.8	0.6	0.38
	1 ⁻	9	7.8	37	1	34	1.7	0.58	
205	1 ⁺	12	29	76	1	87	0.9	1.8	0.24
	1 ⁻	12	15	45.8	1	32	1.85	3.4	
210	1 ⁺	16	24	210.2	1	86	2.4	5.6	0.04
	1 ⁻	16	22.6	58.3	1	42	2.9	5.9	
215	1 ⁺	10	15.4	11.4	1	16	1.8	2.2	0.29
	1 ⁻	10	29.2	102.3	1	27	2.5	4.1	

ARCTIC OCEAN



1. Red lines – pure water;
2. Green lines- One year ice;
3. Blue lines - Multi-year ice;
4. Brown lines- Pack ice

CONCLUSION

From the aforesaid follows, that statistical characteristics for "spottiness" of brightness temperatures in microwaves can be used for detection and classification of the phenomena on a surface of the ocean, that was caused by a degree of sea roughness.

The analysis of empirical histograms for "spottiness of brightness temperatures in microwaves" shows, that in most cases (l^+ , l^-) - characteristics will be coordinated with exponential distribution, and amplitude characteristics will be coordinated with normal distribution. Therefore for detection and classification of the phenomena on a surface of ocean it is necessary to apply optimal algorithms for the COMPUTER training to taking statistical decisions for the aforesaid distributions