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USAGE of NEURON-LIKE FRAMES In a PROBLEM of CLASSIFICATION of OBJECTS ACCORDING to their HYDROACOUSTIC SIGNALS

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The basic task is to consider the identification of the "strange" vessel's image located in a zone of capabilities of a nominal acoustic complete set of the submerged vehicle. It is supposed that the parsed data are vectors of multidimensional Euclidean space where they place according to a function of distribution. Each vector is an object to be identified and the vector's coordinates are its identifications. The dimension of space of identifications is always great. Primary goal of research is the allocation of basic "generalized identifications" which reduces the initial dimension of identifications and allows to identify the object. The compression of initial space descends step-by-step. At the primary stage the temporary non-steady process carrying the information is processed according to the technique of Kolmogorov- Hinchin[1], at the second stage- the multilayer perceptron of a definite type (a replacative net), permitting to discharge object [2] is used. This paper deals with the primary stage of compression of initial identifications .

Task Formulation

This paper deals with an acoustic system which functional diagram is shown in a Fig. 1.

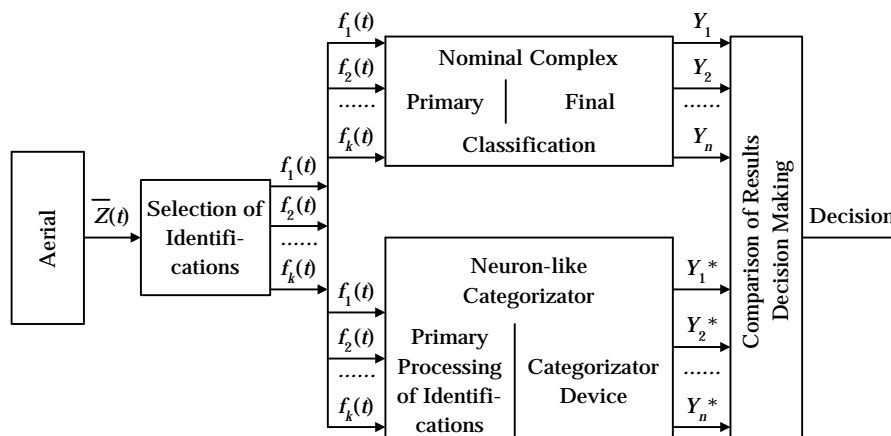


Fig. 1. A functional diagram

Neuron-like categorizator is determined simultaneously with the determination of the nominal hydroacoustic complex making primary processing of identifications (precompression of identifications space) and categorizing of objects. In a Fig. 1 the following notations are used: $\bar{Z}(t)$ – output signal of the hydroacoustic aerial; $f_1(t), f_2(t), \dots, f_k(t)$ – discharged temporary functions of identifications, according to which a classification is made; $Y_1, Y_2, Y_n,$ – category (objects), discharged by the nominal recognizing device; $Y_1^*, Y_2^*, Y_n^*,$ – category (objects), discharged by neuron-like recognizing device.

The operator of a considered hydroacoustic complex has a capability to compare outcomes obtained from an output of both a nominal complex and neuron-like categorizator operating simultaneously the basic one. The solution is received based on the analysis of outcomes obtained from an output of both systems.

It is necessary to point out that neuro-categorizator realized with the help of rather restricted nominal computing means of the submerged vehicle has shown rather satisfactory outcomes comparable to the operation of a nominal complex. If taking into consideration the time of decision making it's turned to be superior the latter.

In the present paper the basic attention is paid to a narrow enough problem connected with preliminary processing of the information based on a technique with good results of the researches carried out beforehand.

The unit of preliminary processing of information (UPI)

UPI is a device according to the technique of Kolmogorov-Hinchin [1] representing non-steady temporary process of its basic statistical parameters practically in real time. The functional diagram of UPI is shown in a Fig. 2.

The scheme represents the called algorithm with the help of which temporary processes $f_1(t), f_2(t), \dots, f_k(t)$ keeping information identifications (the dimension of which is rather great) are replaced by their statistical characteristics: by mathematical expectation m_{xi} , root-mean-square deviation s_{xi} and correlation moment k_{xi} , where i – number of temporary process. All temporary processes of identifications are subject to the previously described processing. Thus, at every instant three generalized characteristics are moved on an input of the recognizing net. The categorizing is carried out; that is $\bar{S}_x^k(t) = [m_{xk}(t), s_{xk}(t), k_{xk}(t)]$ – one of the input vectors of a recognizing net describing process $f_k(t)$ at a considered instant t .

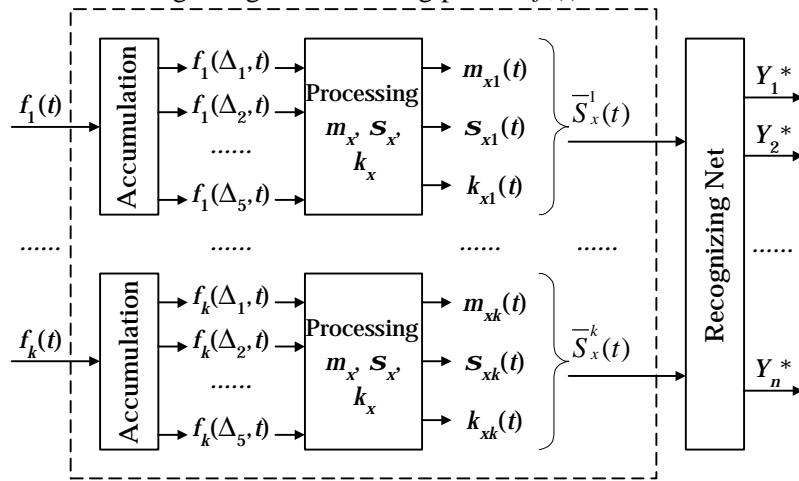


Fig. 2. The unit of preliminary processing of a signal

The UPI operational algorithms

As it's been already mentioned the method of Kolmogorov-Hinchin is used at the solution of the precompression of the information .

The essence of a method is that besides some limitations the classic definitions of a random variable and the stochastic function completely coincide if to identify Δ final number of previous histories and real-time process itself at some time period simultaneously.

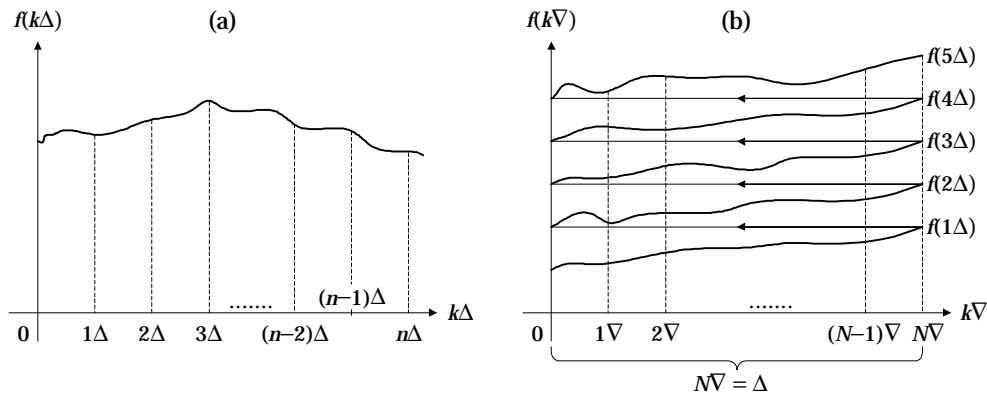


Fig. 3. Temporary functions of identifications

In our case the temporary function of identifications $f(t)$ shown in a Fig. 3 is identified and analyzed. In accordance with a selected technique the continuous process $f(t)$ is broken into a number of discrete intervals with duration Δ stored in memory. The studied real-time process is applied to the same device. In a Fig. 3 (b) the curves located in memory of the "accumulation" unit $f(1\Delta), f(2\Delta), f(3\Delta), f(4\Delta)$ and applied in real time function $f(5\Delta)$ are shown.

All discharged temporary discrete values are broken into N of equal sections with the duration ∇ at the end of which one there is a processing of all implementations. $m_x(i\nabla), s_x(i\nabla)$ and $k_x(i\nabla)$ are determined. That is, after the analysis of an interval Δ_i ($i = 0, \dots, n$) it is possible to receive the information shown in a Fig. 4 (a), to construct both a vector $\bar{S}_x(I\nabla)$ and a "condition" hodograph of identified object (Fig. 4 (b)). These values are delivered at an input of a recognizing net for the process of an object classification according to its yardstick $\bar{S}_x(I\Delta) \in \Omega_j$, where $1, \dots, j, \dots, m$ – the object's number due to the classification.

The net of recognition

The net of recognition used at the problem solution represents the neuron-net paradigm integrating the Kohonen's cards and the Grossberg's layer. The net structure has (in minimum version) two layers: the Kohonen's layer and the Grossberg's layer. The former layer contains final number of neurons. All components of input vector are applied through Kohonen's synapses to every neuron. All neurons of the Kohonen's layer have lateral connection. It provides these group of neuron with the competitive nature. The output layer (Grossberg's one) contains two neurons – according to the number of classes the parsed vector is related to. It is also necessary to solve a problem of the identified tags fitting to an object according to which the net is fixed. It is supposed, that the number of output net is determined by the number of objects due to be recognized.

The conclusion

First of all it is necessary to point out that neuron-like recognizing nets have the right to existence and are rather perspective. The nets constructed with the help of the onboard computer complexes of the submerged vehicle with rather restricted capability have appeared to be rather competitive comparing with a nominal hydroacoustic complex. During 6 – 10 minutes of the object's identification the probability of exact classification is not lower than 85%, and at classification of a type surface object or underwater object the probability is not less than 97%.

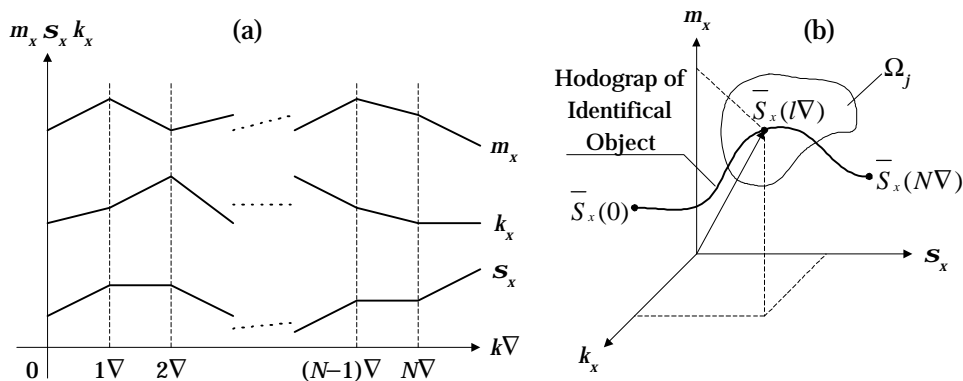


Fig. 4. Output characteristics of the unit of a preliminary processed signal

The used technique of the information precompression according to Kolmogorov-Hinchin's method can be used for pretreatment of any informational temporary processes which have identifications subjected to categorizing.

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