# CLASSIFICATION OF LIVING SYSTEMS STATES ON THE BASIS OF A HYBRID APPROACH TO THE ANALYSIS OF DATA ON SYSTEMIC RHYTHMS

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The article describes hybrid technology classification of living systems. The essence of the approach consists that the difficult dynamic system is given in space of parametres of slow waves. With that purpose, the process of analyzing the condition system is breaks into a number of stages. In the first stage the signal, which describes a condition of system, select the available slow waves. Available slow waves are determined by the wavelet -analysis of a signal system. In the second stage define parameters of the slow waves are depend. Used for this purpose are the windows Fourier transformation significant lines of the wavelet -plane. In the third stage, the classification status of the system is carried out by neural network analysis of the spectral factors relevant lines of the wavelet-plane.

**Keywords: A hybrid method, informative signs, neural network analysis, living systems, systemic rhythms**

Analysis of numerous home and foreign researches in the field of complex systems studying, carried out during the last 10 years, showed that latent components of system processes. System rhythms possess significant information value. Such processes are not distinguished and not processed practically in modern diagnostic systems and this greatly reduces potential possibilities of perspective diagnostic systems [1, 2]. That is why it is necessary to create qualitatively new methods and algorithms that allows distinguishing and analyzing signals in the objects characterized by complex system rhythms.

Experimental studies on test and real signals, That being characterize the states of complex systems, showed that neither frequency nor time-frequency analysis is an effective instrument for distinguishing modulation parameters from quasiperiodic signal.

To distinguish informative features from quasiperiodic low-frequency signal, characterizing parameter of its modulation, there has been proposed hybrid technology which allows, using certain approaches to the analysis of quasiperiodic signal, to obtain such technology of data processing due to which methods, being used, improve ways of processing from stage to stage, compensating disadvantages of former methods.

Block diagram of intelligent system for realization of classification method on the basis of hybrid analysis for slow waves signals is given in Fig. 1. Input signal X(t), defining the state of a complex object, enters into two processing units: selector of system rhythms and synthesizer of wavelet plane.

Selector of system rhythms of unstable signal by means of Furies windowing transformation (FWT) of input signal distinguishes spectral trains, defines their wavelet transform and carries out morphological analysis of benchmark lines in obtained wavelet-plane. Latent system rhythms, being available for analysis, are defined as a result of this procedure.

Some state or class of states is introduced into states base of living objects, It is necessary to determine belonging to the state of the object, being under investigation on the basis of the analysis of object state vector $X(t)$. It allows you to set a priori a priori those slow waves from set $M$ which are relevant for the given condition.

According to the weaving each selector of line numbers in wavelet-plane, corresponding to low-frequency modulation of distinguished system rhythms, transmits only limited number of lines from wavelet-plane segment, corresponding to this system rhythm, into the input of FWT unit. Maximal number of analysed lines n is limited by 20 in the given system realization. Besides, this number can be reduced up to 1 depending on the code of state A at the input of living objects states base.

Moreover, the selector of system rhythms can not detect all system rhythms available in data base for test state of the object (class A). In this case we deal with dynamic structure of informative features space at the input of the classifier neural network of direct propagation is used as such classifier in the given system. In connection with the fact that space of informative features is dynamic, base of neural network models have been introduced into classification system. This model changes the structure of neural network depending on the fact that rhythms are detected by the selector of system rhythms. Models base of neural network is controlled by binary outputs of the selector.

FWT is fulfilled on every distinguished line in wavelet-plane. If the number of significant lines is less than $N$, then corresponding FWT units are not used, and this is accomplished by means of commutator of informative features, which turns off outputs of corresponding FWT units from inputs of neural network. In

the same way, units of informative features are not used if corresponding system rhythm is not included into totality defining test state. If the corresponding rhythm is not detected, then all the outputs of FWT units become disconnected from all the inputs of neural network. The base of neural network models is obtained in medium Matlab.

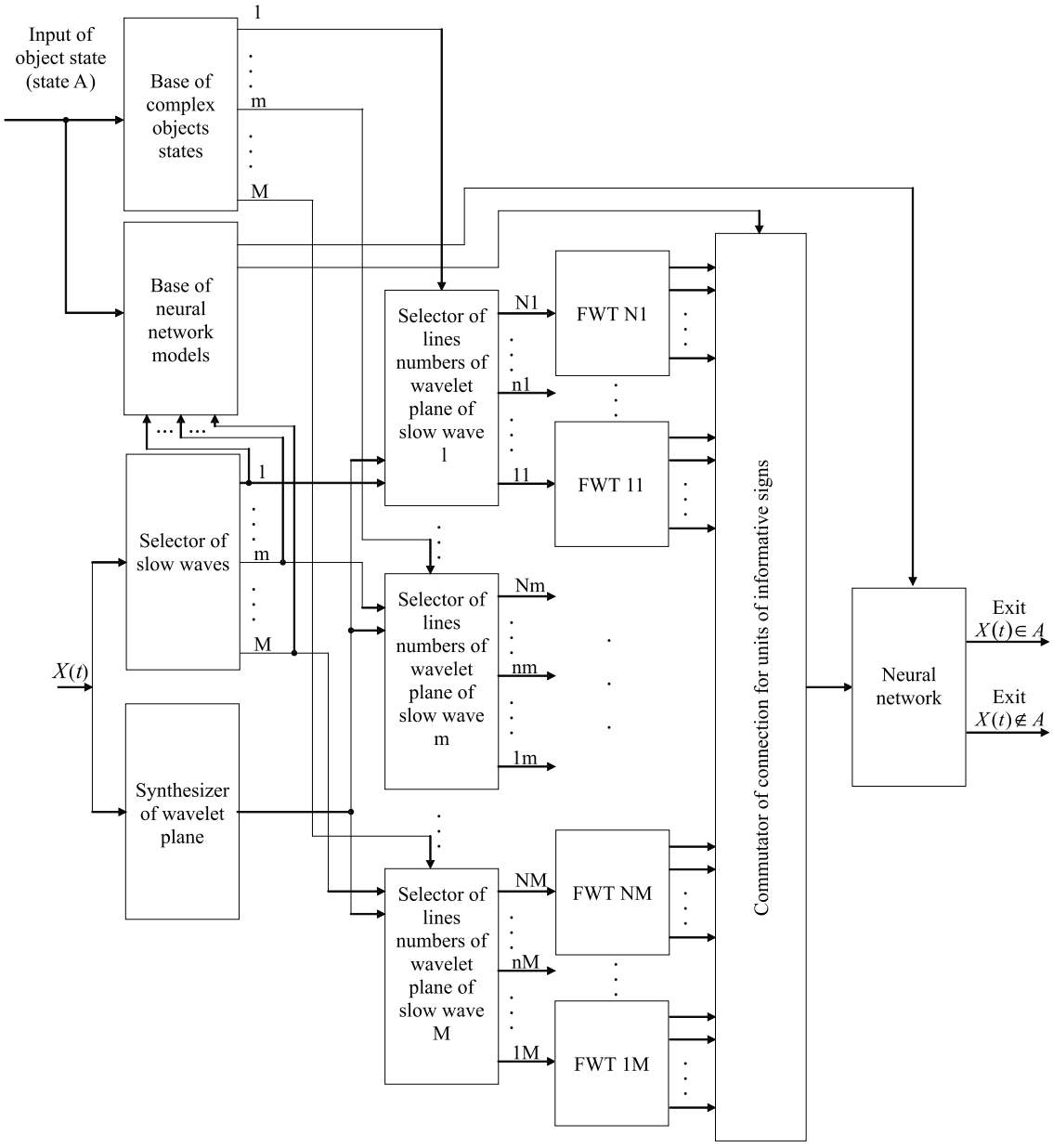


Fig. 1. Block diagram of intelligent system for realization of classification method on the basis of hybrid analysis if slow waves signals

Let us illustrate technology of forming indication space meant for identification of complex system on the example of system rhythms analysis, presented in electrocardiosignal spectrum. FWT of electrocardiosignals (Fig. 2.) is the sequence of wave trains, coordinates of which on frequency axis correspond to frequences divisible by main harmonic of electrocardiosignal.

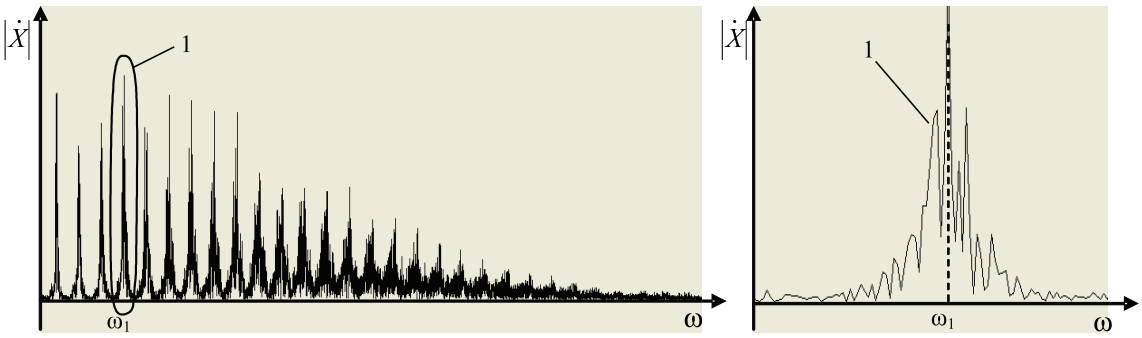


Fig. 2. FWT electrocardiosignal (on the left) and diagram of one train of spectral waves (on the right)

A set of slow waves, relevant for this state, is chosen for each state of a living object, and selector of slow waves determines accessible slow waves. (Fig. 3.) gives the example of wavelet structural analysis – transformation of FWT train of electrocardiosignal in (Fig. 2.)

The least correlated wavelet lines – planes of FWT ECG spectral train (Fig. 2.) are analyzed for search of accessible slow waves. Fragments of the development of this wavelet-plane of spectral train according to lines and three least correlated wavelet-plane lines are given in (Fig. 3.) Accessible slow waves, being present in the current signal are determined by means of morphological analysis of these signals in slow waves selector.

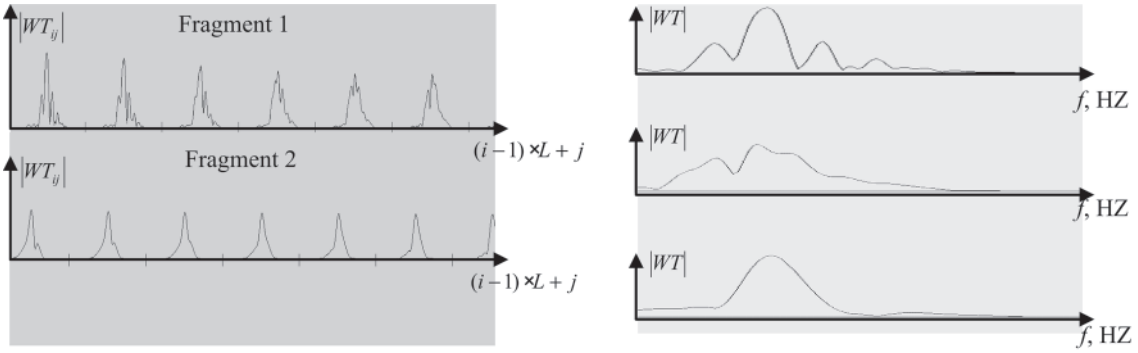


Fig. 3. Fragments of the development of wavelet-plane of spectral train FWT ECG according to lines (A) and three least correlated lines of wavelet-plane (B):
L – Length of wavelet-plane line; i – Number of wavelet-plane line;
j – Number of wavelet-plane column number, (i – 1) L + j – Number of WT read-out

(Fig. 4.) Gives electrocardiosignal wavelet-plane, which comes into the input of selectors for lines of slow waves wavelet-plane. It has been obtained according to 11000 read-outs of signal ECG, digitized with the frequency 100 HZ. The plane contains 800 lines and has boundary frequencies 40 HZ. And 0,125 HZ.

For each allocated slow wave the block of informative signs which arrives on corresponding inputs of a neural network of direct distribution is formed. The network acts as a binary classifier for each current vector of system state and given state at the input of objects state base.

Evaluation of efficiency of proposed methods, algorithms and means of intelligent support for decision making was executed on the example of intelligent system for diagnosis of psychosomatic diseases. Coronary disease (CD) has been chosen as a psychosomatic disease.

As a result of carried out researches, there were formed learning and control extracts for checking sufficiency of methods and algorithms for decision making, based on the analysis of system rhythms of living out approbation of proposed methods and means based on representative control sampling on the example of coronary disease diagnosis.

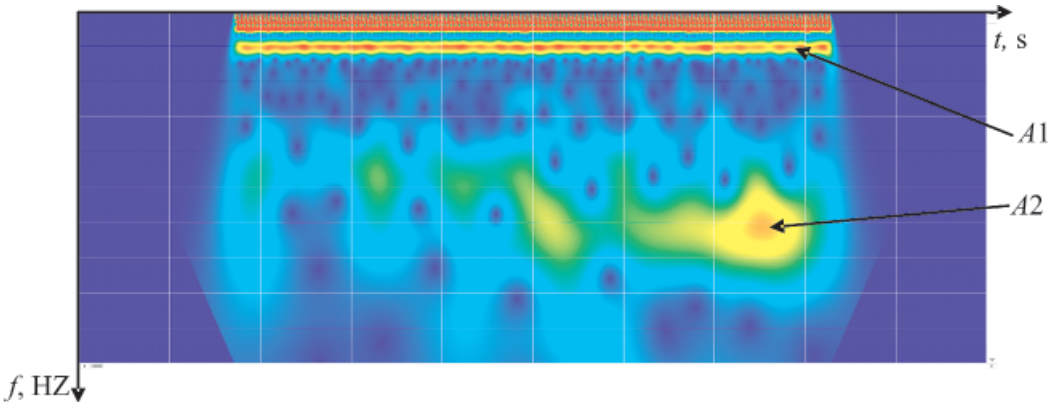


Fig. 4. Wavelet-plane of electrocardiosignal with slow waves sector of the second order A2 (A1 – Area of slow waves of the first order)

The analysis indicators of the quality of classification models of the decision-making based on an offered method showed, that they concede all for two percent to indicators of the quality Received on the basis of an expert estimation. Comparative characteristics of expert assessments of risk of cardio – vascular complications and estimates obtained on the basis of the proposed models of intelligent systems allow us to recommend received technical and algorithmic solution for practical use in diagnostics of functional state of cardio-vascular system.

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