UDK 519.21: 612.172.1

Ya. Dragan, V. Dozorsky, I. Dediv, L. Dediv

PRINCIPLES AND MEANS OF METHODS OF STATISTICAL PROCESSING OF PERIODICALLY CORRELATED RANDOM PROCESSES IMPLEMENTATIONS

ANNOTATION

The work is devoted to the grounding of methods of statistical processing of signal implementations in presenting them as periodically correlated random process. The method of electrocardiosignal statistical processing for detection of ischemic heart disease is developed.

Keywords: periodically correlated random process, ischemic heart disease, a method of statistical processing

The correct means of statistical processing of periodically correlated random processes implementations as mathematical models of rhythmic processes are based on the statistics of stationary random processes, which are interpreted as ergodic and then the calculations of their probability characteristics estimates are grounded, by replacing the distribution averaging on the averaging in time.

An important for application of statistical processing methods of individual periodically correlated random process implementations is the question of concept of reduce to a stationary, because the periodically correlated random process is non-stationary by definition.

Based on the schedule of such presentation of signals and linear converters with the same type of change in time of their characteristics the submitting of periodically correlated random process as a sum of products of periodic function and stationary process is reasonable. In the perspective of radio communications, such product is interpreted as a modulation of these harmonics stationary informative random processes, that can be called stationary components of periodically correlated random process (each component generates a steady process, all the components create a stationary vector process).

Specific presentation of periodically correlated random processes was substantiated by K. Jordan, through translational basis functions of L_2 (0, T), coupled in the sense of Hadamard on the n-dimensional stationary sequence with its components for each time interval $D_k=[kT,(k+1)T]$. This reveals another aspect of the structure of periodically correlated random processes, but the statistical methods of rhythmic processes processing, based on translational representation of periodically correlated random process, practically are not designed. But such representations are the means of grounding of using the traditional analysis, well developed on the basis of presentation by the modulation components in the form of infinite dimensional vector stationary process.

The situation is that every time it is necessary to argue in detail every step of the statistical analysis of rhythmic processes reyestrohrams. Means of conceptual and formal apparatus of stochastic signal power theory, which is the logical conclusion of correlation and covers both theory periodically correlated random processes and the theory of stationary random processes, provides sufficient grounds to do so.

The situation with the necessity of detailed arguments for each step of the statistical analysis method originated in developing the method of electrocardiosignal processing for the problem of coronary heart disease detection.

In existing diagnostic systems the processing of electrocardiosignal is conducted on ST segment (by the changes in signal amplitude at this sector doctors determine the presence or absence of coronary heart disease). The information focuses on other electrocardiosignal segments (PQ, QR, RS) actually are

ignored. For the processing are used the methods of analysis of morphological parameters electrocardiosignal time implementations and methods of spectral correlation analysis. The decision on the presence or absence of coronary heart disease episodes accepted the results of the observation segment ST signal averaged over a short time interval. However, the episode of ischemia develops within a few seconds, so much of the information not only about the presence of coronary heart disease episodes and about his course in the study is almost lost. Therefore, the development of new effective methods of electrocardiosignal processing for detection of coronary heart disease that would allow evaluation of the changes of ST segment and other segments is an important task.

Based on the electrocardiosignal properties and relationships that determine the adequacy to the problem of pathological conditions detection the mathematical model in the form of periodically correlated random process, for the processing of electrocardiosignal realization can be used the sinphase method, based on inherent assumption that values of electrocardiosignal samples taken by correlation period at different time choosing the origin forms a stationary ergodic random vector sequence.

The resulting stationary "invested" sequences are components exclusively in phase of periodically correlated random sequence. After the formation of stationary sequences their study is performed using the methods of correlation and spectral analysis of stationary random processes theory.

The described method of stationary sequences forming is implemented in the environment of Matlab. In forming such sequences the value of correlation period was calculated using the method based on estimating of maximum of variation statistical indicators function. Based on the developed software the processing of electrocardiosignal realization for a patient in a state of medical standards was conducted.

For each numbered sequence a permanent evaluation expectation is obtained. In a such form was calculated the evaluations of maximum and minimum deviation values of each element fixed sequence of its expectation. These estimates forms the boundary of electrocardiosignal changes for the state of medical standards.

When the peak value deviation of ST segment on the state standards, this rejection will be appears in stationary sequences, and therefore will be out of the limits.

The algorithm of electrocardiosignal processing by the developed method should include: 1. forming the stationary sequences from a sample of electrocardiosignal realization, lasting 30-40 sec., which contains no appears of coronary heart disease; 2. to calculate sample of boundary changes values of elements of stationary sequences (maximum and minimum deviation from expectation); 3. to evaluate the possibility of going beyond the limits of each subsequent value fixed sequences.

To verify the proposed method the processing of electrocardiosignal containing episode of ischemia was conducted. The results confirmed the coincidence of theoretical and experimental data

Conclusions

The use of sinphase method to processing the electrocardiosignal enables to reduce signals of this type to stationary sequences, by the changes which elements value the appears of coronary heart disease can be detected as the ST segment and the other segments (PQ, QR, RS). The grounding of the same processing steps enables the correct interpretation of the results and development of processing algorithms to enable automated detection of coronary heart disease. The developed method of statistical processing can be used for the tasks of building of modern systems software of patient functional status control.