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INFORMATION APPLICATION FOR DATA MEDICAL MONITORING

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Analysis of the areas of application of data processing systems, in which splines playback algorithms are implemented, allows one to distinguish the following areas:

– medical monitoring;
– economic monitoring;
– technical monitoring;
– geophysical monitoring.

Subsequent analysis will be subject to automated data processing systems that allow solving the problems of operational analysis of data with the use of spline transformations, and implementthemin information technology. Particular attentionwillbepaidtodataprocessingsystemsinmedicalmonitoringsystems, inparticularmonitoringofparametersofthecardiovascularsystemfor a person.

Mostly, spline transformations are implemented in regression analysis tasks in the form of independently functioning programs or special purpose libraries. Such software is of interest for solving problems of approximation of functions given tabularly. For a wider range of tasks, application complexes and application software packages are used. Preferably, all packages have, in addition to the computational schemes of general purpose spline transformations, and their modifications, developed by the authors.

A large number of software tools have been developed for solving problems of probabilistic-statistical analysis. Pristavka A.F.[1] work gives them the following classification:

– independently functioning programs;
– program libraries;
– statistical compilers;
– multifunctional programs;
– problem-oriented systems.

In the theory of automation of the data processing process, the development and study of their mathematical support play an important role. The development of the fundamentals of this theory and the creation of really operating systems is given a lot of attention in the world. In this scientific direction, the most interesting results at different times were obtained in the works of famous scientists academiciansV.M. Glushkov and A.P.Eershov. The most common is the application packet method.

An analysis of modern automated data processing systems allows us to distinguish structural features that should have a statistical software product, namely [2]:

- modularity of the software;
- functional scalability of a product using a well-known procedural programming language;
- the presence of a comfortableanddevelopeduserinterface;
- using a simple problem-oriented language to formulate a user's task or other mechanism;
- compatibility with other software.

The stochastic process was investigated in this work:

$$\gamma(\alpha) = \big(t(\alpha), x(t), y(t), z(t)\big), \qquad (1)$$

which is represented as an array of observations:

$$\Omega_{4,N} = \{(t_i, x_i, y_i, z_i); i = \overline{1, N}\} \qquad (2)$$

The formula (2) is a parametriccurvewhere:

t_i - moments of the time of the measurement of blood pressure and pulse; x_i, y_i, z_i .

The problem of using data from monitoring results is often the absence of scientifically-based norms, relatively small number of measurements and gaps in measurements. Therefore, for the furtheruse and operation of the monitoring data, the problem offilling the gaps and data smoothingis requiredt obesolved, and there foreitisnecessaryto find a nonparametric estimation ofthecurve - the function of monitoring the process of changing the parameters of arterial pressure of patients.

In this work we present the method of estimating the multidimensional observation function in time, which is based on the use of polynomial splines explicitly on the basis of B-splines, close to interpolation on average, on a grid with a constant step. The choice of this approach is due to simplicity and high computational efficiency and smoothing properties.

This method is as follows. Let Δ_h^k be a time-division of the time axis with $t_i = i * h, (i \in Z)$, if *k* is odd and$t_{i+0,5} = (i + 0,5) * h, (i \in Z)$ if *k* is even. Consequently, in other words, the implementation of a random process is fixed at equal intervals of time.

In this work we also solve the approximation of the curves $\gamma(\alpha)$, which depends on one or two parameters, and it is executed with the help of B-splines under a similar scheme. So the curves were studied:

$$\gamma(\alpha) = (t(\alpha), x(t)), \tag{3}$$

their implementation is an array:

$$\Omega_{2,N} = \{(t_i, x_i); i = \overline{1,N}\} \tag{4}$$

where x_i is the significance of the change in blood pressure in time.

Approximation of this one-parameter curve for values of arterial pressure using local polynomial splines $S_{2,2}(p, y)$ is presented in fig. 1.

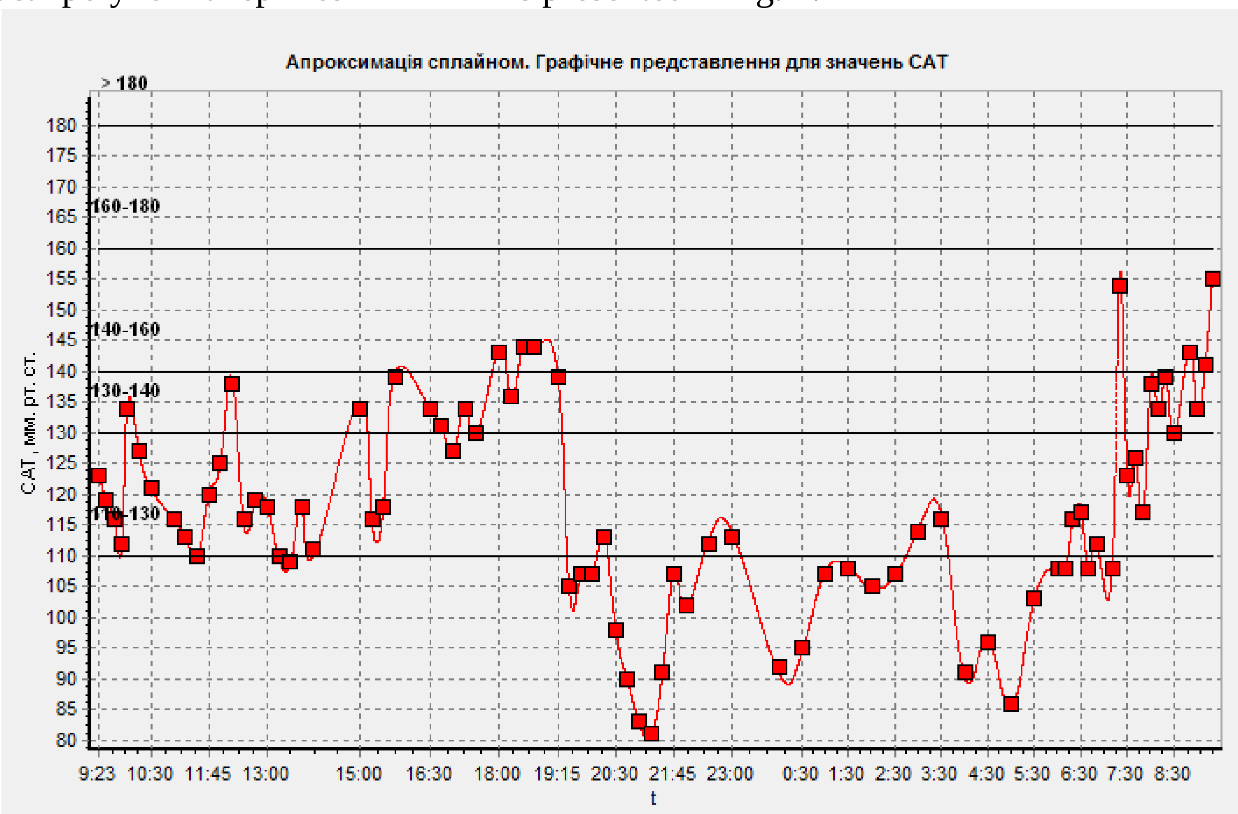

Fig. 1. Approximation of one-parameter curve for values of arterial pressure using local polynomial splines

The finding of probability data is based on the constructionoftheMarkovgraph, whichwaspresentedearlier. Consider the computational scheme for finding probabilities for a one-dimensional case on an example of monitoring data for blood pressure values.

Construction of a one-dimensional model. Let the graph of the functioning of the system look like it is shown in fig. 2

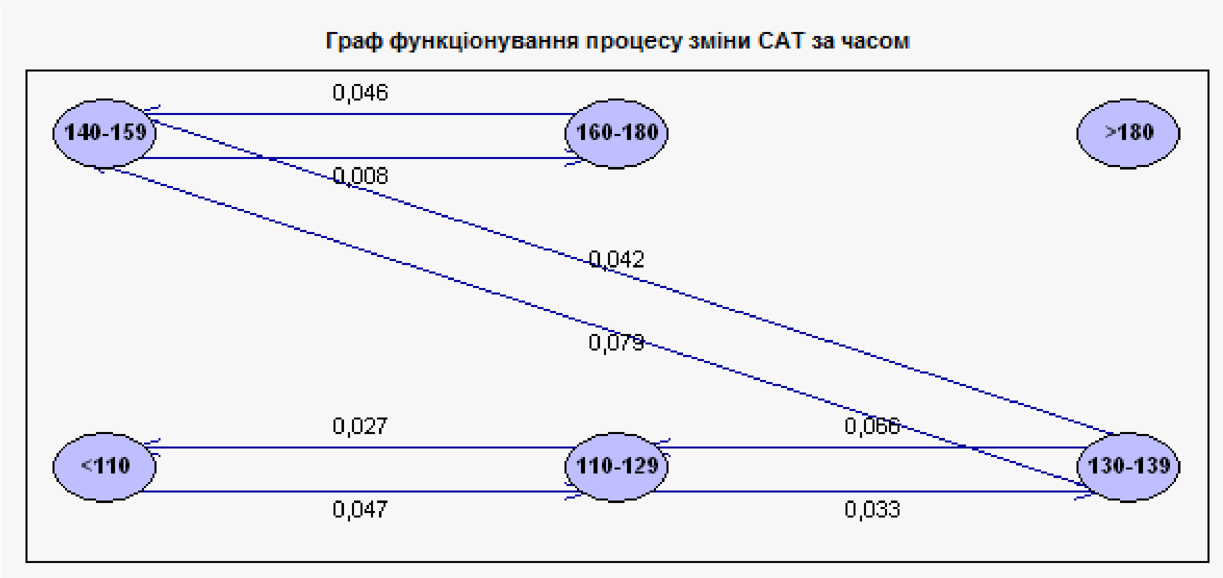

Fig. 2. The graph of the functioning of indicators of blood pressure regulation

We introduce events $A_0, \ldots, A_5$, that characterize the probability of finding a system in the states 0, 1, ..., 5, respectively:

A_{00} - at time t_0 the system was in the state 0 and, through a time interval, Δt it remained in the same state;

A_{01} - at the time t_0 the system was in the state 0 and, through the time interval Δt , went to 1;

...

A_{55} - at the time t_0 the system was in state 5 and, through the interval Δt , it remained in the same state;

and:

$$A_0 = \bigcup_{i=0}^{5} A_{i0}, \qquad A_1 = \bigcup_{i=0}^{5} A_{i1}, \ldots, \qquad A_5 = \bigcup_{i=0}^{5} A_{i5}$$

characterizes finding in the proper state.

Note that the state DAP value 0 corresponds to <110 mm. mercury column;

1 corresponds to the value ofAP 110-129 mm. mercury column;

2 corresponds to the value ofAP 130-139 mm. mercury column;

3 corresponds to the value ofAP 140-159 mm. mercury column;

4 corresponds to the value ofAP 160-180 mm. mercury column;

5 corresponds to the value ofAP>180mm. mercury column.

Accordingtoresearchresults, a programwasdevelopedthatallows us:

The structure of the software in the language UML using theUse Case Diagram is shown in fig. 3

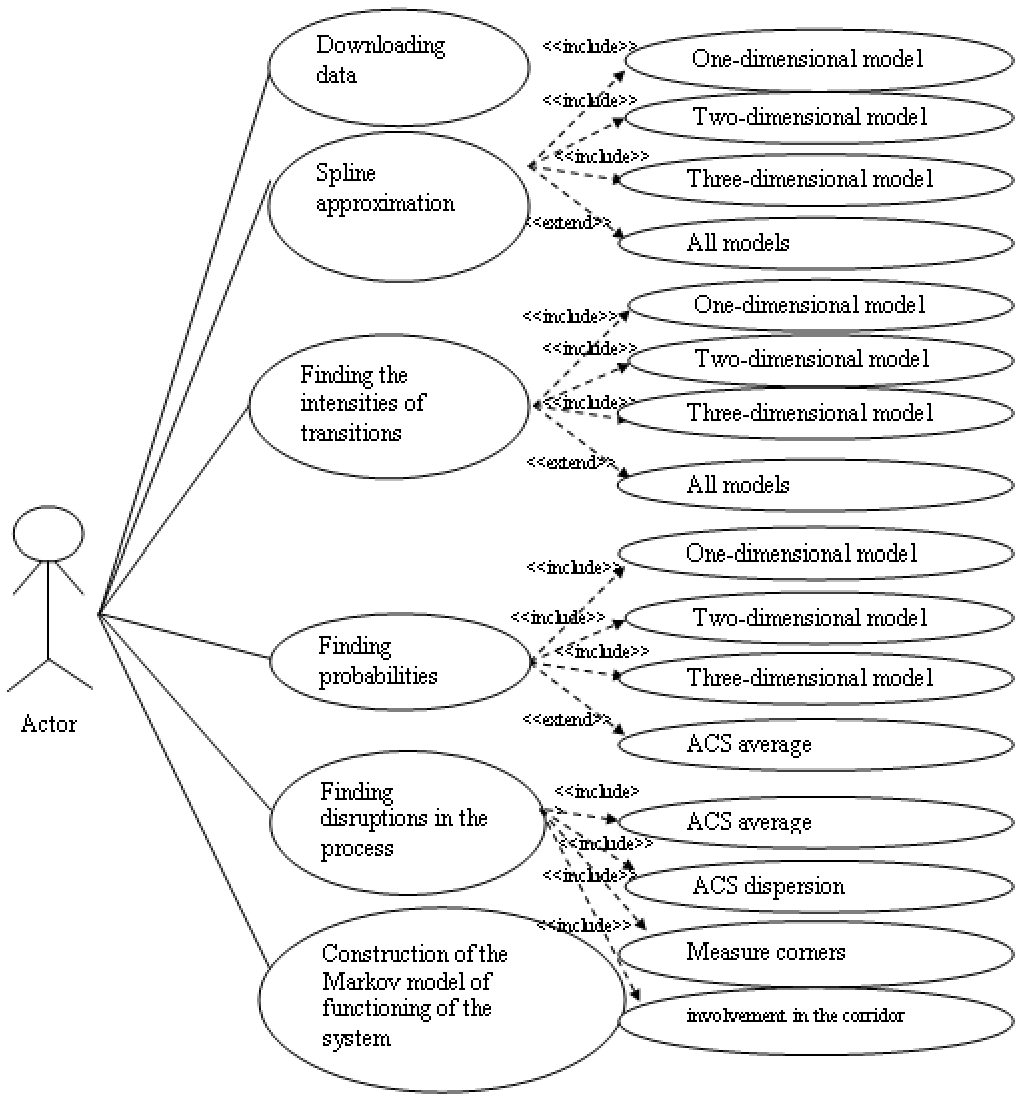

Fig. 3.UseCase-diagram of“MonitorModeling” software

As a result, we created asoftwareenvironment "MonitorModeling" inwhichthe computational schemes and methods were implemented:

1. Construction of one-dimensional Markov model of the system of regulation of blood pressure. This model takes into account each of the studied parameters separately and makes it possible to significantly simplify the processes of diagnosis in various forms of arterial hypertension.

2. Testing the work of the developed software was conducted on the monitoring data provided by the Ukrainian Research Institute of Medical and Social Disabilities. During the analysis for one of the patients with the help of the proposed computational schemes, it was found necessary to change the dose of the drug and the nature of the treatment.

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