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CALCULATION METHOD OF THE GENERATION OF THE REALIZATIONS OF VECTOR RANDOM SEQUENCES

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Calculation method of the generation of the realizations of random sequences is introduced. Canonical expansion of vector random sequence is assumed as the basis of technology. As distinct from existing methods introduced information technology allows to take into consideration non-linear stochastic relations and doesn't impose any significant limitations on the qualities of random sequence (scalarity, Markovian property, monotony, stationarity etc.). Calculation method can be used for wide area of applied problems connected with modelling of different stochastic parameters.

Запропоновано обчислювальний метод генерації реалізацій випадкових послідовностей. В основу методу покладено канонічний розклад векторної випадкової послідовності. На відміну від існуючих методів, запропнонований обчислювальний метод дозволяє враховувати нелінійні стохастичні звязки і не накладає жодних істотних обмежень на властивості випадкової послідовності (скалярність, марковість, монотонність, стаціонарність і т.д.). Обчислювальний метод може бути використаний для широкої області прикладних задач, пов'язаних з моделюванням різних стохастичних параметрів.

Introduction. As it is known generators of the realizations of random sequences are used widely in different spheres of science and technology in particular for: modelling of difficult physical phenomena [1]; imitation of different regimes of functioning of dispersed computer systems [2]; systems of energy and water supply with the purpose of study of their characteristics and capabilities [3]; generations of request flows and failure flows in the systems of mass service [4]; mathematical modelling of radio technical systems [5] during the forming of the signals and hindrances with required stochastic qualities etc.

Method of conditional distribution and Neumann's method [6] are the most general methods of modelling of random sequences with random density of distribution. But these methods are practically not used for great number of points of discretization in view of the complexity of the solution of the problem of estimation of the density of multidimensional distribution of high dimensionality according to statistical data. Specific limitations (stationarity, Markovian property, scalarity, linearity etc.) are as a rule imposed on the properties of random sequence during the forming of the realizable in practice algorithms of the generation of realizations of random sequences that considerably restricts the accuracy of the solution of the problem of modelling of random sequence with the most general stochastic characteristics. Therefore, the problem of obtaining of information technology of the generation of the realizations of random sequence with non-linear relations for random quantity of points of discretization is topical.

Problem Statement. Vector random sequence $\left\{\bar{X}\right\} = X_h\left(i\right),\ \mathrm{i}=\overline{1,I},\ h=\overline{1,H}$ in the investigated range of points $t_i,\ i=\overline{1,I}$ is completely determined by discretized moment functions $M\left[X_l^{\nu}\left(i\right)X_h^{\mu}\left(j\right)\right],\ \ i,j=\overline{1,I};\ \ l,h=\overline{1,H};\ \ \nu,\mu=\overline{1,N}$ which are calculated by known formulae of mathematical statistics on the basis of the results of preliminary experimental investigations. It is necessary to work out information technology of the generation of realizations of a random sequence with specified stochastic qualities.

Solution. The most universal model of a random sequence is a canonical expansion [7-9]. But assumption about the presence of only linear stochastic relations is essential deficiency of existing canonical representations [7,8] of vector sequences. Therefore, informational technologies on the basis of known models have restricted accuracy characteristics. For removal of stated deficiency let's introduce into consideration the array of random values.

$$\begin{vmatrix} X_1(1) & X_1(2) & \ldots & X_1(I) \\ \ldots & \ldots & \ldots & \ldots \\ X_1^N(1) & X_1^N(2) & \ldots & X_1^N(I) \\ \ldots & \ldots & \ldots & \ldots \\ X_H(1) & X_H(2) & \ldots & X_H(I) \\ \ldots & \ldots & \ldots & \ldots \\ X_H^N(1) & X_H^N(2) & \ldots & X_H^N(I) \end{vmatrix}.$$

Correlated moments of the elements of the array completely describe the probabilistic relations of a modelled vector random sequence in the investigated range of points $t_i, i=\overline{1,I}$ that's why the application of a vector linear canonical expansion to the lines $X_h(i),\ i=\overline{1,I}; h=\overline{1,H}$ allows to obtain canonical expansion with a complete taking into account of a priori information for each component:

$$X_h\left(i\right)=M\left[X_h\left(i\right)\right]+\sum_{\nu=1}^{i-1}\sum_{l=1}^{H}\sum_{\lambda=1}^{N}W_{\nu l}^{(\lambda)}\beta_{l\lambda}^{(h,1)}\left(\nu,i\right)+ \tag{1}$$

$$+\sum_{l=1}^{h-1}\sum_{\lambda=1}^{N}W_{il}^{(\lambda)}\beta_{l\lambda}^{(h,1)}\left(i,i\right)+W_{ih}^{(1)},\ i=\overline{1,I},$$

$$W_{\nu l}^{(\lambda)}=X_l^{\lambda}\left(\nu\right)-M\left[X_l^{\lambda}\left(\nu\right)\right]- \tag{2}$$

$$-\sum_{\mu=1}^{\nu-1}\sum_{m=1}^{H}\sum_{j=1}^{N}W_{\mu m}^{(j)}\beta_{mj}^{(l,\lambda)}\left(\mu,\nu\right)-\sum_{m=1}^{l-1}\sum_{j=1}^{N}W_{\nu m}^{(j)}\beta_{mj}^{(l,\lambda)}\left(\nu,\nu\right)-$$

$$\sum_{j=1}^{\lambda-1}W_{\nu l}^{(j)}\beta_{lj}^{(l,\lambda)}\left(\nu,\nu\right),\ \nu=\overline{1,I};$$

$$D_{l,\lambda}(\nu)=M\left[\left\{W_{\nu l}^{(\lambda)}\right\}^2\right]M\left[X_l^{2\lambda}\left(\nu\right)\right]-M^2\left[X_l^{\lambda}\left(\nu\right)\right]- \tag{3}$$

$$-\sum_{\mu=1}^{\nu-1}\sum_{m=1}^{H}\sum_{j=1}^{N}D_{mj}\left(\mu\right)\left\{\beta_{mj}^{(l,\lambda)}\left(\mu,\nu\right)\right\}^2-$$

$$-\sum_{m=1}^{l-1}\sum_{j=1}^{N}D_{mj}\left(\nu\right)\left\{\beta_{mj}^{(l,\lambda)}\left(\nu,\nu\right)\right\}^2-\sum_{j=1}^{\lambda-1}D_{lj}\left(\nu\right)\left\{\beta_{lj}^{(l,\lambda)}\left(\nu,\nu\right)\right\}^2;$$

$$\beta_{l\lambda}^{(h,s)}\left(\nu,i\right)=\frac{M\left[W_{\nu l}^{(\lambda)}\left(X_h^s\left(i\right)-M[X_h^s\left(i\right)]\right)\right]}{M\left[\left\{W_{\nu l}^{(\lambda)}\right\}^2\right]}= \tag{4}$$

$$=\frac{1}{D_{l\lambda}(\nu)}(M\left[X_l^{\lambda}\left(\nu\right)X_h^s\left(i\right)\right]-M\left[X_l^{\lambda}\left(\nu\right)\right]M\left[X_h^s\left(i\right)\right]-$$

$$-\sum_{\mu=1}^{\nu-1}\sum_{m=1}^{H}\sum_{j=1}^{N}D_{mj}(\mu)\beta_{mj}^{(l,\lambda)}\left(\mu,\nu\right)\beta_{mj}^{(h,s)}\left(\mu,i\right)-$$

$$-\sum_{m=1}^{l-1}\sum_{j=1}^{N}D_{mj}(\nu)\beta_{mj}^{(l,\lambda)}\left(\nu,\nu\right)\beta_{mj}^{(h,s)}\left(\nu,i\right)-$$

$$-\sum_{j=1}^{\lambda-1}D_{lj}(\nu)\beta_{lj}^{(l,\lambda)}\left(\nu,\nu\right)\beta_{lj}^{(h,s)}\left(\nu,i\right),\ \lambda=\overline{1,h},\ \nu=\overline{1,i}.$$

Random sequence $X_h(i), i=\overline{1,I}; h=\overline{1,H}$ is represented with the help of $H \times N$ arrays $\{W_l^{(\lambda)}\}$, $\lambda=\overline{1,N}$; $l=\overline{1,H}$ uncorrelated centered random coefficients $W_{\nu l}^{(\lambda)}$, $\nu=\overline{1,I}$. Each of these coefficients contains information about the corresponding values $X_l^{(\lambda)}(\nu)$ and coordinate functions $\beta_{l\lambda}^{(h,s)}(\nu,i)$ describe probabilistic relations of the order $\lambda+s$ between the components $X_l(\nu)$ and $X_h(i)$ in the sections t_ν and t_i.

Calculation method of the generation of the realizations of a vector random sequence on the basis of the model (1) consists of the following stages:

- accumulation of the realizations of the investigated random sequence;
- calculation of the discretized moment functions $M\left[X_l^\nu(i)X_h^\mu(j)\right]$, $i,j=\overline{1,I}$; $l,h=\overline{1,H}$; $\nu,\mu=\overline{1,N}$ on the basis of statistical information;
- forming of a canonical expansion (1) with the use of moment functions;
- estimation of the densities of distribution of the coefficients $W_{\nu l}^{(1)}$, $\nu=\overline{1,I}$ of a canonical expansion (1);
- generation of the values of the coefficients $W_{\nu l}^{(1)}$, $\nu=\overline{1,I}$ with a required law of distribution with further transformation of these values with the help of a canonical expansion (1) into the realization of random sequence.

Conclusion. Obtained model and worked out on its basis calculation method of the generation of the realizations of random sequences don't impose any significant limitations on the class of modelled random sequences (linearity, Markovian property, stationarity, monotony, scalarity etc.). The only restriction is finiteness of the moments $M\left[X_j^\lambda(\nu)\right]$ in the points of discretization that as a rule is fulfilled for actual random sequences.

REFERENCES

1. R.Y. Rubinstein, Simulation and the Monte Carlo Method. New York, John Wiley & Sons, 2007, - 317 p.

2. I.N. Alyanah, Modeling of Computer Systems. Leningrad, Mechanical Engineering, 1988, - 233 p.
3. A.V. Lykin, Mathematical modeling of electrical systems and their components. – Novosibirsk, NGTU, 2009, - 228 p.
4. E.S.Ventzel, Probability theory and its engineering applications. Moscow, Science, 1998, - 480 p.
5. V.D. Kudritsky, Predictive control of radioelectronic devices. Kiev, Technics, 1982, - 168 p.
6. A.V. Buslenko, Modeling of Complex Systems. Moscow, Nauka, 1978, 400 p.
7. V.S. Pugachev, The theory of random functions and its application. Moscow, Physmatgis, 1962, - 720 p.
8. V.D. Kudritsky, Filtering, extrapolation and recognition realizations of random functions. Kiev, FADA, LTD, 2001, - 176 p.
9. I.P. Atamanyuk, V.Y. Kondratenko and O.V. Kozlov, Kondratenko O.V. “The algorithm of optimal polynomial extrapolation of random processes” // Modeling and Simulation in Engineering, Economics and Management. New–York, Springer, LNBIP 115, 2012. - pp. 78-87.

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АРКИ КРИВОЛІНІЙНОГО КОНТУРУ З ЛИСТОВОЇ ПРОСТОРОВОЇ РЕШІТКИ

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В роботі пропонується при допомозі методу відкритої типізації виготовлення легких металевих арок сільськогосподарських споруд з листової просторової решітки. Таке конструктивне рішення приводить до підвищення жорсткості конструкції та до зниження металоємності.

В работе предложено при помощи метода открытой типизации изготовление лёгких арок сельскохозяйственных сооружений из листовой пространственной заготовки. Такое конструктивное решение приводит к повышению жесткости конструкции и снижению металлоемкости.