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S.К. Meshaninov

ESTIMATION OF RELIABILITY OF FUNCTIONING OF THE CONTROL-TESTING ELECTRONIC SYSTEMS WITH THE USE OF TASK ABOUT A MAXIMUM OF PRODUCT

Наведені результати аналітичних досліджень оцінки надійності і ефективності використання контролююче-керуючої електронної апаратури як складної технічної еволюціонуючої системи із застосуванням завдання про максимум множини. Дана класифікація чинників, які визначають ефективність електронного апаратного функціонування в різних врегулюваннях.

Ключові слова: Надійність, ефективність, електронна апаратура, контролююче-керуюча електронна система, еволюція.

Introduction. The modern control-testing electronic systems (ES) of any type it is expedient to estimate with the use of task about a maximum of product. In accordance with work [1], a task about a maximum of product is formulated as follows: it is necessary to find N non-negative numbers the sum of which does not excel the set number $a>0$ and which have maximal work here.

Raising of task of researches. For ES, as one of the most technologically loaded managing elements of modern production this task can be formulated as follows:

Let: $0 < a \le 1$ – total probability of accident-free work; $P_1 \cdot P_2 \cdot .... \cdot P_n$ – work faultless probabilities of work of ES subsystems ; n – number of ES subsystems.

Then the condition must be executed:

$$\begin{cases} 0 < \sum\limits_{i=1}^{n} P_i \le 1 \\ \prod\limits_{i=1}^{n} P_i \to \max \end{cases}. \qquad (1)$$

Values $\sum_{i=1}^{n} P_i$ и $\prod_{i=1}^{n} P_i$ are phase coordinates, and aggregate of sizes $P_1 \cdot P_2 \cdot .... \cdot P_n$ – managing parameters.

If a condition (1) is executed, then betweenness by reliability and efficiency of functioning of ES optimally.

Thus, the purpose of the real work is research of possibilities of the use of task about a maximum of product as it applies to an estimation and calculation of reliability of functioning of control-testing electronic systems.

Basic part. For the optimal mode of functioning ES must be executed next terms:

$$\begin{cases} P_{i\,pos} \le P_i(t) \le 1 - P_i(t-1), \\ P_i(t) \in \left[P_{i\,pos}; 1\right] = \Omega \end{cases} \tag{2}$$

where Ω – management area.

If at every instant correlation (2) is executed, then a management is considered possible.

The change of level of reliability of functioning of ES it is expedient to examine as an additive casual process of change of probability of faultless work:

$$P(t) = P'(t) + P''(t), \tag{3}$$

where $P'(t)$ – stationary constituent of probability the faultless work; $P''(t)$ – stocastic constituent of probability the faultless work.

Any supervisory-managing ES is the difficult technical system, which can be conditionally divided on n subsystems functioning of which takes place simultaneously, thus they are united consistently.

We will consider that time t the discrete great number of values can accept only: $t = 0;\ 1,\ ...,N$, thus N – time of continuous (faultless) work of ES.

Then a management can be expressed by means of next correlation:

$$\{P_1(t),\ P_2(t),...,\ P_n(t)\}. \tag{4}$$

At every instant t the state of ES is characterized n by phase coordinates: $x_1, x_2, ..., x_n$, id est by a point X of spase E^n. Thus, every moment of time t is the phase state $X(t)$ have n coordinates.

Thus, in each time t the state of each of subsystems of cleansing coalface is characterized accordingly by sets l,k,m,q ... coordinates (parameters).

Then, finally, for any moment of time the phase states of subsystems of ES can be analytically described as follows:

$$P_1(t)=f_1\{a(t)\}=\{a_1(t),a_2(t),...a_l(t)\};$$
$$P_n(t)=f_n\{d(t)\}=\{d_n(t),d_n(t),...,d_n(t)\}, \qquad (5)$$

where $f_1,....,f_n$ – some functions; $a_i(t),....,d_i(t)$ – functions of change of parameters of the state of subsystems of ES .

For each of subsystems of ES there is a sequence: $\{a(0),a(1),...,a(t),...;b(0), b(1),...b(t),...;c(0),c(1),...c(t),...;d(0),d(1),...,d(t),...;\}$ it is the trajectory of her evolution.

Initial state $\{a(0);b(0);c(0);d(0)\}$ it must be set. It is the state of ES to beginning her functioning after handing over in exploitation.

Expression (5) taking into account a condition (1) can be rewritten in another kind:

$$\begin{cases} 0 < P_1(t)=\{a(t)\}=f_1\{a_1(t),a_2(t),....,a_l(t)\}\le 1, \\ 0<P_2(t)=\{b(t)\}=f_2\{b_1(t),b_2(t),....,b_k(t)\}\le 1, \\ \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots \\ 0<P_n(t)=\{d(t)\}=f_n\{d_1(t),d_2(t),....,d_q(t)\}\le 1. \end{cases} \qquad (6)$$

Further development (evolution) of control-testing ES is simply certain, if there is a management $P_1(t),...,P_n(t)$, set by means of correlations:

$$P_1(t)=f_{1t}[P_1(t-1),P_1(t)];\ P_2(t)=f_{2t}[P_2(t-1),P_2(t)];$$
$$P_n(t)=f_{nt}[P_n(t-1),P_n(t)].$$

$$J=\sum_{i=1}^{n}P_i(t), \qquad (7)$$

where f_{it} – vector-function

Thus, the task of optimal management reliability of functioning of ES consists in that, knowing his initial state $\{P_1(0),P_2(0),..., P_n(0)\}$, to choose such possible management $\{P_1(t),P_2(t),...,P_n(t)\}$, which will give a maximal value to the functional (7).

More correctly, correlation (7) has a next kind:

$$\begin{cases} J_1 = \sum_{i=1}^{l} a_i(t), \\ J_2 = \sum_{j=1}^{k} b_j(t), \\ \dots\dots\dots\dots \\ J_n = \sum_{h=1}^{q} d_h(t). \end{cases} \quad (8)$$

We will consider a stationary process which, using work [2], which will break up on $n = \frac{t}{\Delta t}$ intervals, where t duration of process; Δt – duration of interval.

We will designate P_1 – probability not exceeding of level x a process for time Δt. Then it is possible to write down next close expression: $P_x(t) \approx P_1^n$.

For the estimation of probability P_1 we use an estimation [3]:

$$P_x(t) \geq P_0 - N_x(t), \text{ при } t \leq P_0[N_x(t)]^{-1}, \quad (9)$$

where P_0 – probability not exceeding of the set level in initial moment of time.

$$N_x(t) = \int_0^t n_x(\tau) d\tau, \quad (10)$$

where $n_x(\tau)$ – middle number of extrass in time unit for a level x.

Thus:

$$P_x(t) = (F_x - n_x \Delta t)^{t/\Delta t}, \quad (11)$$

where F_x – function of distribution of size x.

Putting $\Delta t = 1$, we will get:

$$P_x(t) = (F_x - n_x \Delta t)^t. \quad (12)$$

For a stationary process expression (12) can be rewritten in a kind:

$$P_x(t) = \exp[t \ln(F_x - n_x)]. \quad (13)$$

For a transient:

$$P_x(t) = \exp\left\{ \int_0^t \ln[F_x(\tau) - n_x(\tau)] d\tau \right\}. \quad (14)$$

At the ground of these dependences no suppositions were done about the law of distribution of ordinate of process and his duration. Therefore expression (14) can be used for the arbitrary process of any duration, that satisfies to the operating of ES conditions.

Thus, terms (1) and (6) are the terms of optimal betweenness by reliability and efficiency of functioning of control-testing ES.

Conclusions. An analytical way is get mathematical expressions, allowing to choose optimal betweennesss safe and most effective the modes of exploitation of ES.

LITERATURA

1. Potseluev A.V. Statistical analysis and synthesis of the difficult dynamic systems / Potseluev A.B. – M.: Engeneering, 1984. – 208 p.
2. Chervoniy A.A. Reliability of the difficult systems. [issue. 2-nd, processed and add.] / Chervoniy A.A., Lukiyashenko V.I. – M.: Engineer, 1976. – 288 p.
3. Pereverzev E.S. Models of accumulation of damages are in the tasks of longevity / Pereverzev E.S. – К.: Nauk. dumka, 1995. – 360 p.

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