Секція 5. Технології інформаційного менеджменту та інтелектуального опрацювання даних

Analysis of Reliability Parameters for Complicated Information Measurement Systems

Andriy Sydor

Department of Computer-Aided Design, Lviv Polytechnic National University,
12 S. Bandera street, Lviv, UKRAINE, E-mail: sydor@polynet.lviv.ua

A method of analysis of reliability parameters for complicated systems by means of generating functions is developed taking account of aging of the systems output elements. Main reliability parameters of complicated information measurement systems are examined in this paper.

Keywords – information measurement systems, reliability parameters, ageing elements, Weibull distribution, generation function.

I. Introduction

Information measurement systems are sets of functionally related measuring, computing and other auxiliary technical instruments for acquisition of measurement data.

There exist different methods of analysis of reliability parameters for complicated systems [1-2]. But existing traditional methods of reliability evaluation are not able to satisfy requirements of investigations of complicated systems such as complicated information measurement systems.

II.Analysis of Reliability Parameters

Information measurement systems provide means for measurements of individual properties of objects and phenomena in science and industry and for measurements of variables that are used to estimate the state of objects and phenomena. The popularity of information measurement systems is due to the general trend in measuring engineering towards integration in the design of measuring instruments, and on this level these systems are designed as aggregates of individual measuring devices.

Therefore consider a system ramified to level 1 with ageing output elements which lifetime is circumscribed by the Weibull distribution, where a_1 elements of level 1 are subordinate to the element of level 0.

By analogy with [3] we obtain the following generation function of the system:

$$S_1(z) = p_0 \sum_{x_1=0}^{a_1} C_{a_1}^{x_1} p_1^{x_1} q_1^{a_1 - x_1} z^{x_1} + q_0 , \qquad (1)$$

where p_0, q_0, p_1, q_1 are probabilities of trouble-free operation and failure probabilities of elements on levels 0,1 correspondingly, z is an arbitrary parameter.

We use $T_{1W}(x_1)$ to denote the average duration of the system's stay in a state of x_1 operating output elements on condition that lifetime of ageing output elements is circumscribed by the Weibull distribution. Under condition $0<x_1\le a_1$ we obtain the following expression:

$$T_{1W}(x_1) = C_{a_1}^{x_1} \sum_{j_1=0}^{a_1-x_1} C_{a_1-x_1}^{j_1} (-1)^{j_1} \int_0^{\infty} e^{-\lambda_1 (x_1+j_1) t^{\beta_1}} e^{-\lambda_0 t} dt. \qquad (2)$$

The sum of average durations of the system's stay in states over count of output elements from k to a_1 is equal to the average duration of the system's stay in the prescribed availability condition k.

Let $T_{\Gamma 1W}(k)$ be the average duration of the system's stay in the availability condition k provided that lifetime of ageing output elements is circumscribed by the Weibull distribution. We obtain:

$$T_{\Gamma 1W}(k) = \sum_{x_1=k}^{a_1} C_{a_1}^{x_1} \sum_{j_1=0}^{a_1-x_1} C_{a_1-x_1}^{j_1} (-1)^{j_1} \int_0^{\infty} e^{-\lambda_1 (x_1+j_1) t^{\beta_1}} e^{-\lambda_0 t} dt. \qquad (3)$$

Without use of reliability parameters it is impossible to settle a number of problems of systems' design and operation, for example: selection of structure and rational redundancy, organization of inspection monitoring and preventive maintenance. It is necessary to work out methods of reliability prediction with regard for systems' specific features such as possibility of structure rearrangement, preservation of serviceability in case of partial failures at the expense structural redundancy.

Conclusion

Prediction of reliability parameters at stages of design of complicated systems makes possible to evaluate probabilistic and time characteristics of systems, to compare reliabilities of possible variants of systems' structures depending on requirements of production process.

Thus, analytical expressions are worked out for evaluation of two main reliability parameters of complicated information measurement systems:

– the average duration of the system's stay in each of its states;

– the average duration of the system's stay in the availability condition.

References

1. G. Chen, X. Huang, X. Tang, "Reliability analysis of hierarchical systems," in *Proceedings of Annual Reliability and Maintainability Symposium RAMS-2005*, Alexandria, Virginia USA, pp. 146-151, January 24-27, 2005.
2. T. Linquist, L. Bertling, R. Eriksson, "A method of age modeling of power system components based on experiences from the design process with the purpose of maintenance optimization," in *Proceedings of Annual Reliability and Maintainability Symposium RAMS-2005*, Alexandria, Virginia USA, pp.82-88, January 24-27, 2005.
3. A. Sydor, "Evaluation of reliability characteristics for ramified computing systems," in *Proceedings of the Second IEEE International Workshop on Intelligent Data Acquisition and Advanced Computing Systems*, Lviv, Ukraine, pp. 80-83, September 2003.