Automation of Building of Behavior Models of The Non-Markov Discrete-Continuous Stochastic Systems by the Method of Erlang Phases

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Abstract – **The construction of models of behavior of discrete-continuous stochastic systems Non-Markov type by the method of Erlang phases is the object of consideration. This paper shows the principles of improving the technology of building the models of discrete-continuous stochastic systems, that allows you to build automated graph of states and transitions of Non-Markov type systems with using the method of Erlang phases. Improved technology is illustrated by the example of a queuing system.**

Keywords – **reliability, expanded Markov model, Non-Markov system, method of Erlang phases, queuing system.**

INTRODUCTION

Designing radioelectronic equipment, to improve its functional properties and competitiveness, it is necessary to ensure a high level of reliability. Radiolectronic equipment responsible purpose the object of research is, such as information processing and control systems in the objects of the military and space means, measurement systems and control system technological processes in the branch energetics, medical equipment and more. A feature of such systems is that they are usually short-term used, the duration of the usage of systems in operation (non-operation) mode is small. Malfunction or failure of such systems can lead to significant economic losses or environmental disasters.

Another feature, that should be taken into account in the construction of reliable models of such systems is that during loaded mode described systems are strongly influenced by the environment (abrupt change in temperature, pressure, electromagnetic and radiation irradiation, mechanical stress, vibration, etc.). Such influence of the external factors leads to a dramatic aging of the electronics, the intensity of failures of system elements is time-dependent variable quantity. In reliability theory, such systems are called Non-Markov.

VITAL TASK

At the stage of system designing projection the problem of modeling the behavior of described systems is actual. For the construction of reliability models of Non-Markov type systems it is recommended to use the method of Erlang phases (EP) [2-3]. The feature of this method is that it allows the system of Non-Markov type to lead to equivalent Markov by expanding the state space system. Using this method, the processes occurring in the investigated system are described by different from the exponential distribution are approximated by the Erlang distribution or composition of distribution Erlang. The disadvantage of this method is the lack of automated construction of mathematical model equivalent to Markov system as a graph of states and transitions, which greatly complicates the use of EP method in practice.

In this paper is set the goal of developing an automated method of constructing models of behavior of Non-Markov discrete-continuous stochastic systems (DCSS) as a graph of states and transitions, with the using of EP method.

MODIFICATION OF AUTOMATED TECHNOLOGIES OF BUILDING THE MODELS OF DISCRETE-CONTINUOUS STOCHASTIC SYSTEMS

Automatization of Non-Markov behaviors systems construction, using the EP method is the modification of the improved technology of automatizated construction of models of DCSS [1]. That's why it is necessary technology to make several additions, which are related to the construction of verbal and structural-automatic model. Made amendments will make a behavioral system model automated construction in a graph of states and transitions, using the method of EP. Basic principles of usage of the modified technology is presented as a sequence of stages:

Stage 1. Construction of a verbal model. Input data for verbal models of Non-Markov type system construction, except presenting the structure and behavior of these systems, is data about mathematical models of the probability distribution (density distribution f(t), mathematical expectation mc, dispersion σ2) for processes that occur in the studied systems. These usually are the processes of aging equipment, maintenance, receipt and processing of information, the effect of external factors and more.

Stage 2. Construction of structural-automatic model. According to [1] the construction of structural-automatic model is based on verbal model that specifies the input data as a list of basic events and conditions and circumstances under which these events occur. To use the method of EP, namely the automated establishment of additional chain of fictitious states, you must modify the stages of formation of structural-automatic model.

In forming the vector of states of the system for the automatizated usage of a choice of additional components of the vector states EP method must make which determine being of the system in fictitious states. After selecting additional components of the vector states in the set of formal parameters are recorded constants that define the initial values of additional components of the vector states and values of intensities of transitions between fictitious states.

In forming a modifications rules tree to describe the basic events that lead to the emergence of Non-Markov processes in

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the system it is necessary to form subsidiary conditions and circumstances which will describe the process of the stay of the system of fictitious states.

Stage 3. Building a graph of states and transitions. Modified structural automaton model is input data for the software module ASNA, allowing to obtain automatically an advansed Markov model of system. Using software module ASNA allows to get automatically distribution to calculate the probability of staying in the states.

Stage 4. Checking the accuracy of approximation. Based on the probability of the distribution of residence in the state, it is calculated approximate equivalent intensities, which should describe the relevant process (aging, repair, etc.). The comparison of the parameters of the real distribution and calculated parameters of approximating distribution is made.

If the accuracy of the approximation does not meet specific criteria, it is necessary to adjust intensity values of transitions between additional states.

Stage 5. Formation of indexes of the efficiency of the performance researching system. From the resulting distribution of the staying of the system in the states required indicators of the systems efficiency.

EXAMPLE OF USING METHODOLOGY OF AUTOMATED CONSTRUCTION OF BEHAVIOR MODEL OF NON-MARKOV SYSTEMS

The methodology of automated building models of Non-Markov DCSS using EP method is demonstrated by example of the information processing that operates on the principle of queuing system (QS) and single-channel, single-phase and unreliable service E3 | G | 1 | 2 [1].

The researching system works as follows: application, which comes in QS with no queues and the unemployed and working channel service goes to maintenance. If the channel is busy or faulty maintenance and in the queue there is empty space, the application that comes is in but lost in a crowded queue.

Duration of receipt of applications for the considered QS, is distributed by the Erlang distribution of order 3. [3]

of channel load service and the loss of the application.

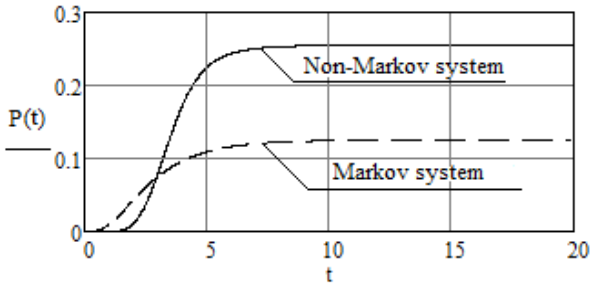

Figure 1. The probability of service of application

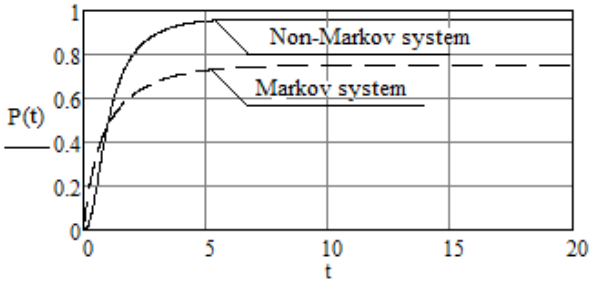

Figure 2. The probability of loss the application

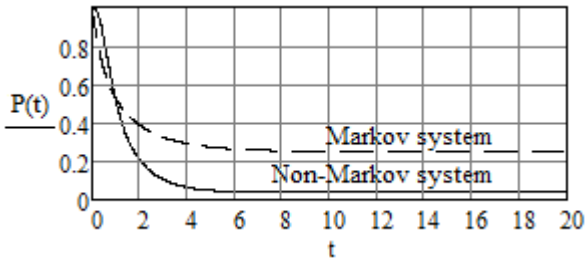

Figure 3. The probability of no application in the channel

Channel service can be faulty, and disability can occur when the channel is free, and when the channel is busy servicing requests. An application that is served at the time of occurrence of malfunction channel comes back into the queue if there is space. If there is not free space, it is lost.

Using the developed model calculate the probability

CONCLUSIONS

The methodology of automated building of the behavior models of systems of Non-Markov type by improving the technology of modeling discrete-continuous stochastic systems. For this reason, modified the construction of the system state vector and tree rules and modifications is made.

It is worked out the technology, unlike the current enables to adequately consider non-exponential distributed processes the receipt and processing of applications, the processes of aging and maintenance, etc.

LITERATURE

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