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DEVELOPMENT OF AUTOMATED SYSTEMS RESEARCH TECHNICAL SYSTEM RELIABILITY

Automated system intended for investigation of engineering systems reliability, oriented on the use of structural reliability schemes is elaborated. The system provides the choice of reliability assessment method, contains the tools for formation and study of structural reliability schemes. Models and software facilities needed for system realization are considered.

Keywords: *automated system, reliability, engineering system, model.*

Introduction

With the development of computer technology, processes of automation cover all spheres of human activity. The process of evaluation the reliability of engineering systems (TS) reliability is time-consuming computational problem [1 – 3], which requires automation resources for its solution. The research program of structural reliability schemes "Hans" [4] allows to calculate the reliability index between two key nodes by gradual convolution of the scheme. Program "Calculation of structural reliability of communication networks" [5] is to design new computer networks, analysis of their quality indexes and modernization of communication network environments. Automated system of reliability and quality of equipment "Asonika" [6] allows to perform complete calculation of reliability indexes of radioelectronic equipment. Since modern computer-aided systems of engineering systems reliability investigation are highly specialized, the problem of development of general methods of reliability evaluation and their implementation in the environment of automated system is very urgent. The aim of research is automation of the process of engineering systems reliability investigation. As the object of the research we imply the processes of reliability evaluation automation based on the use of structural schemes. The subject of the research involve methods and tools for engineering systems reliability evaluation. Main tasks to be solved are elaboration of models and facilities of automated system.

Mathematical description of the system

In general form automated system can be represented in the form of the sequence (1):

$$M = \{A_0, \Theta_p, \Lambda, U, H, Y, \Psi\}, \quad (1)$$

where A_0 – goal: development of models and tools for automation of the process of (ES) reliability evaluation; the system should consist of input / output unit , unit for reliability evaluation applying different methods and unit for database operation; principle of sub-matrixes, method of Boolean matrixes and BIM-method are referred to the methods, realized in the system;

Θ_p – basic resources: the result of the work are models and means of automated system of ES reliability study, their and program implementation; under resource base of the system we imply the computer; under the parameters of resources we imply the computer specifications;

Λ – set of factors that are taken into account in the model: engineering system is presented in the form of graph, factors of data model are assumed to be structure and composition of the system, ways of combining elements of the scheme, the number of vertices, the number of edges and edges weight values that reflect the probabilistic characteristics of reliability, that is why having the constraints $0 < p < 1$, key feature of the system operation is the choice of evaluation strategy according to one of realized methods;

U – set of management strategies: model realizes the process of research according to the chosen method, which is characterized by its algorithm and features of operation. The system has

its own extended functionality. Control can be carried out using the toolbar buttons, tabbed menu bar or hot key. Graphs can be created or downloaded from the database of system information resources;

H – operator of modeling, which establishes the correspondence between the set of factors Λ, which are taken into account in the model, the set U of possible control strategies and the set of Y values of the original characteristics of the system (2):

$$H : \Lambda \times U \xrightarrow{A_0, O_m, R_s} Y , \qquad (2)$$

where O_m – resources at modeling stage, corresponding to basic resources of the system; Rs – properties of the system, being modeled: model of system data presents the data structure in the form of graph, operates objects "edge" and "peak" providing full functionality by creating object "graph" and after completion of the formation of input data selection of reliability evaluation method is performed; Y – set of values of output characteristics of system model: system is designed to study the reliability indexes of ES; initial data are values of trouble-free operation probability – matrix of complete interconnections of system elements for the method of nested matrices and the method of Boolean matrices, for BIM-imprint method initial data are considered to be the value of reliability index between two key nodes in the scheme; W – efficiency index of the system being modeled: characteristic feature of the methods of sub-matrices and Boolean matrices is to ensure the principle of universality by using complete matrix of system interconnections.

Development of precedents model of automated system

Precedents – is the form of representation of typical methods of user system interface. Analysis of precedents becomes of paramount importance in the process of determination of functional requirements to the system. The upper level of abstraction of behavior models of the system is occupied by the model of business precedents (Fig. 1), which identifies the array of system capabilities.

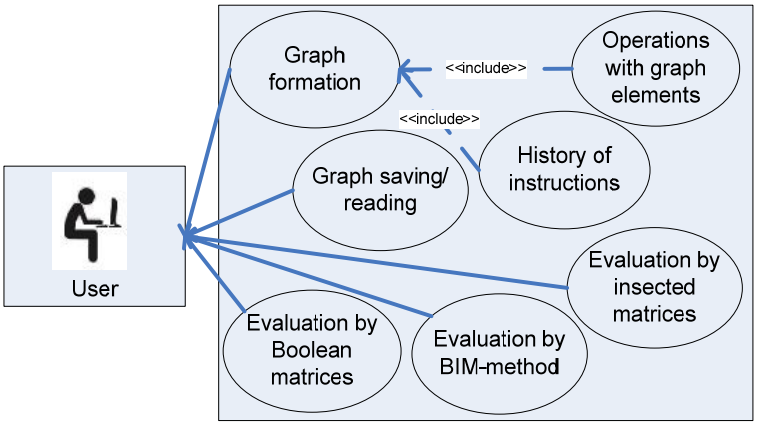

Fig. 1.Diagram of business-precedents of automated system of complex ES reliability study

Diagram of business precedents is based on the architecture of business processes [7]. It provides the possibility of overall analysis of probabilistic behavior of the system. For description of business- precedents brevity of expressions, oriented at determination of functional possibilities of the system and concentration on the main stream of precedents is a characteristic feature. The diagram is formed by setting the interaction between the user and system. Association «include» (Fig. 1) defines the component precedents as the components of the basic precedent, establishing architectural links between precedents. Thus, the user starts the operation in the system aimed at the formation of graph-scheme of ES by means of the user interface (Actions with the elements) and provides the possibility of formation, analysis and use of commands history (Actions with the

history of commands). In addition, User can download the graph from the input file and record in operating graph in selected file (Save / read of the graph). After completion of initial data preparation stage User selects the method of ES reliability evaluation: by the method of sub-matrices, by using Boolean matrices or by BIM-method. The next step in developing an automated system is to create a precedents diagram with greater amount of details (Fig. 2).

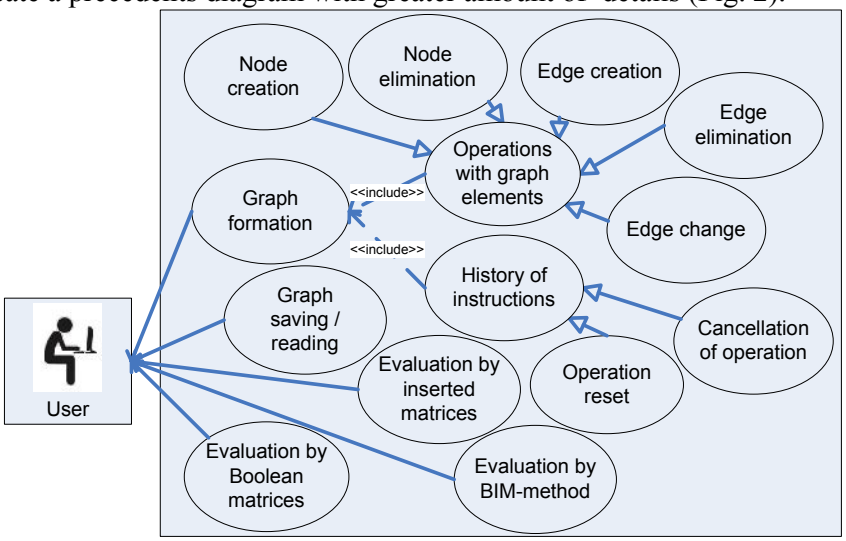

Fig. 2. Diagram of precedents of automated system

Development of generalized model of automated system intended for the study of complex engineering systems reliability

Research of complex ES reliability in the automated system provides the formation of a module of generalized model of the system (Fig. 3), their software implementation and software synchronization.

The generalized model consists of seven units united by the core of the system. Module of graphic input and processing of data is responsible for the formation of a graph structure. The model includes tools for creating and deleting of graph elements, change of weight indicators of graph edges .Module of data graphic output is responsible for the graphic display of complete interactions matrix, obtained in the process of implementing the principle of sub-matrices or method of Boolean matrices [9, 10]. BIM- method provides the output of identified value between the two key vertices of the graph.

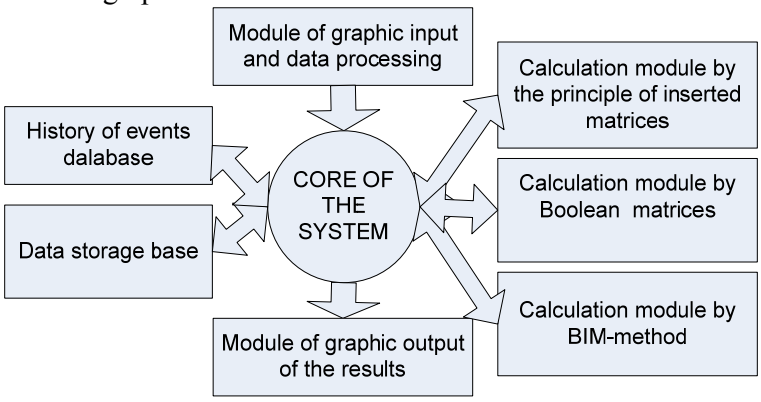

Fig. 3.Generalized model of automated system

Formation of the database of the history of events is to ensure the functional possibility of cancellation of performed operations. Storage base of information data is intended for archiving of

graphic schemes. Calculation unit structurally contains calculation modules of ES complete interactions matrix by selected method of algorithmization: by the principle of sub-matrices, by Boolean matrices, by BIM-method. The core of the system is two-unit structure, shown in Fig. 4.

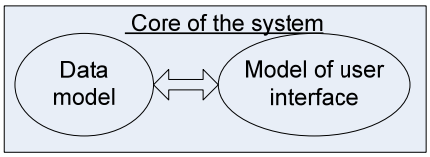

Fig. 4. Structure of the system core

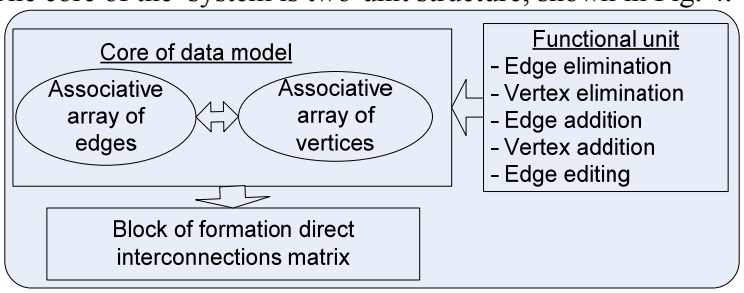

Fig. 5. Mo0del of automated system data

Model of system data (Fig. 5) identifies the means of formation of operating data and provides their formalization by means of graph theory. The main structural unit of the data is the graph, composite elements of which are peaks and edges. Object "graph " may contain an arbitrary number of nodes and edges. Data model is of three –element structure. The core is formed by two associative arrays. Functional unit provides the realization of possible operations over information data. Unit of direct interconnections matrix formation provides calculation process intended for determination of reliability indices by the principle of sub-matrices and by the method of Boolean matrices. Model of interaction with the user provides the realization of interface elements of the system. User Interface – is a set of tools for processing and display of the information, oriented to ensure effective man-machine relationship. The suggested model forms control and display tools for presentation of the intermediate results of reliability study process. Its structure comprises the graphic input module, data processing module and module of graphic output of the results (Fig. 6).

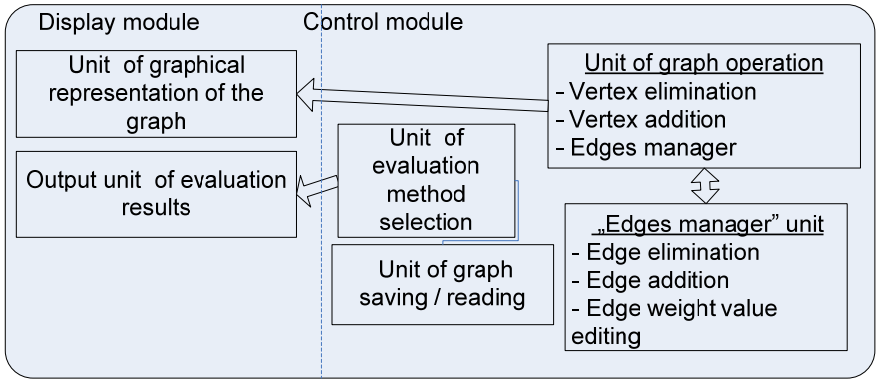

Fig. 6. Model of user-system interface

The model contains two structural modules, responsible for program control processes and graphic information processing. The display module provides formation of graphic field of the system, where the graph of structure diagram is presented, and forms a window of complete interactions matrix.

Software implementation of the automated system

The process of environment modeling of the automated system is completed by the construction of UML-diagrams.

UML (Unified Modeling Language) – is a unified language of object-oriented modeling, used in

the process of software development [7]. UML-diagrams enable to adapt system models for their further program implementation, define a system of interconnections between basic classes of data (Fig. 7).

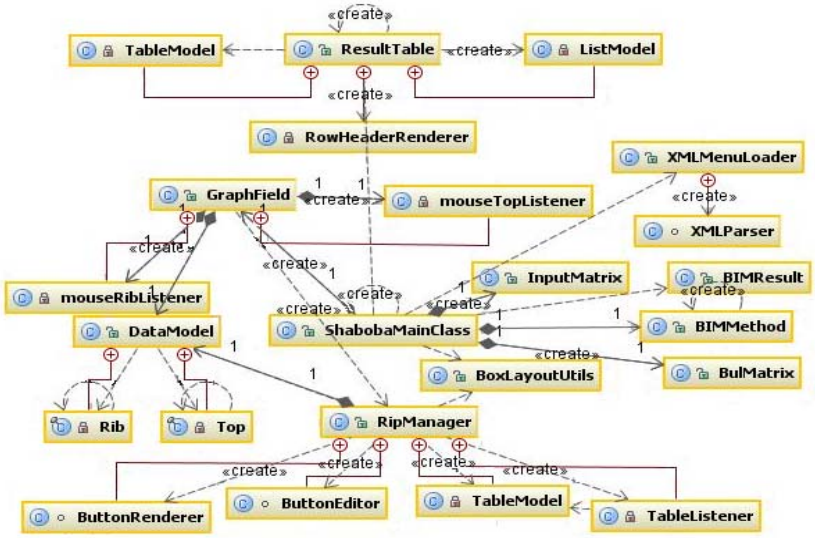

Fig . 7. UML-diagram of system classes

Class diagrams show static (declarative) elements: classes, data types, their content and relations. In addition, UML-diagrams identify system architecture, highlighting nested packages, containing designation of basic elements of behavior, dynamics of which is revealed diagrams of other types [8].

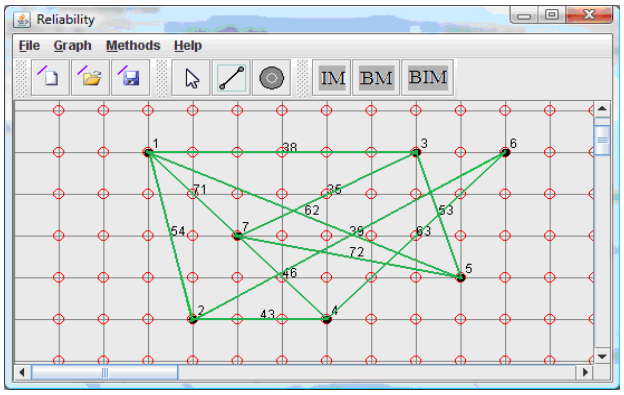

Fig. 8. Form of construction of structural diagram of ES reliability

Software environment of the system is realized in windows mode. The main area of the principle window of the system (Fig. 8) occupies the operation field of formation and representation of the graph of reliability structural diagram. Toolbar buttons provide the implementation of the processes of creating, modifying and saving of the graph, calculation of reliability indexes of the scheme on the basis of the selected method. Presentation of the data in the form of graph introduces specific features in the formation of data model. The model is based on the use of two associative arrays. Each edge and vertex has its identification number, which plays a role of key in databases of the system.

Conclusions

The analysis and development of key aspects of the automated system realizatioin is performed. Models of automated system of reliability indexes study based on reliability block diagrams are suggested. Model of business-precedents of the system is elaborated, which is extended to a simple model of precedents. Internal models of system core are developed: data models and models of system interaction with the user. UML-diagrams of system classes are constructed, which reflect class architecture and internal interclass relations. The suggested models are implemented in the environment of automated system of engineering systems reliability study on the basis structural diagrams.

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