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APPLICATION OF PRINCIPLES OF DESIGNING OF HEURISTIC SYSTEMS OF SUPERVISION IN TECHNOLOGIES OF TECHNICAL DIAGNOSTICS

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The principles of planning of the heuristic supervision systems are expounded and the process of their application in technologies of technical diagnostics is described. It is suggested to use the Heuristic Supervision systems as a basis for designing of process of diagnostics of technical objects.

Наведено принципи проектування евристичних систем спостереження. Описано процес їх застосування в технологіях технічної діагностики. Запропоновано використати евристичні системи спостереження як основу при побудові процесу діагностування технічних об'єктів.

Introduction

Principles of Designing of the heuristic supervision systems (HSS) and their Applications in Technical Diagnostics Technologies.

The presented work focuses on the principles of designing HSS and their applications in technical diagnostics technologies. The authors suggest using the HSS as the basis the for developing the diagnostic processes of technical objects.

The efficiency of diagnostic process is determined by the adequacy of the (used) model and characteristics of the technical devices for determining the object parameters. The basic diagnostic procedure consists of the process of obtaining an adequate model of a diagnosed object and the method of its application.

It's acknowledged that the heuristic monitoring system (HMS) is a tool of information modeling aimed at ensuring monitoring technologies of the surrounding objects [1].

According to D.A. Waterman, monitoring is comparing the results of monitoring the system's behavior with its predicted behavior [2].

Diagnostics of technical objects is an integral par of their monitoring. According to Birger's definition, technical diagnostics is a science of recognizing technical object states [3].

The main aim of technical diagnostics is to investigate object working powers and to predict their subsequent behavior [4].

When diagnosing an object its two states, namely good working order and the defective one are usually recognized and probability of these states' development is determined. An object is a determined device, that is, each of its states has a predetermined list of external displays.

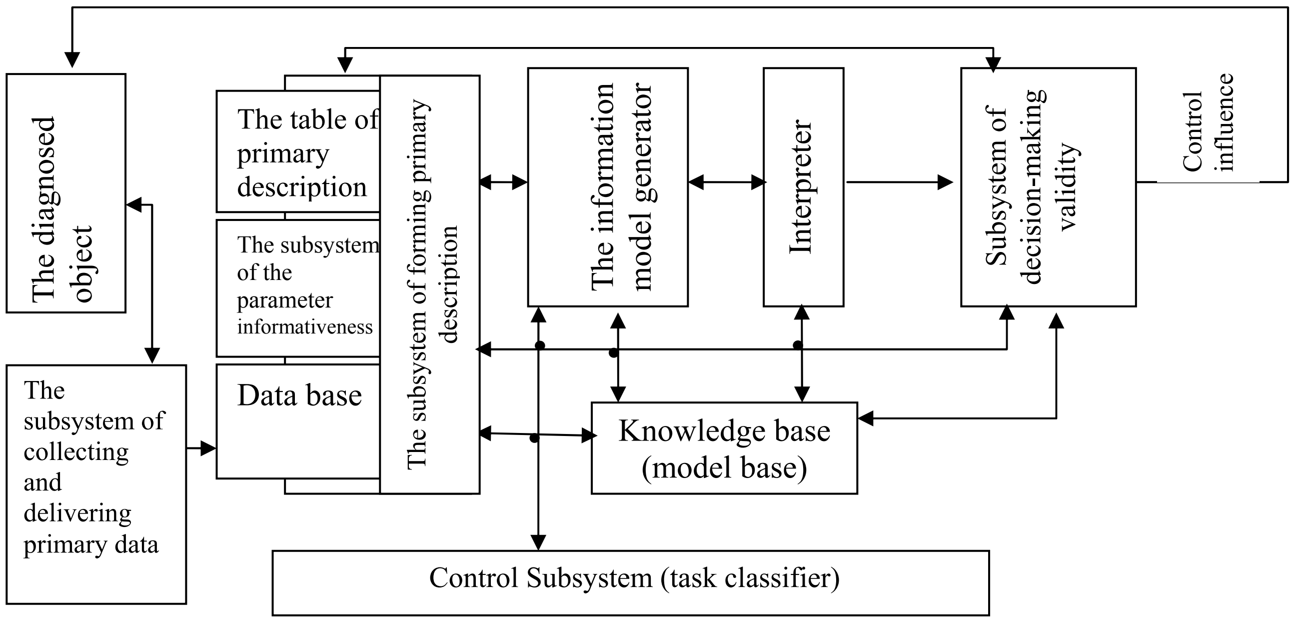
All informative properties of the mechanism details are shown in their interactions (in the processes of their interactions) [4]? V.I. Vasiliev describes a diagnosed object model as a process of transforming information about the states of the object's details into numerical values of diagnostic signal [5].

The vector of states W (w_1, w_2, …w_n) is functionally transformed into the pattern vector (vector of diagnostic signals) X (x_1, x_2,…x_n). When solving technical diagnostic problems the parameters of diagnostic signal are known. As the parameters of states W are unknown they are considered as recognition objects. In this case technical diagnostic problems may be solved according to pattern recognition technologies. The most effective tools used for pattern recognition are neural networks of various topologies and the algorithms of group method of data handling (GMDH).

Modern information systems that ensure the diagnostic process and use its results have various structures and use various modeling tools. Most firms working out such systems design them according to their own principles to satisfy needs of their own activities [6]. These information systems are not in any way related to the works of other firms of the same type. Each firm creates its own system structures, its own technology of interaction with the system, its own methods of input-output and storage of information, its own interface. As a result there exists a great amount of unified software products which demand individual teaching of users, and that in its turn causes a lot of problems when the sphere of practical application of information diagnostic systems is extended. Thus there exists an urgent necessity to develop general principles of designing such systems that could ensure determining the diagnosed object state at any stage on the basis of common monitoring technology and one software product.

The aim of this work is to describe technical object diagnostics technology designed according to the HSS principles [1].

The authors suggest that the diagnostics technology is considered as a type of monitoring in which processes of object state modeling and determining the object state according to this model are used. To ensure this technology it is suggested to use the HMS, the structure of which is presented in figure.



Structure of the HSS

The subsystem of collecting and delivering primary data contains devices and other technical means of obtaining numerical characteristics of the object parameters, methods of their applications and of delivering the obtained data.

The communication between the subsystem of collecting and delivering primary data and the diagnosed object is bidirectional.

As some measurement methods foresee a certain influence on the object the object itself can be measured both directly and indirectly.

The subsystem of forming primary description works as follows. The obtained data are delivered to the data base and accumulated there, the parameter informativeness is determined and the table of primary description is made from the selected informative data.

The information model generator has tools to make the algorithm of designing an information model. It contains the modules that realize multirow and combinatorial algorithms of GMDH, genetic algorithms, the most effective neural networks and several algorithms that realize the authors' ideas. The HSS has knowledge base of the internal format to store the obtained model for subsequent use.

The interpreter ensures the applications of the obtained models.

To find out possibilities of model application its characteristics are determined which, in their turn, are compared to the criteria of applications.

In case the model characteristics satisfy the requirements the interpreter ensures object model applications by automated entering numerical characteristics of the modeling parameters and interpreting modeling results, thus making them clear to a user. Actually correspondence of current technical object state to its planned one is determined. The subsystem of decision making validity is designed for taking into consideration the consequences of possible influences on the diagnosed object on the basis of modeling results. The list of control influences is determined, formed and delivered to the diagnosed object.

The scientific method of system analysis and synthesis was applied to design the HSS. The program complex was defined as a system. The main aim of designing the HSS was to realize the preset modeling technologies by providing this software product with system properties, namely integrity, hierarchism, integrativiness, communicativeness, and others in accordance with a descending designing technology.

Integrity

Connecting separate subsystems into a system makes it possible to realize the modeling technology of object of monitoring, that is to obtain and formalize primary object information according to the preset task, to make a model, to determine its qualitative and quantitative characteristics (adequacy and accuracy), to investigate its properties, to experiment with the model, to calibrate the model (to correct it according to changes of modeling conditions) and apply modeling results. A separate subsystem can't ensure a complete modeling cycle.

Hierarchism

The software product structure is hierarchic. It consists of subsystems of forming primary object description of generating and of applying information models. The subsystems, in their turn, contain modules of lower levels – the components, which realize separate subsystem functions, separate modeling methods etc. The components consist of elements with realize separate operations. The hierarchic levels of the presented system are combined in the way that their functioning and internal system connections allow to achieve the main aim of the system – to ensure the information modeling technology of the diagnosed object.

When constructing the software product the object-oriented programming technology was applied in the C^{++} Builder language. Each element of the information system is a class; each operation is a procedure or a function which "is seen" by other objects, that is, each of them can be initiated from other system objects.

Integrativiness

The components of the subsystem of the information model generating realize antagonistic evolutionary modeling methods, which compete with each other realizing their algorithm advantages while modeling one and the same object. At the same time a separate element that realizes the functions of each method is used to realize the functions of other elements as objects of several classes. For example, an element which realizes the solution of an equation system, normalization of over-determined matrix and other, is used by several algorithms of model generating. Besides, these antagonistic components are connected by using common subsystems of forming primary object description and of applying information models. The possibility to use commonly model library as well as certain modules of a component as a part of another component's algorithm results in obtaining new algorithms of information model generating that are adapted to the state requirements of a certain modeling spheres in general.

Communicativeness

The modeling information system contains means of communication with the environment and other software products. To make the primary object description the data can be entered either by an operator or the subsystem of primary object description or imported from the Excel.

The results of modeling as well as all interim results are exported to the file of the ".mdl" format and to the Excel. If the HSS program complex is not available models in the Excel may be applied foe model experiments. The technology is programmed on the descending designer principle. First the top levels of the hierarchic system, i.e. classes realizing the general system functions, were designed. After that the lower hierarchic levels (components and elements), i.e. classes realizing more specified system functions, attributes, "inherited" by other objects of this class and operations of already designed classes were created.

A system element as a class is basic for all other program classes i.e. it helps to generate any amount of "structurally identical" objects. Though every new object generated with the help of this class has the same set of attributes and operations defined by this class description, it is unique. The uniqueness is ensured by the following factors:

– each object is provided with its unique object identifier (OID) by a special mechanism of object identification. The object has one and the same OID during the whole period of its existence irrespective of what happens to it during this period. Two objects can't have common OID;

– each object is in its unique state that determined by its attributes values.

When designing the HSS the principles of sectioning, basic conversing, compounding, modifying, aggregating, multipurposeness and successive system development were applied.

The sectioning method consists of dividing the system into equal sections and creating any systems by connecting the unified sections. Algorithms that are based on laws of mass selection and self-organization can be easily sectioned. The basic system is built of main subsystems:

– the subsystem of the primary object description;
– the subsystem of information model generating;
– the subsystem of information model applying.

According to the sectioning principle the subsystem 1 and 3 are standard. The subsystem of information model generating contains the set of the GMDH algorithms, genetic algorithms, evolutionary modeling methods, neural networks and a designer of new algorithms. Sections are each of the algorithms of the model generating as a whole or its elements. New algorithms of information model generating are designed by combining separate sections. These new algorithms have new features and are unified according to the standard subsystems of the primary object description and of the model applying.

When the HSS designing the basic aggregate principle that foresees transforming the HSS into systems with different purposes by connecting specialized subsystems to this aggregate was applied in following way. The HSS structure is built by connecting specialized algorithms of information model generating to the basic aggregate which contains the subsystems of the primary object description and of information model applying. The hierarchic monitoring systems with different purposes are created by connecting the basic aggregate of the HMS computer subsystems to specialized subsystems of modeling result interpreting and of decision–making validity.

When applying the conversing principle the basic system or its main elements are used to design information systems of different purposes. These systems are either similar or differ by the working processes. The HMS as an object modeling system is transformed into an expert system (ES), an information system of information coding – decoding, an archive-maker. To achieve this transformation the information model generating subsystem is used as a part of the ES in order to determine the rules of data transformations, to form information conversion keys.

To raise total power or productivity of the system the principle of compounding is applied. The processes of teaching and determining the characteristics of several models of the same selection row that use the resources of several processors simultaneously are used parallel in the HMS. Thus the calculation period is shorter and the system productivity rises.

Modifying is known as transforming the system to adjust it to different working conditions and functions without any change in its structure. The system modifying procedure in the HMS is quite simple.

To change the monitoring objects it is enough to change methods of forming primary description of this object.

Applying of the aggregating principle foresees creating new systems by connecting unified aggregates that are autonomous subsystems. The aggregates are unified according to requirements if compatibility with the basic system. They are connected in various amounts and combinations on the basic system foundation.

The multipurpose principle foresees extending the system functions, the range of its operations. This principle improves system adjustability to the requirements of the modeling process, raises the coefficients of applications in the monitoring technology. Functions extending is performed by:

– introducing additional working elements;
– using external unified elements;
– regulating, for example quantities of models that are transferred to the flouring selection row, determining the quantities of selection rows;
– regulating the main indices, for example, of the system productivity or capacity.

The principle of the successive system development is realized by providing the HMS structure with resources for further development. Using the resources of system development allows it to work according to the advanced requirement of modeling technology. The HMS provides possibilities to connect additional algorithms of information model generating, modeling results achieved by other information systems presented in the Excel format, further using modeling results and HMS models by other information systems for various purposes.

Thus integral principles of designing information systems of diagnostic modeling were suggested.

Conclusions

They were developed to design programming means for object modeling, monitoring of the objects and their functions can ensure realization of technical diagnostics technologies.

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