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MODERN TRENDS IN THE DEVELOPMENT OF THE CONCEPT OF THE SOFT MEASUREMENTS

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Abstract. Progressive and continuous development of technical and information technology bases of various measuring systems has significantly expanded their applications. The use of these tools has led to the possibility of successful solution of the problems of evaluation and control of the properties of complex objects, effective management. In such systems, information systems are implemented based on the measurement approach. This approach involves the principle of uniformity of measurements at each stage of the measurements. The application of the measurement approach covers a wide range of tasks for its use for parametric and structural identification, for classification and image processing, for evaluation of production systems management, product quality assessment, monitoring of ecosystems.

Keywords: fuzzy systems, object-based approach, management and measurement.

Currently, fuzzy logic is a fruitful and rapidly developing direction, making a major contribution to the development of intelligent technologies. Fuzzy logic is increasingly used in expert systems and systems of support and decision-making, cluster analysis, semiotics, image analysis. Fuzzy controllers and intelligent control systems have become widespread.

Modern trends in the development of intelligent systems are directly related to soft computing, that is, the complex development and use of fuzzy mathematics in close integrative connection with neural networks and genetic algorithms. The appearance of the direction of soft measurements contributed to the active involvement of devices theories of optimal solutions, artificial intelligence, fuzzy systems in the modern measuring environment. Efforts are being made to study the various measuring scales. Currently, the concept of "measurement" is used to determine the membership function and the degree of fuzziness of various phenomena and processes.

In turn, soft measurements are undoubtedly useful in the implementation of measuring processes and significantly improve their quality. For systems of soft measurements the sphere of their application considerably extends, the computing power as methods of numerical processing of information are used, there are new opportunities of purposeful regulation, constant estimation of quality of the received analytical decisions.

Progressive and continuous development of technical and information technology bases of various measuring systems has significantly expanded their applications. The use of these tools has led to the possibility of successful solution of the problems of evaluation and control of the properties of complex objects (CO), effective management.

Complex objects include technological processes, production systems and complexes, information transmission networks, material resources (man-made objects), ecosystems, processes and natural phenomena. In such systems, information processes are implemented based on the measurement approach. This approach involves the principle of uniformity of measurements at each stage. In addition, according to this principle, continuous metrological support of the results of the work of complex objects of intermediate and final nature, that is, the actual measurements of certain processes occurring in them.

The modern concept of soft measurements covers a wide range of tasks for parametric and structural identification of objects, for classification and image processing, for evaluation of management of production systems, continuous assessment of product quality, periodic monitoring of ecosystems, for the implementation of environmental management. The solution of such problems takes place against the background of a complex information situation - a priori uncertainty of knowledge about the properties of the object to be controlled, uncertainty of knowledge about the environmental factors affecting the object, the lack of direct observation of them, the presence of inaccuracy and incompleteness of the experimental information. Thus, the methodology of solving such problems becomes fundamental.

Application of classical models and approaches of measurements in the form of numerical value and experimental component or application of method of processing of measuring information without observance of the principle of unity of measurements do the solution of the above problems practically impossible.

Therefore, it is necessary to timely and relevant study of the issue of improving the methodological base of measuring systems in the direction of strengthening the role of the cognitive function of measurements, obtaining results in the form of knowledge-analytical expressions, key conclusions, practical recommendations on the basis of all a priori and continuously incoming information in the process of measuring procedures. Ensuring this requirement attracted to the measuring environment devices of the theory of optimal solutions, artificial intelligence and fuzzy systems. On the basis of the desire to measure the non-quantified properties of various objects, a General theory of measurement was created. Currently, the semantics of different types of measurement scales is used to improve the efficiency of measuring resources.

The integration and interpenetration of different methodologies led to the emergence of the concept of intelligent measurement. In 1994, L. Zadeh introduced the terms "computational intelligence" and "soft computing" into scientific use. He also formulated the main principle of soft computing, which consists in the admissibility of inaccuracy and incompleteness of truth to achieve the ultimate interpretability, flexibility and low cost of a solution. Approximate models, which include methods of fuzzy calculations based on functional approximation, optimization and random search for solutions, are the basis of soft calculations.

When creating systems that work with uncertainty, it is important to understand which of the components of soft measurements or their combination is suitable for solving a particular problem, in this case, it is advisable to use hybrid intelligent systems.

Hybrid intelligent systems are divided into several classes:

a) a hybrid system with a fixed substitution, where one model is used in which one of the elements replaced with another model;

b) hybrid systems with interaction-independent modules that exchange information and perform a variety of functions to obtain a common solution;

C) polymorphic hybrid systems – one model is taken to simulate the functioning of others, reasoning through a chain of rules is modeled, for example, using a neural network.

The methodology of Bayesian intellectual measurements (BII), based on the regularizing Bayesian approach (RBP), was developed in response to the direction of development of the concept of intellectual measurements given by modern science and the challenge of time. RBP is a modification of the Bayesian approach to obtain optimal solutions to these problems under conditions of significant a priori uncertainty with mandatory compliance with the principles of unity of measurements in the process of solution formation.

The concept of BII is a new type of synthesis methodology for the implementation of generalized measurements for the purpose of qualitative solution of the applied problem, based on a comprehensive knowledge of the properties of a complex object and the environment in which it operates. The process of solving an applied problem

based on the BII methodology is a process of purposeful transformation of the hierarchical structure of scales with dynamic constraints (SDOS), which have the ability to adaptively change their structure when accumulating information about a complex object (CO) and its functioning environment, which in turn has the ability to adequately reflect the properties of an evolving complex object. The results of the application of the SDO can be obtained numerical values of various parameters, a certain analytical form of functional dependence or the whole system of analytical dependences that determine the state of a complex object, linguistic values and expressions regarding the properties and States for the CO, recommendations that ensure the stable operation of the CO.

The main principles of BII are:

- integration of information, diverse in form and content, to improve or achieve the required quality of measurement results;
- metrological substantiation of the obtained solutions, which can be presented in the form of quantitative indicators of a posteriori (residual) uncertainty measure;
- implementation of the principle of self-development of models of objects of measurement and environment of their functioning on the basis of adaptation of structures of SHDO to properties of CO which are studied and learned in the course of BII.

The ability to quickly change the method of processing fuzzy knowledge gives the use of modern fuzzy logic. In this logic, reliability is presented as a fuzzy true value – that is, an arbitrary subjective value that makes no statistical sense. Fuzzy logic is a logic that uses as generalized conjunction and disjunction operators a t-norm and a t-conorm satisfying a system of certain axioms.

In turn, in the modern analysis of big data, together with the uncertainty present in them, give rise to the problem of shortage of information resources, which occurs when they are processed. Algebraic Bayesian network (ABN) provides the ability for the solution to this problem. They decompose the database into small, interconnected sets-a kind of fragments of knowledge. Decomposition provides an opportunity to abstract from the structure of knowledge fragments in the situation of work on global structural issues and forms a task of another kind and direction – maintaining the integrity and consistency of ABS. Currently, there is a rejection of rigid schemes of reasoning, which are based on a deductive procedure. Interest from closed formal systems modeling subject areas will be redirected to the study of quasi-axiomatic systems, where a part of axioms will have variable character.

Thanks to the development of the concept of soft measurements, the means of cognitive graphics suggest a new approach to solving problems and their formulation is also developing. The theory of cognitive computing becomes the Central point of development of works in the field of cognitive processes. In turn, the logic of actions in connection with the continued development of robotics will go beyond formal systems into a new field of semiotic modeling and multi-agent systems, which will lead to a deeper development of the mathematical theory of dynamic open systems. Soft computing will continue to develop, that is, the complex development and use of measurement methods that are based on fuzzy logic, neural and genetic calculations implemented in various combinations in hybrid intelligent systems will continue.

The directions of intelligent measurements based on the receipt and use of metrological knowledge in the process of obtaining the result, neural and evolutionary changes that are implemented in various combinations in intelligent measurement systems based on the concept of soft measurements are created and developed. The development of the direction of soft measurements in modern science allows to use all the positive qualities and advantages of this approach: simplicity, processing speed, flexibility of inference logic, a variety of forms of presentation of the results, a variety of complexes of metrological characteristics.

For systems of soft measurements expands the scope of their applications, significantly increasing their quality and capacity, as use of modern methods of numerical processing of information, opportunities for focused regulation, the permanent evaluation of the quality of analytical solutions for practical use.

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