About development of automation control systems

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Abstract. The shortcomings of approaches to the development of modern control automation systems and ways of their improvement are given: the correct formation of objects for study and optimization; a joint synthesis of control objects and control systems, an increase in the structural diversity of the elements of control systems. Diagrams of control systems with purposefully variable structure of their elements are presented. Structures of control algorithms for an object with a purposefully variable structure are given.

1. Introduction

The increase in the indicators efficiency of industrial and social systems is impossible without qualitatively new approaches and methods of automation control. To date, a sufficiently high level of technical means of automation and basic (service) software has been achieved. The development of new directions in automation of control and methods and algorithms acceptable for practical use did not meet the requirements. There are several reasons for this situation and ways to improve automation control systems.

The problem setting and identification of the complete object under study and optimization are the first and most important steps in the problem solving under uncertainty. The greatest difficulty is the correct selection (formation) of a complete object of study and optimization. At this stage, the greatest number of errors is allowed, which, of course, leads to erroneous, including qualitatively, solutions. General principles for the identification of a complete object can serve the principles of system analysis, formulated in [1], where it is stated that the complete object should not be covered by strong external feedbacks. All feedbacks should be included in the object under study.

The examples of incorrect selection of a complete object are:

1) identification of objects in control systems based on the data of normal operation [2];

2) prediction of states and outputs of control objects when using the prediction results for generating control actions [3].

From these positions a revision of approaches to the creation of industrial complexes and training of specialists – engineers are needed. Traditionally, when creating industrial and often social complexes, technological diagrams (processes, units) are first developed, and only then control subsystems. This violates the principles of system analysis and, as a result, the optimal performance of the complex is not achieved. Achievement of the given dynamic properties of the complex is assigned to the control part of the system. Often this is either impossible due to the structure and parameters of

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the control object, or significantly complicates the control subsystem, especially its intellectual component.

2. Directions and approaches to the problem solving

More rational is the path of joint synthesis of the control object and the control subsystem. This requires a rethinking of methods and approaches to design of industrial complexes, development of appropriate methodologies and regulations, and it is also necessary to introduce changes in training and professional development programs for specialists, where the focus would be on the automated production (social) complexes, rather than on production processes (technologies) and control automation subsystems.

One of the promising options for creating efficient industrial complexes can lie in the way of increasing the structural diversity of control objects and control systems.

The developed theory of ***control systems with a variable structure*** presupposes changes in the structure of control system only, depending on the state of the control object and/or external conditions [4, 5]. Theoretical studies with a purposeful change in the structure of control object are only at the initial stage. In practice such systems are encountered very often. Here the following examples can be given: rolling production of a metallurgical enterprise, when the metal rolling route is first formed, that is, the structure of the control object is formed, and then the technological modes of rolling are realized; coal enrichment, when, depending on the properties of coal, technological chains and corresponding technological units are first determined, and then processes of coal enrichment with the possible operative replacement of the initial structure elements are carried out within this structure. Such systems can also include systems of competitive selections (tenders) for performance of research, design and experimental, construction and installation works on creation of industrial and social complexes. From the participants the performers are selected (the structure of the object is formed), the number of which can vary during the course of the project.

3. The generalized diagram of the object control system with a purposeful variable structure

The generalized diagram of the object control system with a purposeful variable structure can be represented in figure 1 [6]. Three types of implementation of this diagram are possible.

1. With the introduction of additional object structures to expand the range of permissible states and the choice of a sequence of structures to meet the specified requirements for control effectiveness.

2. With the current evaluation and analysis of performance indicators of control, the choice of the necessary structure of control object and provision of smooth control modes.

3. With the identification of type representative situations of the control system functioning for each system structure, imitating recalculation, estimation of control effectiveness indicators, selection of the necessary structure of the control object and provision of smooth control modes.

With such implementation of diagrams at the design stage it is necessary to include the option of changing the structure of the object.

4. The algorithm for object control with a purposefully variable structure

The most universal and effective for practice is the third option of the diagram implementation from figure 1 with the identification of type representative situations (TRS) and simulation of all structures of control system. The algorithm for implementation of such diagram is shown in figure 2 [6].

The absence of adequate mathematical models of objects and perturbations acting on them in real conditions makes it necessary to use full-scale mathematical modeling using realizations of full-scale data and special recalculation models in the "small" [7] or small-scale physical models operating in "accelerated" time with observance of similarity conditions of model and full-scale systems

5. Diagram of simulated full-scale mathematical modeling of the object control system with a purposefully variable structure

As an example of simulated full-scale mathematical modeling the diagram in figure 3 can be considered, in which, in addition to the notations of figure 1 the following is added: Z – is the cost of production; Q – performance indicators; indices "M" – model; "FSM" –full-scale model.

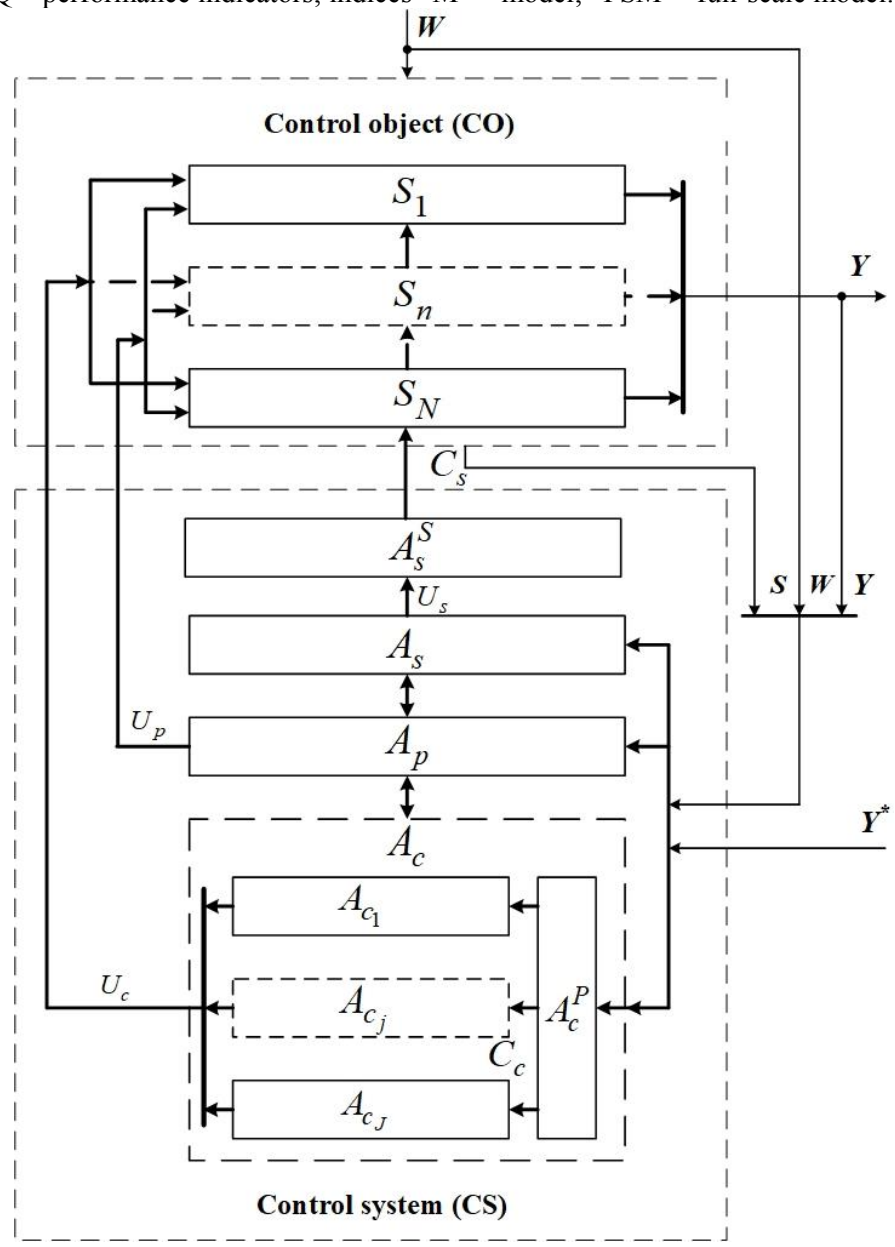

Figure 1. Generalized diagram of the object control system with a purposefully variable structure.

S_n – the *n*-th structure of the CO; $n=\overline{1,N}$; A_s, A_p, A_c – algorithms of structural, parametric and coordinate control; A_{cj} – the *j*-th structure of the coordinate control algorithm A_c, $j=\overline{1,J}$; A_s^S, A_c^P – algorithms for switching the CO structure of and the algorithm A_c; C_s, C_c – control commands to switch structures; *W* and *Y*, *S* – vectors of external and output actions, states of the object; Y^* – task on *Y*, targets, constraints; U_s, U_p, U_c – structural, parametric and coordinate control actions.

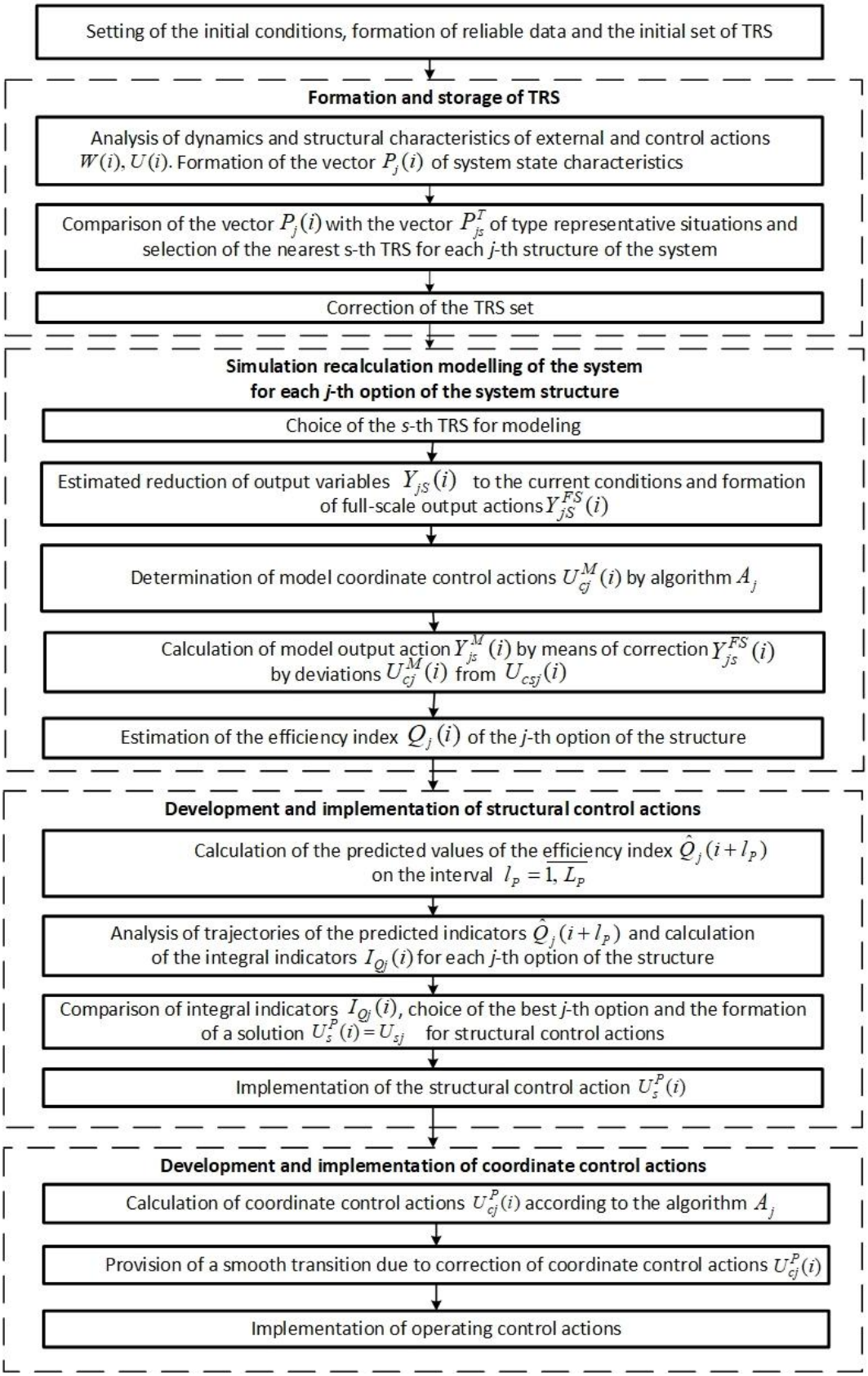

Figure 2. Algorithm for object control with a purposefully variable structure.

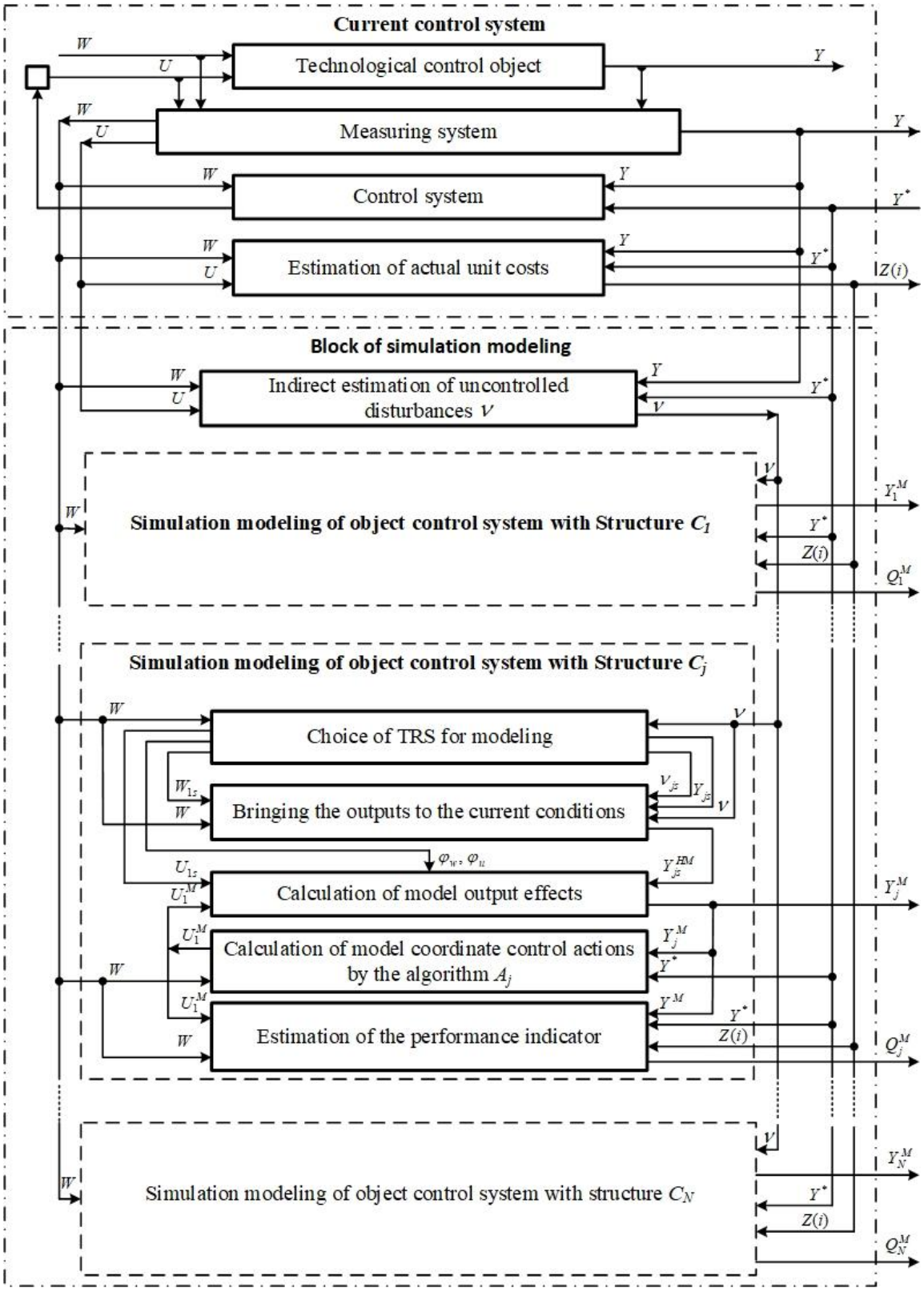

Figure 3. Diagram of simulation full-scale mathematical modeling of the object control system with a purposefully variable structure.

6. Conclusion

The refinement of the proposed approaches, the results of their implementation at the mining enterprises gave grounds for drawing a conclusion about their effectiveness and the need to expand theoretical research and to disseminate across technical, social and economic sectors.

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