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APPLICATION OF INTELLIGENT PROCESS CONTROL SYSTEM

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Abstract:
The article discusses the latest developments in the field of automation, as well as the use of intelligent control systems and modern technologies in the field of technology

Keywords: Intelligent system, logic regulator, STEP-TIME, algorithm.

Relevance. Recently, in the technology of automation of complex objects and processes that are of great national economic importance (carbonation and distillation columns, steam boilers, intelligent robots, aircraft, etc.), there has been a steady trend towards the use of one-dimensional logical (fuzzy and with clear terms) regulators. As a rule, such control objects can be described only verbally (verbally) and, moreover, the overwhelming majority of them are multidimensional with interconnected adjustable parameters. The fundamental disadvantage of this approach is the automation of multidimensional systems with adjustable parameters affecting each other using separate (autonomous) controllers, whose outputs are independent by definition, i.e. react exclusively to "their" input.

In addition, multidimensional systems are characterized by a number of specific features [10, 12, 20, 28, 56, 62, 63], the main of which is the significant mutual influence of control loops while maintaining the values of technological parameters in the required range. From the above, it is obvious that in the development of multidimensional controllers, the main problem is cross-coupling [56, 57]. The task of the synthesis of a multidimensional system, first of all, is to compensate for the mutual influence of regulation channels, due to the introduction of additional compensating connections [75,94,95].

It is known [96, 97, 98] that modern multidimensional fuzzy and discrete-logic controllers, due to a large error and low speed, do not allow eliminating the mutual influence of control loops with acceptable accuracy. This is especially pronounced when managing multidimensional objects presented in the form of a description in a natural language.

Modern systems and software packages for programming industrial and PC-based controllers and intelligent control devices, such as TRACE MODE, SIMATIC STEP 7, TwidoSoft, etc. do not contain specialized tools that would allow to fully implement or analyze the structure of multidimensional logic controllers [12,34,67,74,105,106,109,110].

The above arguments allow us to consider intelligent control of technological processes based on multidimensional clear logical controllers with compensation for the mutual influence of control loops as an urgent scientific task, the solution of which will improve the parameters of this type of controllers, as well as significantly improve the quality of control of technological processes and objects described verbally.

The article consists in the development of an intelligent control system (IMS) that uses a multidimensional precise logic controller (MLR) to improve the control parameters of verbally described technological processes and objects with interconnected adjustable parameters, and on this basis, allowing to improve the quality of finished products, as well as reduce energy costs.

To achieve this goal, the main tasks:

1. To develop an intelligent process control system based on a multidimensional clear logical controller, the logical inference block (LB) of which is presented in the form of a control action system with a mechanism for generating identification numbers of production rules.
2. To develop the structure of the system of production rules for MLR, in which, in addition to regulating the values of technological parameters, the mutual influence of the control loops is compensated.

3. Develop a specialized algorithm for interpreting continuous physical quantities with an equivalent set of two-valued logic arguments (STEP-TIME) in order to increase the speed of phase-zification processes in MLR.
4. To develop software for an automated development system for MLR, invariant with respect to the programming languages of industrial and PC-based controllers of the IEC 61131-3 standard.
5. Develop a methodology for the automated development of an intelligent control system based on MLR and assess its practical significance for improving the quality of control in the automation of specific technological processes and industries.

2.RESEARCH METHODS.

To solve the problems posed in the article, the methods of control theory, the theory of simulation modeling, elements of the theory of algorithms, two-valued logic, multidimensional fuzzy and discrete-logic controllers were used.
1.An intelligent control system based on a multidimensional clear logical regulator, in which the inference block is represented as a system of control actions with a mechanism for generating identification numbers of production rules.
2. The structure of the MLR production rules system, which consists of regulating and compensating components, which are processed in each scan cycle.
3. STEP-TIME algorithm for fuzzification of continuous physical quantities of MLR with the ability to choose the nature and order of distribution of clear terms on the universal number axis.
4. Software of the automated development system MLR, invariant with respect to the programming languages of industrial and PC-based logic controllers described in the international standard IEC 61131-3.
5. Methodology for automated development of IMS based on MLR with compensation for the mutual influence of control loops, and the results of assessing its practical significance for improving the quality indicators of management of complex technological objects and processes.

3.RESULTS:

1. An intelligent control system based on a multidimensional clear-cut logic controller consists in representing a logical inference block (LB) in the form of a control action system with a mechanism for generating identification numbers of production rules, which makes it possible to increase the performance of a multidimensional ACS and verify complex logical structures,
2. The novelty of the structure of the MLR production rules system lies in the representation of the system in the form of two functional parts: regulating and compensating, which makes it possible to reduce the degree of mutual influence of the control loops.
3.The novelty of the STEP-TIME algorithm for fuzzification of continuous physical quantities, in contrast to the well-known ANY-TIME algorithm, consists in the absence of software counters and a structure modification block, which allows minimizing the number of MLR comparison operations.
4. The novelty of the methodology for the automated development of an intelligent control system based on MLR with compensation for the mutual influence of control loops lies in reducing the time for its development and in increasing the quality of control.

4.CONCLUSION

KEY FINDINGS AND RESULTS

1. An intelligent control system has been developed on the basis of a multidimensional clear logical controller with compensation for the mutual influence of control loops, in which the inference block is presented as a system of control actions with a mechanism for generating identification numbers of production rules, which makes it possible to increase the speed of the multidimensional ICS and verify complex logical structures ... It is shown that the number of production rules in MLR is (35 ^ 65)% lower than in multidimensional DLR.
2. The STEP-TIME algorithm for fuzzification of continuous physical quantities is proposed, which provides a multiple reduction in the number of MLR comparison operations. The algorithm of MLR operation has been developed. It was shown that the number of comparison operations in MLR is 95% lower than in multivariate DLR.
3. The software has been developed for the system of automated development of multidimensional precise logic controllers, which is invariant with respect to the programming languages of industrial and PC-based controllers described in the international standard IEC 61131-3, which makes it possible to implement and analyze the complete MLR program code.
4. A methodology for the automated development of an intelligent control system based on a multidimensional clear logical regulator was compiled and an assessment of its practical importance for improving the quality of regulation on the steam boiler at Sterlitamak TPP and distillation column No. 4 of the AD-1 workshop of Soda OJSC (Sterlitamak). The use of MLR led to a decrease in overshoot and to an increase in the accuracy of regulation of the main technological parameters by 48.5% (steam boiler at the CHPP) and (40–45)% (distillation column of JSC Soda).

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