

DOI: <https://doi.org/10.33216/1998-7927-2019-253-5-47-49>

UDC: 004.415.2

## DESIGN OF TECHNOLOGICAL PROCESSES CONTROL ALGORITHMS USING THE SOFTWARE LIBRARY OF ALGORITHMIC ELEMENTS

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## РОЗРОБКА АЛГОРИТМІВ КЕРУВАННЯ ТЕХНОЛОГІЧНИМИ ПРОЦЕСАМИ З ВИКОРИСТАННЯМ БІБЛІОТЕКИ ПРОГРАМНОГО ЗАБЕЗПЕЧЕННЯ АЛГОРИТМІЧНИХ ЕЛЕМЕНТІВ

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*The results of designing the program library of algorithmic elements for the creation of algorithms and construction of control schemes for technological processes are presented in order to accelerate the formation of the final structure of the system.*

**Keywords:** software library, algorithmic element, technological process, control system

### 1. Introduction

The main function, which relies on the automatic control system of technological processes - providing information about the state of the system and its management in case of rejection of parameters.

The degree of availability of information functions of the system, centralized control and measurement of the parameters of the state of the technological process is based on both the software and hardware implementation of the system.

Algorithmic design is to develop algorithms for the functioning and creation of software for computer systems.

Acceleration of the creation of control algorithms, the construction of schemes of interconnections of the system, the identification of priority control channels - is a topical issue in the design of control systems of technological processes.

Circuits of control and executive mechanisms, which constantly interact with the software system, receive commands from the controller, which provides centralized control of the technological process.

Modern design technologies for the creation of control systems for technological processes involve the use of pre-drawn templates that are made out in software libraries of algorithmic elements.

The purpose of the project is to create a program library of algorithmic elements for accelerating the design of control systems, and, if necessary, rapid modernization of algorithms.

### 2. Proposed approach

To provide information when designing a control system, an important role is played by the program library of algorithmic elements, which contains information about the function of the element and greatly accelerates the process of creating the final version of the system.

Issues in the design of software libraries of algorithmic elements are devoted to publications [1, 2].

A significant contribution to the development of modern technological design systems is provided by Altium, a software company Altium Designer [3].

The process of creating the finite control algorithms at the design stages consists in solving complex problems - from the creation of adaptive parametric models to the construction of a work process using computer technology.

When implementing control algorithms, the software library needs constant updating and support.

The proposed software library of algorithmic elements used in the design systems of process control circuits contains:

- combinational logic elements (AND, NOT, OR, MOD2, encoders, decoders, multiplexers, etc.);
- elements of a serial type (RS-trigger, D-trigger, registers, counters, etc.);
- dynamic elements (elements of integration, differentiation and filtering);
- static elements (adder, elements of subtraction, division, square root product, etc.)
- elements of nonlinearity (elements of restriction zones, insensitivity, elements of the relay with hysteresis, etc.);
- elements of regulation (regulators of the laws of regulation).

Here is an example of using a simple element in the implementation of a list of static elements that performs subtraction of two analog input values  $Y = X1 - X2$  (fig. 1).

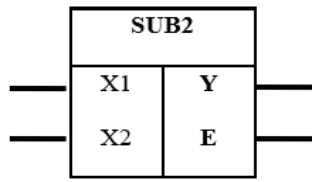


Fig. 1. Graphic representation of the subtraction element

The element contains two analogue inputs X1, X2 and a discrete output E of the overflow characteristics on the analog output Y of the subtraction element. There are no parameter settings for this item.

Here is an example of implementing a more complex element from a set of constraint elements that is used to simulate the constraint characteristics. The element contains the analog input X, the analog output Y and the index of the working area (fig. 2).

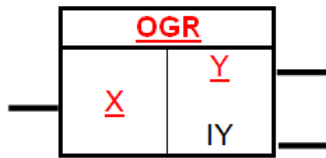


Fig. 2. Graphic representation of the restriction element  
The element implements as follows

The element implements the following expression:

$$y = \begin{cases} YH, & \text{при } x \leq a \\ K \cdot X, & \text{при } a < X < b. \\ YB, & \text{при } x \geq b \end{cases} \quad (1)$$

Unlike the previous one, this item has parameters YN (lower limit of measurement of the output value), YB (upper limit of measurement of the output value and K (proportionality factor). Such elements may be present, for example, when generating schemes of different types of regulators for checking the input range signal and limit the range of the output signal in case of critical situations.

The diagram below shows the principle of the limitation element (fig. 3).

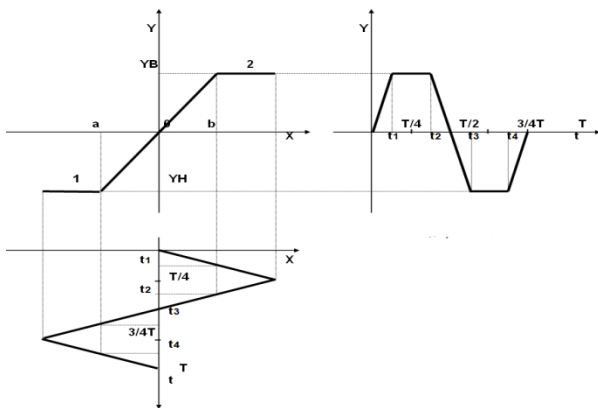


Fig. 3. Limit work element diagram

In more complex technological schemes, such as the digital proportional–integral–derivative controller (PID controller), which is more versatile than other regulators, it is possible to use one of the well-known regulatory laws.

In the XZ, the digital PID controller analyzes the XOS feedback and issues the control signal Y in case of deviation (fig. 4).

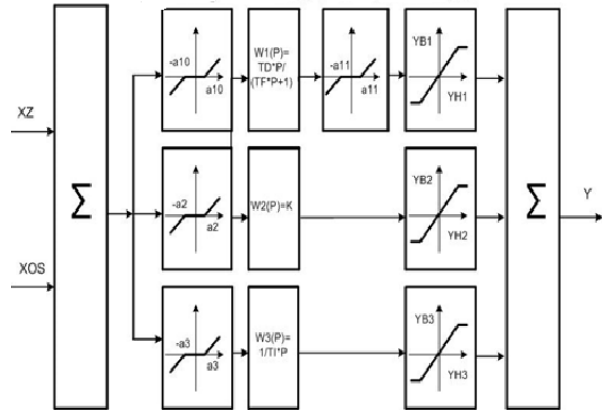


Fig. 4. Digital PID controller

The output signal of the digital controller is determined by three components: the proportional, differential and integral parts of the equation.

The presented regulator is a program element that implements a discrete part of the equation:

$$W_{PID}(p) = K_p \left( 1 + \frac{1}{T_i \cdot p} + T_d \cdot p \right) \quad (2)$$

Graphic editor of functional schemes is used to solve the following tasks of the technological chain:

- constructing / editing a graphic image of a single element of a functional schema;
- build / edit a functional schema.

The development of graphic images for constructing algorithms is carried out with the help of Altium Designer software company Altium, which, according to the developers of the company, reduces the time for designing the final solution in 2 times [3]. It should be noted that the company creates products not only for industrial systems, but also for the educational process. Among the advantages of the Altium Designer system should be noted:

- intuitive keys and commands that are commonly accepted;
- online help system;
- the mechanism of synchronization of the design stages to achieve the final result.

For a program description of the functional purpose of algorithmic elements, the programming language C++ [4] is used, which allows the use of software in various operating systems.

At the final stage of design, a set of automata (algorithms) of control on the basis of algorithmic elements is combined into a single program, loaded into the controller's memory and launched for execution in sequence in the order of the set queue or when receiving control in accordance with the conditions.

For example, the technological circuit (control machine) of the equipment may look as shown in fig. 5.

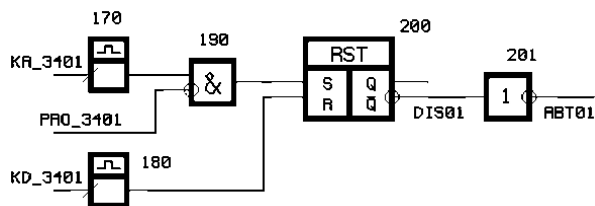


Fig. 5. Technological scheme of the control automaton

In case of necessity the introduction of changes in the technological scheme is carried out by replacing one element with another or by adding the necessary element / elements, which reduces the time for the program implementation of the control system.

### Conclusion

Modern approaches to the design of algorithms, software and hardware require acceleration of final decisions, and, if necessary, a reduction in the time for their modernization.

On the example of designing the software library of algorithmic elements, it is shown for its application for the construction of algorithms of automata and implementation of control schemes of technological devices.

Application of the software library will significantly reduce the time for designing and upgrading the final decisions of the technological process.

The advantages of using such software libraries are the study of many options for using the model at any stage of the design without the restructuring of the control system, rapid upgrading of algorithms, thus creating precise models of objects consisting of dozens of elements.

As a result of implementing the goal of designing a database of existing graphic images (Schematic Library Document), stored in \*.PsbSch format, is supplemented with new elements that allow the implementation of elements of integration, differentiation, adder, etc.

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**Кардашук В.С. Розробка алгоритмів керування технологічними процесами з використанням бібліотеки програмного забезпечення алгоритмічних елементів**

*Представлені результати розробки програмної бібліотеки алгоритмічних елементів для створення алгоритмів і побудови схем управління технологічними процесами з метою прискорення формування кінцевої структури системи.*

**Ключові слова:** бібліотека програмного забезпечення, алгоритмічний елемент, технологічний процес, система управління

**Кардашук В.С. Разработка алгоритмов управления технологическими процессами с использованием библиотеки программного обеспечения алгоритмических элементов**

*Представлены результаты разработки программной библиотеки алгоритмических элементов для создания алгоритмов и построения схем управления технологическими процессами с целью ускорения формирования конечной структуры системы.*

**Ключевые слова:** библиотека программного обеспечения, алгоритмический элемент, технологический процесс, система управления

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Стаття подана 30.07.2019.