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PRINCIPLES OF ELIMINATING THE IMPACT OF DISTURBANCES ON INTEGRATED INFORMATION AND ANALYTICAL SYSTEMS

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Abstract: *Today, production management using integrated information and analytical systems and their integration with the elements of Industry 4.0 is considered one of the most pressing problems in all areas of production. The correct formation of the structure of information systems in their development contributes to the formation of elements of Industry 4.0 and their further full and high-quality integration into other areas. When implementing these processes, one of the most important steps is to reduce the impact of disturbances on integrated information and analytical systems. Taking into account the above, the article considers mathematical models of the principles of eliminating the influence of disturbances on integrated information and analytical systems. In addition, the optimal solutions for reducing the impact of disturbances on integrated information and analytical systems are presented.*

Key words: *Industry 4.0, digitization, integrated information and analytical system, analytical information, object, management principles, control of system deviations, electron, statistical and dynamic characteristics of the system.*

Аннотация: *Бугунги кунда ишлаб чиқаришни интеграллашган ахборот-таҳлилий тизимлари орқали бошқариш ва уларни Industry 4.0 элементларига бирлаштириш ишлаб чиқаришнинг барча соҳалари учун долзарб муаммолардан бири ҳисобланади. Ушбу тизимларни ишлаб чиқишда ахборот тизимлари тузилмасини тўғри шакллантириш Industry 4.0 элементларини ҳосил қилиш ва келажакда ушбу элементларга бошқа хизматларни сифатли ва тўлиқ интеграциялашни таъминлайди. Ушбу жараёнларни амалга оширишнинг энг асосий босқичларидан бири ғалаёнларни интеграллашган ахборот-таҳлилий тизимларга таъсирини камайтириш ҳисобланади. Юқоридагиларни инобатга олган ҳолда мақолада ғалаёнларни интеграллашган ахборот-таҳлилий тизимларга таъсирини бартараф этиш тамойилларининг математик моделлари кўриб чиқилган. Бундан ташқари, ғалаёнларни интеграллашган ахборот-таҳлилий тизимларга таъсирини камайтириш бўйича оптимал ечимлар келтириб ўтилган.*

Таянч сўзлар: *индустрия 4.0, рақамлаш, интеграллашган ахборот-таҳлилий тизим, таҳлилий ахборот, объект, бошқариш тамойили, тизимнинг оғишларини назорат қилиш, электрон, тизимнинг статистик ва динамик тавсифлари.*

Аннотация: *На сегодняшний день управление производством с помощью интегрированных информационно-аналитических систем и их объединение с элементами Индустрии 4.0 считается одной из самых актуальных проблем всех направлений производства. Правильное формирование структуры информационных систем при их разработке способствует образованию элементов Индустрии 4.0 и их дальнейшей полной и качественной интеграции в другие сферы. При осуществлении данных процессов одним из важнейших этапов является уменьшение влияния возмущений на интегрированные информационно-аналитические системы. Учитывая вышесказанное, в статье рассмотрены математические модели принципов устранения влияния* *возмущений на интегрированные информационно-аналитические системы. Кроме того приведены оптимальные решения уменьшения влияния возмущений на интегрированные информационно-аналитические системы.*

Ключевые слова: *Индустрия 4.0, оцифровка, интегрированная информационно-аналитическая система, аналитическая информация, объект, принципы управления, контроль отклонений системы, электрон, статистические и динамические характеристики системы.*

Introduction

In the process of operation, any integrated information-analytical system (IIAS) (object of management) is affected by different types of disturbances. Disturbances can affect both the system and the object of control, as well as the elements that make them up. Therefore, to improve the quality of management systems, it is necessary to know well the nature of these disturbances [1-3].

Both the environment and the information environment are a common source of unrest for the object and system of management. The physical environment can include heat, electric fields, and energy sources that cover the atmosphere with its dust, smoke, moisture, and harmful compounds. Additional devices need to be added to the control system to compensate for the disturbances caused by the physical environment.

Disturbances in the information environment are understood involving the intrusion of external information (virus) that is intentionally or accidentally entered during the operation of an automated system [4-6].

Research Methods and materials

The absence of control or corrective information at a given (necessary) time, or its erroneous flow, can also be seen as an action that leads to system upheaval. Because such a situation also undermines the stability of the management system. To prevent such disturbances, appropriate programs are provided to control the quality of the information received in the management system. If there is no control program, then provide the required information about external sources by short-term a priori forecasting method or provide immediate connection to the network of a similar control system to process control effects in “turn-by-turn” mode or system emergency shutdown materials, components, changes in the parameters of products raw materials, semi-finished products, etc. concerning the parameters set by the technological process in the IIAS constitute external upheavals. In the control system, at least the change in the executing devices and the control effects resulting from the intervention of the control subject in the control object (or system) must also be added to the external (disturbances) because large or small changes occur in the controlled process operators. If these relationships are identified, then the control system should also be designed with multi-link hierarchical intersecting relationships in mind [7-8].

As result of processing of controlled technological operators, the change of technological operators in the system along the interconnected chain of components means a change in the statistical characteristics of technological operation and technological process, which must be taken into account in the design of IATT.

Internal (disturbances) in the system and the control object are associated with uncontrolled changes in the parameters of equipment, sensors, initial information, data transmission and sensors of the executive bodies. Interference of various natures that arises in the control and management interfaces is also included in internal disturbances. The level of these disturbing effects can reduced by schematic-technical solutions (decisions) and by software-interface solutions (decisions) with a high level of interference protection. To do this, mathematical filters (filters of the Kalman filter type) or circuit devices with a high degree of protection against (friction) effects are used (high-density integrated circuits).

However, the main and modern solution in the design of automated systems are a priori mathematical and electronic models, in which the general scheme of conformity of the control system and the control object until the required product is developed. This is an effective method can interpret the effect of friction on the control object and ultimately reduce the effect of friction on the control process by increasing the compatibility of the control object's mathematical model with the electronic model and building adaptive control systems (easily adapted in the process control process).

Results and discussion. Since the object of functional control (technological process, design process, etc.) is autonomous concerning the automated control system, we consider methods of modeling the elimination of the effects of friction on the object of control.

The principle is that the control system acts on the control object in such a way that this effect is aimed at eliminating the deviation of the controlled variable from the given value (Fig. 1).

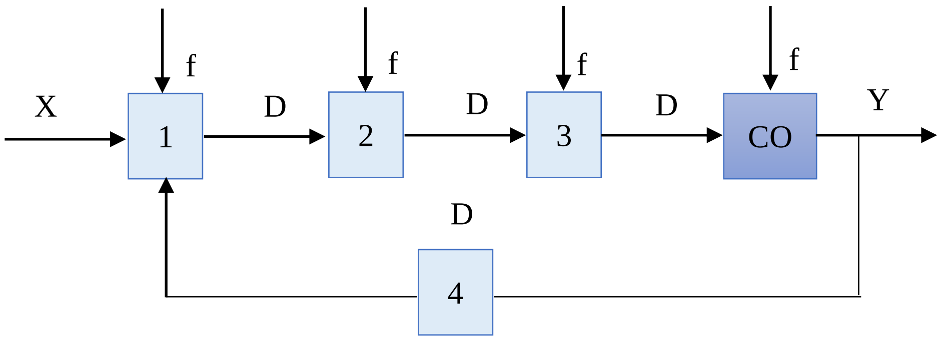

Fig. 1. ***Functional software scheme of system deviation adjustment.***

Where 1 is the software comparison element, which generates a signal that controls the deviation of the actual value of the output quantity from the given one; 2 - element-amplifier of the signal it is necessary for functioning of the executive body (element); 3 - executive element organ (or processor); CO - control object (or system); 4 - outgoing control size sensor; *f* is the friction in motion.

The deviation of the value of the controlled quantity from the given one under arbitrary deviations is transferred to the control effect on the control object, which effect is in addition to the effect of the initial command device on this object. The initial command device ensures that the controller receives the given values of the output parameters in the absence of deviations. It is necessary to take into account that the signal is also at the input of the feedback in the design of the control system to generate a signal that allows to compensate for the effect of friction at the output of the feedback chain at very large amplification coefficients. This signal is the difference between the value of the output parameter under control and the friction obtained under the influence of the control object, hence the difference must have a finite value. This means that it is not possible to eliminate the effect of friction on the adjustable magnitude in the deviation adjustment and control systems [10-12] (where the set mode in astatic systems may also be an exception). In such systems, the feedback block develops a regulated effect proportional to the integral of the deviation of the actual value of the control quantity from the given value. It follows that it is possible to reduce the effect of friction on the control object by adjusting the deviation. But it cannot be eliminated. This is also a shortcoming of the method of eliminating the effect of wear on the control object. The principle of deviation control is the controller in a two-dimensional (x, y) coordinate system on the elements. (a) Let us consider the example of point movement (Fig. 2).

Point *(a)* the trajectory of the motion in the form of a curve $y(t)$ has different coordinates from its given coordinates x_0, x_1, x_2 the effect of friction on the values of the arguments and the x_1, y_1^* incompleteness of the control system. *(a)* let these coordinates have values of x_1, y_1 under a new trajectory of the point. Given the value y_1^* measured at the moment x_1:

$$\Delta y = y_1^* - y_1, \tag{1}$$

will have the appearance.

It follows from this relation that the Δy obtained reflects the state of the control object at the moment x_1 and has nothing to do with its past and future state. Again Δy can be used as a regulator or as on the control system. In this case *(r)* the control effect can be nonlinear or linear:

$$r = f(\Delta y). \tag{2}$$

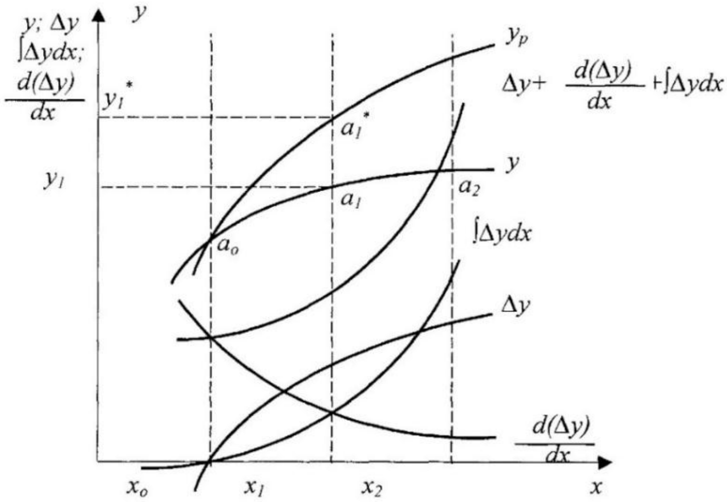

Fig. 2. ***Graphs of the change of the trajectory of the controlled point and the controlled effects according to the law of adjustment.***

Such a control system is called a control system. Typically, in adjustment systems, there is $r = k\Delta y$, where k - is a coefficient that does not allow the control object to obtain full compensation for the frictional effects on the deviation. The advantages of control systems using static adjustment laws are their good dynamic properties and easy access to stability. Taking into account the dynamics of system motion, taking into account the transition state of the control object leads to the need to use this prediction (for example, in the form of a mathematical or electronic model) in predicting and controlling its aposterior state. Entering the integral of the deviation of the laws of adjustment, we obtain the following expression:

$$r = f\left(\int \Delta y dx\right). \tag{3}$$

Here in the special case of linear alignment for continuous systems of alignment or for the astatic law of alignment when $r = k\int \Delta y dx$

$$r = F\left(\sum_{i=1}^{n} \Delta y_i, \Delta x_i\right) \tag{4}$$

relationship is used.

For discrete control systems (3), the relationship is the same range of discrete ones (4). In this case F is a discrete function.

If the friction has little effect on the control object, complete compensation of the friction can be achieved in astatic adjustment systems. However, this process is very slow and during this time there are changes in the state of the control system, so in many cases it is not possible to achieve a stable state of the control object. The desire to take into account the aposterior state of the control object leads to the need to put in the control system an element (i.e., a mathematical model, an electronic or natural model based on the first 2 models) that provides such a state. The simplest mathematical operation (modeling) that can be used to obtain the aposterior state of a controlled point movement is to obtain the first-order product of its motion structure. The law of adjustment for the primary product:

$$r = f\left(\frac{d\Delta y}{dx}\right) \tag{5}$$

provides the ability to control it by taking its aposterior position. In the discrete version of the control system (5) the expression:

$$r = F\left[\frac{(\Delta y_i - \Delta y_{i-1})}{\Delta x_i}\right] \tag{6}$$

will appear.

In control, the control systems that apply the law (5) and (6) do not occur in practice, because in the control system there is no feedback at small values of the first product, and at all values the control system is not stable. Therefore, when we talk about the law of adjustment on the first product, we mean the law of adjustment that provides the most effective management:

$$r = f_1(\Delta y) + f_2(\int \Delta y dx) + f_3\left(\frac{d\Delta y}{dx}\right). \tag{7}$$

In some cases, the quality of the law of adjustment can be used from the law of isodrome adjustment:

$$r = f_1(\Delta y) + f_2(\int \Delta y dx), \tag{8}$$

the use of this law allows for effective control of the object during the transition process, which control is provided by the feedback action according to the first constituent formula (1).

This leads to a relatively rapid extinction of the resulting transition process. (8) accuracy of the adjustment in the set mode is increased by the feedback motion (effect) determined by the two terms of the equation so that the flexible feedback control system can be seen. In this case, Au is involved in the operation of different elements of the feedback chain or different blocks of control algorithms, depending on the nature of the value of the change. The control point, designed in accordance with the type of control effect values in different sections of the control point movement (Fig. 1), the constant movement of the actual trajectory of the deviation to the desired direction (8) is constantly increasing, and hence the control effect on the required trajectory. grows. At small deviations of A_y, but in sufficiently large first derivatives, the effective control over the first derivative also increases and (7) and (8) provide a greater control effect than the effect obtained according to the law of adjustment.

Currently, a number of industrial enterprises (including mechanical engineering) use automated systems based on the theory of invariance of CIMATRON, CADDS-5, CATIA, UNIGRAphics. It belongs to the class of systems that compensate for invariant friction of use (Fig. 3). Only once in the system will it be possible to select the structure of the friction compensation management system. Therefore, management systems with structural compensation are rarely used together.

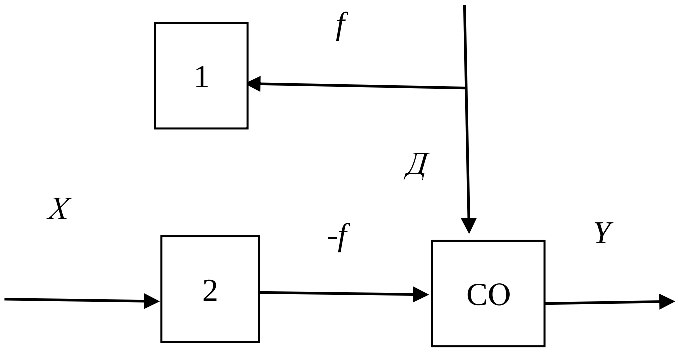

Fig. 3. ***Functional diagram of the wear adjustment system.***
1 - friction sensor; 2 - amplifier executive block; CO - control object.

Modern theory of invariance allows to ensure absolute or partial independence (invariance) of one or more output variables (coordinates) in certain properties of the control system and its elements from one or more frictional effects.

Mathematically, the theory of invariance is well developed enough, so it is necessary to consider some practical aspects of the design of invariant control systems. This is related to the fundamental properties of the homogeneity of the dynamic properties of pulsed and continuous systems. One of the requirements of invariant theory to invariant control systems is that the transmission of friction must have two channels or that the system be built on the principle of two channels (Figure 3).

Conclusion

Thus, if an additional chain is created that converts (f) to friction (-f) to friction, then this friction is affected and get (X, Y) for full compensation because f – f = 0. To implement such a circuit in practice, the friction gauge must have 1 sensor and a 2 amplifier actuator must provide such a transmitter that the value of friction (-f) is obtained at its output. If the transmission function of block 2 remains constant over a wide range of amplitudes and frequencies, then the invariance of the control system is present for virtually all deviations. This is one of the good features of invariant systems. This is because no condition can be imposed on the wear effect other than that its values are finite. In a number of cases of control system design, absolute invariance cannot be achieved or simply cannot be achieved. In a number of cases of control system design, absolute invariance cannot be achieved or simply cannot be achieved. In that case, a deviation control contour is introduced to improve the dynamic characteristics of the system.

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