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DEVELOPMENT OF MATHEMATICAL MODELS AND ALGORITHMS FOR INTELLIGENT CONTROL OF MULTI-LINK HIGH-SPEED ELECTRICAL CIRCUITS

Annotation: the article proposes an approach to create an intelligent control system for high-speed multi-link electrical circuits that work in conditions of interaction of mobility levels. Generalized mathematical models of high-speed multiple systems have been developed. Based on the proposed situational approach and technology of associative memory, the article developed a methodology for building management algorithms based on the organization of a control system that provides real-time management and on this basis considered the cases of achieving energy savings by using them in electrical proceedings.

Developed control methods ensure high-speed operation, electromechanical system the accuracy of synchronization of the working bodies ' rotational frequencies, as well as the correct operation and braking modeling Based on this, the article developed recommendations for increasing the energy efficiency of the enterprise. In the article, the modeling of the electrical circuit of the winding machine of the quality of temporary processes in an uncertain control system is organized, and on the basis of all the values obtained and their analysis, the calculations of optimal speed regimes, which ensure the rational use of electricity, are conducted.

Keywords: electric circuit, multi-joint system, winding machine, electric motor, mathematical model, classifications, neural network, periodic electric circuit, Association.

Introduction

Often the concept of reliability is said to be “more reliable” than any other enterprise, in a broad sense, the electrical equipment produced by manufacturing enterprises. In such cases, if the relative costs are not significant, the "reliability" of electrical equipment is taken into account[1].

An important indicator of energy saving is the optimal management of dynamic objects in real working conditions, that is, in order to minimize energy consumption when the task changes in the parameters of objects, working modes, constraints and in the final state. The rational use of electric circuits, which are part of the managed electro technical complexes, provides energy savings, allows to obtain new qualities of systems and objects [2].

The main part

For dressing the mathematical model of a multi-joint system and analyzing it, let's look at the equations of the dynamics of the performers of multi-joint device drives, which determine the dependence of the M torque created by the constant direct motor of the j-M controller [3]. we will assume that the generalized coordinates are q_k, speeds $\dot{q_k}$ and accelerations $\ddot{q_k}$, based on which we will be able to get the following equations.

$$G_{jj}\ddot{q}_j = M_{jd} - M_{vzj} - M_j,$$

$$M_{vzj} = \sum_{k=1,k\neq j}^{n} G_{jk}\ddot{q_k} + \sum_{k,l=1}^{n} G_{jkl}\dot{q_k}\dot{q_l},$$

$$u_j = K_e\dot{q}_j + \frac{R_{яj}M_{jd}}{K_m} + \frac{L_{яj}}{K_m}\frac{dM_{jd}}{dt},$$

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here G_{jk}, G_{jkl} - coefficients depending on the values of the generalized coordinates and the kinematic diagram of the multi - joint device, M_{vzj}- torque arising from the interaction of the angles, M_j- torque components not connected to M_j-M_{jd} (due to friction, weight, etc.), K_e and K_m, rotational coefficients of proportionality of the electrician and the electromechanical torque; $R_{яj}$ and $L_{яj}$ - the active resistance and inductance of the electric motor jack; u_j - the voltage in the Armature Winding of the electric motor, n-the number of electrical circuits in the multi-joint system. J index indicates the serial number of the proceedings [4].

Such a view of the mathematical model of the executive engine allows to reflect the interaction of excitation in the form of a disturbing moment and to study the effect of the generalized coordinates on the magnitude of the moments of change in M_{vzj}. In this case, we will be able to determine the torque change by constructing a mathematical model so that we can analyze it.

At the stage of analysis, the matrix of the association is calculated according to the following formula:

$$W = \sum_i A_i^T B_i$$

Here are A_i and B_i-i - input and associative vectors, while W is an associative Matrix.

The expression of the vector A is as follows:

$$A = F(BW^T)$$

This structure has the following disadvantages:

-the study of the new association leads to a complete recalculation of the association Matrix;

-the number of associations is limited by the size of the input vector;

-it is impossible to find a link with incomplete data in the input vector.

To eliminate these shortcomings, a single vector is selected as an introductory and associative Vector [2]. Such:

$$W = \sum_i A_i^T A_i$$

When restoring, the associative vector is used as A_i^*, which is a component of A_i.

A distinctive feature of memory in terms of self-organizing structures is the storage of information in the form of attractors, for example, in vibration neural networks.

Depending on the state of the input vector, the system enters one of the attractors, and the more complex the system is, the more they are, the frequency impulse element [1] is shown in Figure 1, which, depending on the initial conditions, manifests itself as having two stable states and a memory duration equal to T.

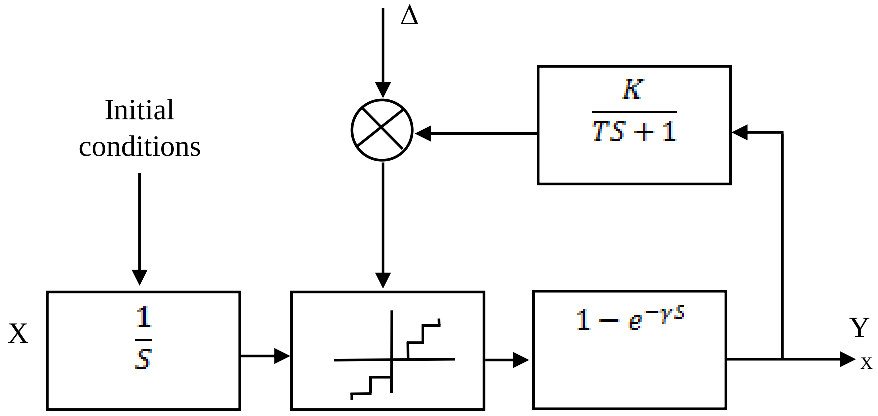

Fig 1. Element of impulse frequency associative memory

$$F_{1,2} = \frac{\Delta}{2K\delta_u\gamma} \pm \sqrt{\frac{\Delta^2}{(2K\delta_u\gamma)^2} - x}$$

Here

K- low frequency filter circuit;

Δ - limit for quantification of growth;

δ_u, γ-amplitude and duration of the pulse.

With the help of software implementation of existing electrical circuits in a silk-making enterprise, it is possible to implement the technology of associative memory on any algorithm. But in order to use such associative memory in a real management system, it is necessary to take into account that the speed of processing data stored in associative memory is limited by the amount of RAM and the speed of access to the memory checkbox. This in turn makes up the case of the management of the electrical circuit by the values of the circuit. Let's say that the number of electric machines available in the electric circuit is two, the minimum and maximum values of the time spent to operate it are determined based on the associative memory.

The implementation of associative memory in Analog elements is free of these shortcomings. With such implementation, the control system can be placed on a multi-threaded device Board, and analog elements allow parallel processing of information, which significantly increases the speed of creating a control signal, especially if the control algorithms are much more complex. To date, several promising non-programming methods of practical implementation of associative memory are being developed.

Electronic signals in integrated circuits require capacitors for the transport of signals. Although capacitors are micron-sized, the space they occupy (taking into account the space required to insulate one capacitor from another) can be so large that there is no space left in the silicone plate to accommodate the calculation schemes. Despite the fact that there is a technology to implement ordinary digital computers in the form of large functional blocks with a relatively small amount of capacitors, this technology does not work in massive parallelism [5].

Therefore, achieving the necessary connection in the electronic program generates significant problems. In addition, the issue of eliminating limited memory capacity can not be solved in any way.

The 2 figure shows a system that performs an optical vector-matrix multiplier. Introduction vector is given to the system using light sources and cylindrical lenses. As a matrix of associations, a weight mask in the form of a photographic film is used, in which the transparency of each square is proportional to the corresponding weight. The output signal is produced by cylindrical lenses and photosets. In this simple example, the net weights are marked, which can only be replaced by masks of different weights. Weights should be variable for use in flexible systems. There is a promising method based on a liquid crystal display (valve) instead of a photographic negative. This allows you to electronically change the weights in microcopies. At present, the liquid crystal valve binary can be used to carry out weights, but there is no stability and contrast to realize continuously changing weights.

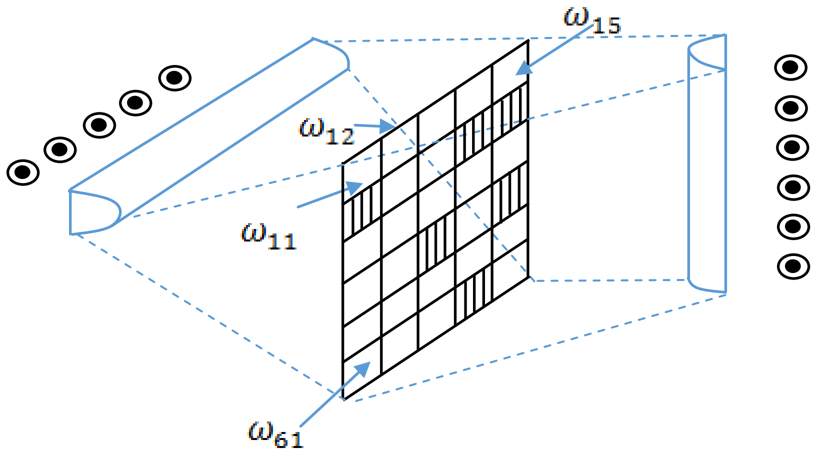

Fig 2. Optical vector-matrix multiplier

The interest in the study of complex dynamic objects of technological equipment, the use of artificial intelligence technologies, in particular, fuzzy control algorithms, in electrical circuit control systems, is growing. Sliders built on this innovative concept are able, in some cases, to show higher indicators of the quality of temporary processes than classical sliders. In addition, using the technology of synthesis of fuzzy control algorithms, it is possible to optimize complex control rings without conducting extensive coverage mathematical studies [6].

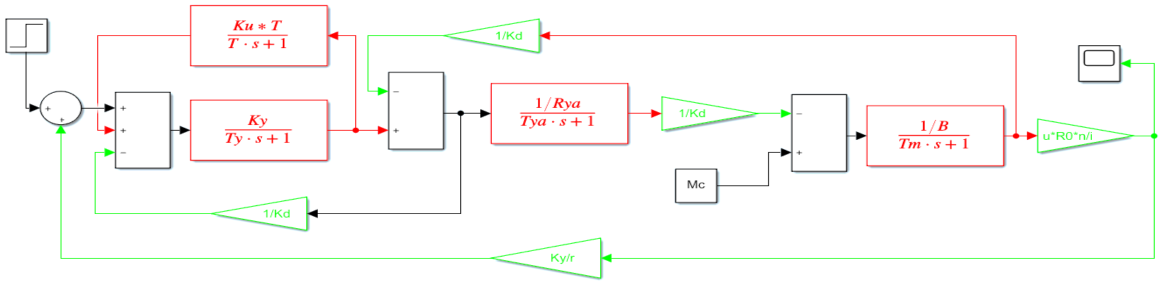

Fig 3. Mathematical model of the structure scheme of the winding machine

As a result of conducting a comparative analysis of the main indicators of the quality of the passing process for the integrated system, we will be able to identify its advantages and disadvantages (figure 3). Two models of control systems are built - in: the PI controller and the stability system “DC motor - controlled rectifier” with the DC engine the classic two-speed stability system is a controlled rectifier based on an unbalanced speed controller. Modeling of stabilization systems and analysis of transient processes were carried out using Matlab Simulink modeling environment [9].

Conclusion

Intellect there are several ways to create manual management systems. According to the results of a comparative analysis of expert systems, neural network structures, local logic and associative memory technologies, it is proposed to develop a intellectual control system based on associative memory technology, since this technology can be software that is implemented in computing.

Thus, the task of the work is as follows:

• parameters of electric motors (proportional coefficients of the electric motor and electromechanical moment of rotation, active resistance and inductance of electric motors steppes);

• number of electrical jurisdictions;

• geometric measurements of steno;

• energy characteristics;

• movement training of the executive body.

The main methods of controlling multi-connected power transmitters are considered, and their possibilities of forming the control of high-speed multi-line devices, which provide the required quality indicators in real time, are analyzed. He came to the conclusion that in order to manage high-speed multi-link electrical circuits, it is necessary to use intellectual systems.

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