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Changing The Absolute Stability Criterion for the Intelligent Control System of Multi-Connection Electric Drives

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ABSTRACT: The article analyses control systems for multi-link electric drives and synthesizes ways to achieve the absolute stability of an intelligent control system using a mathematical model, it is proved that there are ways to save energy by driving electricity. The results obtained with the help of the mathematical model are a step towards the absolute stabilization of their control methods and the harmonization of the coefficients of variables in mathematical expressions by the artificial intelligence method of real-time control through neural networks.

KEY WORDS: Multilink power transfer, dynamic effect, control algorithms, models, moment of inertia, Jacobi matrix, servo drive, equivalent block diagram;

I. INTRODUCTION

In the verification process, the current state classification is performed by selecting the values of the elements of the first-order arrays according to the measured values of the state parameters. According to the class numbers obtained, the parameters of the regulators corresponding to the current state of the control object are extracted from the secondary arrays, which are then transferred to the drives to form the control signal.[1]

The use of associative memory in the proposed intelligent control system allows real-time control. This means that this intelligent system is able to provide high quality control even when the parameters of the control object change at the rate of rapid change of the input signal. [2]

The use of associative memory in constructing the proposed control system as a mechanism for working with knowledge allows to significantly reduce the operational cycle at the tactical level, but at high speeds and when the load changes during this cycle, the object parameters may experience some changes. Changes Therefore, an important part of the proposed intelligent control system development is to ensure the stable operation of the system during the tactical level cycle.

II. METODOLOGY

Due to the presence of two nonlinearities in the structural scheme under investigation, we use the absolute stability criterion for several nonlinear systems developed by VM Popov and VA Yakubovich [1].

According to the circular criterion for several non-stationary linear systems [2], the system is absolutely stable exponentially under the following frequency conditions:

$$\det Re\{[Im + \alpha W(jw)] \cdot \tau_d [Im + \beta W(jw)]\} \neq 0 \qquad (1.1)$$

Here

$$Re\, Z = \frac{1}{2}(Z + Z^*),$$

The Z-matrix and the asterisk denote the Hermit conjugation:

$Z = (Z_{ij}),$ then

$Z = (Z_{ij}),$ then $Z^* = (Z_{ij}^*);$

$$a_j = 0, \quad \beta_1 = K_{1max} - K_{1min}, \quad \beta_2 = K_{2max} - K_{2min} \qquad (1.2)$$

$$\det Re \left\{ \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} + \begin{bmatrix} \beta_1 & 0 \\ 0 & \beta_2 \end{bmatrix} W(jw) \right\} \neq 0 \tag{1.3}$$

W (jw) is a matrix of a linear part that should not have specific values on the imaginary axis.
If the number of nonlinear blocks is two and the condition (1.3) is simplified and takes the following form:
The nonlinearities K1 and K2 are defined by the following expressions:

$$K_1 = \frac{1}{J_0 + J(t)}, \tag{1.5}$$

$$K_1 = \frac{dJ}{dtK_m}, \tag{1.6}$$

$$K_1^* = K_1 - K_1 min, \tag{1.7}$$

$$K_1\ min = \left| min \frac{1}{J_0 + J_0(t)} \right|, \tag{1.8}$$

$$K_2^* = \frac{dJ}{dt} - sup \frac{dJ}{dt}, \tag{1.9}$$

$$K_2 min = \left| min \frac{dJ}{dt} \right|. \tag{1.10}$$

The block diagram of the closed-loop control system of the servo drive is shown in the figure. 1.5, where Wp (s) is the transfer function of the controller, in which the controller parameters are set to a constant value in the middle of the memory selection range (for J_0) where the object parameters are constantly changing.

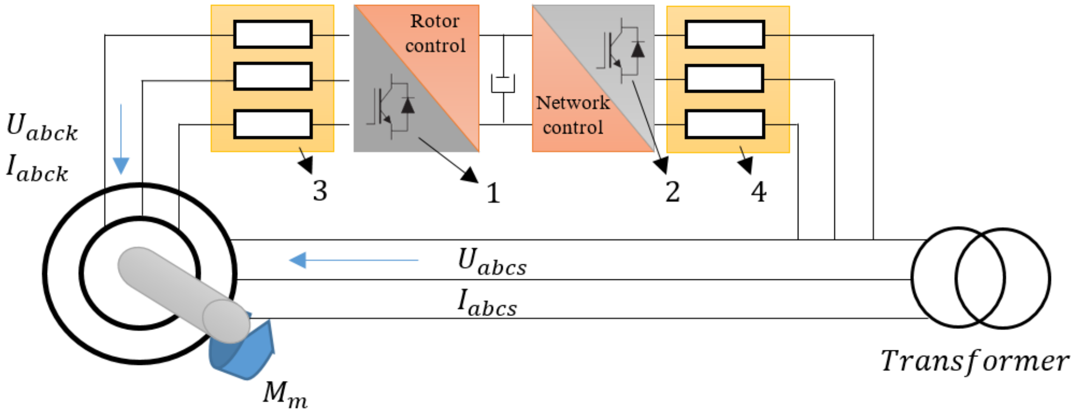

Fig.1.2. General power and double acting AC motor control.

1- Rotor-side VSC, 2- Grid-side VSC, 3- Rotor filter, 4- Grid filter
Using mathematical expressions 1.2. according to the figure (Fig. 1.3), you can build the following model.

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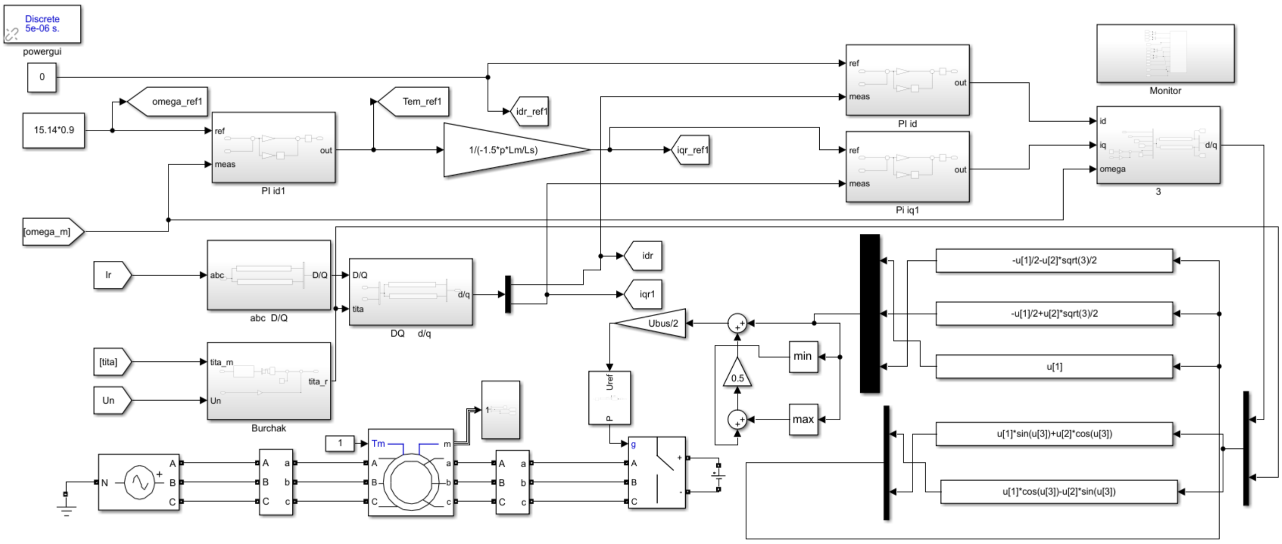

Fig.1.3. Matlab Simulink software is an AC motor control model and control box

$$v_s = R_s i_s + \frac{d\psi_s}{dt} \Rightarrow \left\{ \begin{matrix} v_{as} = R_s i_{as} + \dfrac{d\psi_{as}}{dt} \\ v_{Bs} = R_s i_{Bs} + \dfrac{d\psi_{Bs}}{dt} \end{matrix} \right\} \qquad (1.11)$$

From Equation (1.11), for example, if the voltage drop across the stator resistor is small, the stator current will be constant because the stator is connected directly to the mains at a constant AC voltage; hence d ‖→ ψ→ equals zero. The last two equations show that it is possible to control the rotor currents dq using a regulator for each current component, as shown in fig. 1.3.

By relating DQ to mains voltage, we can construct a mathematical expression given the following equation.

$$\begin{bmatrix} x_a \\ x_b \\ x_c \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ -\dfrac{1}{2} & \dfrac{\sqrt{3}}{2} \\ -\dfrac{1}{2} & -\dfrac{\sqrt{3}}{2} \end{bmatrix} \qquad (1.12)$$

To help the controller in the program, the inverse conditions of equation (1.12) can be included in the output signal of each controller. The stator current and ω_p must be calculated according to the conditions of interaction, but this is simple and does not lead to an increase in additional difficulties. The check must be made in dq coordinates, but then the rotor voltages and currents must be converted to DQ coordinates. First, you can get the angle of the phase vector of the stator voltage, then subtract 90∘ from this calculated angle and thus get θs. In the control block diagram shown in fig. 1.3, the current rings operate with the rotor currents corresponding to the stator side and the conversion to the values shown on the rotor is done during the current measurement phase and before the generation of pulses. Using the above model (Fig. 1.4,1.5,1.6), the following characteristics can be obtained.

This, in turn, shows that the control systems are chosen correctly and the expression of the variable parameters in them has changed.

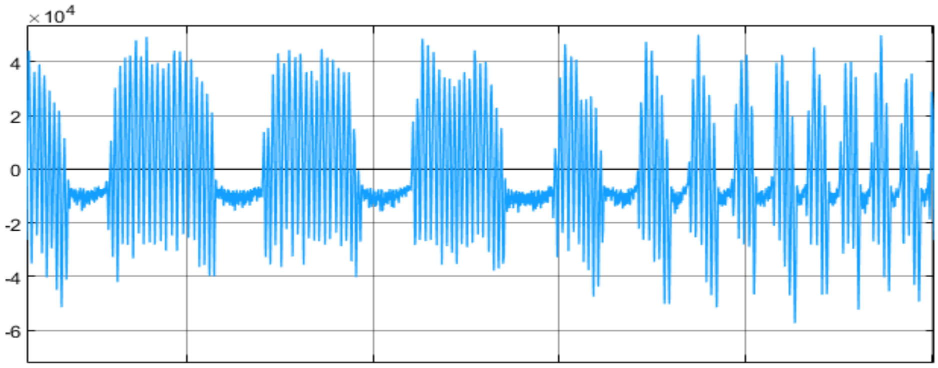

Fig.1.4. Changing the current I_{dr} through the control unit

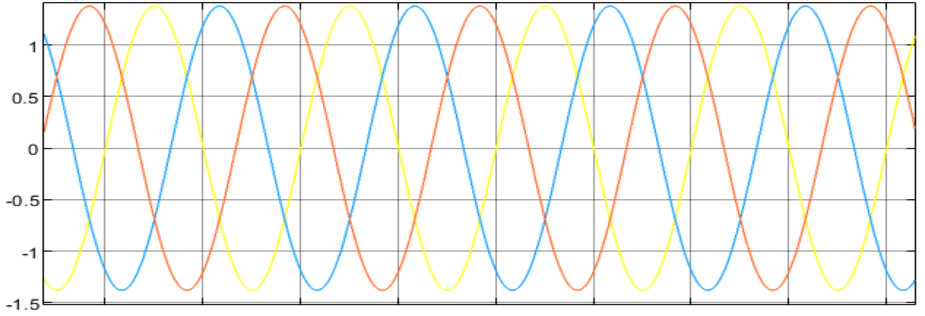

Fig.1.5. Un voltage change via control box

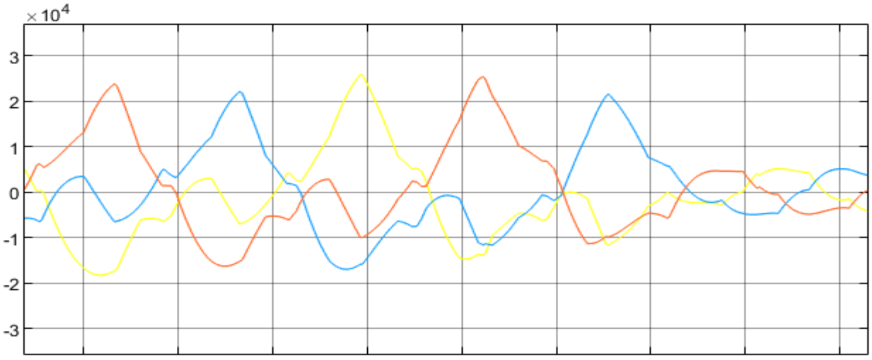

Fig.1.6. Changing the current through the control unit

The main feature of the control of a multi-link motor drive system is the interaction of mobility levels at high speeds of the working body [1-5].

When building intelligent control systems, an increase in the speed of generating control signals is achieved through the use and processing of knowledge in the process of generating control signals [10]. By using the knowledge embedded in the control system, it will be possible to significantly increase the speed of calculating the control law, since the results necessary for this are not calculated in the control process, but are taken from the knowledge base. For example, in contrast to adaptive control systems, where the parameters of a controller with a certain motion trajectory must be calculated during operation, in intelligent systems, a set of controller settings can be included in the knowledge base and this knowledge can be used.

Based on the research, it is possible to develop a general methodology for studying the stability of processes in electric drives, where the parameters of the regulator are discrete and the characteristics of the actuator are constantly changing. The variable part of the mathematical model of a single-engine system is as follows (Fig. 1.2).

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