Abstracts of the scientific papers

of

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Indikator	Total publications	Authored publications	Co-authored publications		
			1-st author	2-nd author	3-rd author
В.4	10	3	3	2	2
Г.7	2	2	-	-	-
Г.8	13	3	1	6	3

Abstracts in category B.4 – habilitation work – scientific publications indexed by world-renown referencing databases

[B 4.1] Marinov E., **Zhekov Zh.**, Neural Sensorless Control of Induction Motor, Advances in Intelligent Systems and Computing, vol.679, 2018, pp 411-418 (Proceedings of the Intelligent information technologies for industry – IITI’2017, 14-16 September 2017, Varna, Bulgaria)

In this paper are presented the problems for realization of direct adaptive neural sensorless control in combination with vector principle for induction motor control. Control system containing neural controllers of the speed and flux channels and neural speed estimator is proposed. These neural controllers perform a function of both speed and active stator current controllers (for the first channel), and respectively flux and excitation stator current controllers (for the second channel) compared to classical vector control. Neural speed estimator is designed as a neural model of the plant. For the controllers and estimator are used on-line trained backpropagation neural networks. Simulation research confirmed sufficient system performance at wide range input signal variation is done. The system is characterized by a simplified structure of the neural model for direct neural adaptive control realization, formed by two identical channels (speed and rotor flux) and neural speed estimator. The simulation research confirms the system performance at reference speed, load torque and moment of inertia variations. The behavior of the system corresponds to the desired quality set by the reference model.

[B 4.2] Atanasov N., **Zhekov Zh.**, Grigorov I., Alexandrova M., Application of Principal Component Analysis for Fault Detection of DC Motor Parameters, Advances in Intelligent Systems and Computing, vol.680, 2018, pp 312-322 (Proceedings of the Intelligent information technologies for industry – IITI'2017, 14-16 September 2017, Varna, Bulgaria)

The main purpose of the principal component analysis (PCA) is to reduce the dimensionality of a data set containing a large number of interrelated variables, retaining at the same time as much as possible of the variations presented in the initial data set. This reduction is achieved by transformation to a new set of the uncorrelated variables called principal components. They are arranged so that the first few of them retain the most of the variations of all of the original variables presented. This paper presents an application of the principal component analysis for real time fault detection of DC motor parameters. The demonstrated simalation results verify the application possibility of the PCA method for real-time fault detection in DC motor. Additive faults of the input and output variables are more easily detected compared to changes in the model parameters. On the other hand the gain model parameters are more efficiently detected in contrast to the time constant parameters. A weak point of the proposed method is the lack of fault isolation capabilities.

[B 4.3] Grigorov I., Atanasov N., **Zhekov Zh.**, Alexandrova M., Application of Recursive Method for Parameter Estimation in Adaptive Control of DC Motor, Advances in Intelligent Systems and Computing, vol.680, 2018, pp 420-427 (Proceedings of the Intelligent information technologies for industry – IITI'2017, 14-16 September 2017, Varna, Bulgaria)

In this article is proposed an application of recursive methods for parameter estimation in adaptive control of a DC motor. The simulation results verify the application possibility of recursive methods of least squares (LS) and instrumental variables (IV) for parameter estimation in adaptive control of DC motor. The results in the low speed interval contains most variance from the set value. As it's already known the recursive instrumental variable method require a second noise signal for the output of the process for better estimates but this affects the control quality. The described methods for parameter estimation can be modified for better performance and process quality in other adaptive control systems operated in real time. When selecting a different weighting can be obtained different variety of robust estimates that can be noise resistant.

[B 4.4] Zhekov Zh., Sensorless Indirect Neural Control of Induction Motor, XXVII International Scientific Conference Electronics – ET2018, 13-15 September 2018, Sozopol, Bulgaria, , pp 285-288

The paper proposes an indirect adaptive neural sensorless control in combination with a vector principle for the control of an induction motor. A control system contains neural regulators of velocity and flux channels. The second mechanism for control signal generation is used, in which the weights of the neural controller are first calculated based on the weights of the online trained neural model of the object and the error between the reference model and the corresponding controlled variable, and then the neural controller generates a control signal. The conducted simulation research confirms the workability of the system when changing the reference speed, the load torque and the moment of inertia within wide range. The behavior of the system practically corresponds to the desired quality set by the reference model.

[B 4.5] Zhekov Zh., E.Marinov, Neural Control of Two-link Planar Robot, XVI-th International Conference on Electrical Machines, Drives and Power Systems ELMA 2019, 6-8 June 2019, Varna, Bulgaria, pp 229-232.

Because in general robots are nonlinear plants with uncertain and variable parameters and interconnected inner loops that gives reason neural networks (NN) to be used in robotics. Every of the mentioned problems above potentially can be solved separately or several of them can be solved simultaneously by NN. In this paper is proposed neural control of a two-link planar robot. The control system contains one feedforward neural network used as both neural model and neural controller. Neural network on-line learning process, based on gradient descent rule and error backpropagation is used. Accomplished simulation research confirms sufficient system performance at load variation. The accomplished research (part of it is represented in this article) confirms sufficient system performance at load variation and validate an adaptive properties of the robot control system.

[B 4.6] Zhekov Zh., Inverse Kinematics Neural Approximation and Neural Control of Two-link Planar Robot, 2020 International Conference Automatics and Informatics (ICAI), Varna, Bulgaria, 2020, pp. 1-5

In this paper is proposed inverse kinematics neural approximation and dynamics neural control of a two-link planar robot. Suggested neural control system is based on the system proposed in [B 4.5] upgraded with neural approximator which solve inverse kinematics task and allow control system to operate at unknown robot kinematics in addition to unknown robot dynamics. The control system contains two neural networks. The first of them is off-line training and is used as approximator of the robot kinematics. The second neural network is on-line training and is used as both - neural model and neural controller. Accomplished simulation research confirms sufficient system performance at load variation and links length variation. An oscillation are observed at the desired path tracking. There are two possible reasons for these oscillations – first of them is the performance of the block "Dynamics Neural Control" and the second is non-perfect desired angles generated from the NA. From the MSE is clear that the error $\varepsilon_{\theta 1}$, when NA generated desired angle for the first link, causes more harmful effect to the entire system performance compared to the error $\varepsilon_{\theta 2}$, when NA generated desired angle for the second link.

[B 4.7] Zhekov Zh., N.Atanasov, I.Grigorov, Modeling and Neural Control of 2-DOF Underwater Planar Manipulator, 2020 International Conference Automatics and Informatics (ICAI), Varna, Bulgaria, 2020, pp. 1-6

In this article is proposed neural control designed for a land-based manipulator [B 4.5] to be applied for control of a 2-DOF underwater planar manipulator. In the underwater manipulator model is taken into account hydrostatic and hydrodynamic forces. Adaptive properties of a neural control system is explore at various parameters of the load. The accomplished research confirms sufficient system performance at load variation and validate an adaptive properties of the underwater manipulator control system. Practically the same transient processes of the angles and the same manipulator trajectory at different loads are possible due to commanding from the control system and generated from the motors different transients of the torques in any experiment.

[B 4.8] Grigorov I., Atanasov N., **Zhekov Zh.**, Comparation in application of recursive estimation and control of the real DC motor parameters in adaptive pole placement control system and adaptive system with self-tuning regulator with minimum variance, 2020 International Conference Automatics and Informatics (ICAI), Varna, Bulgaria, 2020, pp. 1-4

In this paper a comparation is made of recursive estimation and control of the real DC motor parameters in adaptive pole placement control system and adaptive system with self-tuning regulator with minimum variance. The simulation results verify the application possibility of described methods for recursive parameter estimation of the real DC motor parameters in adaptive pole placement control system and adaptive system with self-tuning regulator with minimum variance. As one can see from the results self-tuning regulator with minimum variance using recursive least squares with the use of residues instead of evaluation error (RLSr) in red contains most variance from the set value. That is due to extra step in the estimation algorithm and the current limitation from the Arduino Board and the code for the communication between the board and Matlab. As one can see with the use of regular recursive least squares the response is faster than the pole placement control system due to skipping the step of the solution of Diophantine equation.

[B 4.9] Zhekov Zh., Atanasov N., Modelling and Control of 2-DOF Underwater Manipulator in Presence of Disturbances, 2021 International Conference Automatics and Informatics (ICAI), Varna, Bulgaria, 2021, pp.333-336

In [B 4.7] a neural system for control of an underwater manipulator with a fixed base is proposed, as the adaptive properties of the system when changing the load parameters (dimensions and mass) is studied. The purpose of this report is to expand the research of this control system by considering the influence of underwater currents and the inaccurate positioning of the submarine apparatus on the operation of the manipulator and the possibility of the suggested neural control system of the manipulator to deal with these disturbances. This report provides modelling and neural control of an underwater manipulator. It is proposed the inaccurate positioning and orientation of the underwater vehicle, where the manipulator is mounted on, and water currents, influencing manipulator performance, to be compensated by manipulator control system. It is assumed that the disturbances caused by underwater currents and/or the inaccurate positioning of the underwater vechicle and affecting the manipulator control system have a periodic character - sinusoidal. It is clear that in order the control system of the manipulator to be able to compensate the disturbances, their parameters (amplitude and frequency) must have values in an allowable range. This issue is discussed in more detail in [B 4.10] where an extended study of this system is presented.

[B 4.10] Zhekov Zh., Extended Research of Neural Control System for 2-DOF Underwater Manipulator, 2021 International Conference Automatics and Informatics (ICAI), Varna, Bulgaria, 2021, pp.337-340

In [B 4.9] is modeled 2-DOF underwater planar manipulator in the presence of disturbances and proposed neural system for its control. The purpose of this report is to expand the research of this neural control system by considering the influence of the sinusoidal disturbances at different values of the amplitude, frequency and phase shift. The aim of this report is to extend the study of this neural control system by considering the influence of sinusoidal disturbances at different values of their parameters – amplitude A, frequency f and phase shift φ. The permissible values of the parameters of the deviations of the underwater apparatus were investigated, so that the maximum errors of the underwater manipulator when following a certain trajectory are below a certain value - 10^{-2}m.

Abstracts in category Г.7 - scientific publications indexed by world-renown referencing databases

[Г 7.1] Zhekov Zh., Application of a modulus and symmetrical optimum tuning methods for a cascade control system of a 2-joint planar robot, 2022 International Conference Automatics and Informatics (ICAI), Varna, Bulgaria, 2022, ICAI 2022 – Proceedings pp. 45-49

In this article is proposed 2-joint planar robot cascade control with tree loops. It is consider opportunity for tuning of current (torque) loop, speed loop and angle loop controllers based on optimization methods modulus and symmetrical optimum after feedback linearization of the nonlinear dynamics of the robot. The following disadvantages can be noted: the modulus optimum tuning of the position regulator leads to system instability and its proportionality coefficient must be reduced. The robot lags behind the desired trajectory by 8 mm due to a slow acting of the position loop, and this can be eliminated by increasing its proportionality factor, which is not desirable due to the mentioned above, or by using a combined control principle in the position loop – control by deviation and feedforward control. Feedforward control leds to fast action improoving without stability deterioration. After the corrections the research shows a good tracking of the desired trajectory regardless of the added 1% white noise. The conducted simulation research confirms the good performance of the system under different operating conditions.

[Г 7.2] Comparative study of two on-line trained neural approximators of a robot inverse kinematics, 2022 International Conference Automatics and Informatics (ICAI), Varna, Bulgaria, 2022, Proceedings pp. 24-28

Unlike [B 4.6] where is consider off-line neural approximator of the robot inverse kinematics in this paper are proposed two online trained neural approximators of the robot inverse kinematics. The first one (NA1) consists of an inverse neural model of the robot forward kinematics, and the second one (NA2) consists of a forward neural model of the robot forward kinematics and an optimization procedure. The working principle of approximators requires robot forward kinematics input and output variables to be known (measured). For comparison of their performance is used two-link planar robot and its kinematics. Two sets of simulation studies were conducted. The first group investigates the neural approximators working separately from the robot control system, in which case they receive data from the system, and it receives reference positions (angles) from the exact solution of the inverse kinematics. The second group of studies observes the operation of the control system working with one or the other neural approximator, from which it receives reference positions. In

stand-alone operation NA1 performs better than NA2, but the two-link robot control system works better with NA2.

Abstracts in category Г.8 – scientific publications in non-indexed journals or in edited collective proceedings

[Г 8.1] Marinov E., **Zhekov Zh.**, Adaptive sensorless control of asynchronous electric drive, International Conference AUTOMATICS AND INFORMATICS'09, SAI, Bulgaria, 2009, I-93÷I-96

Asynchronous electric drive is proposed characterized by an adaptive speed regulator and a neural estimator of the speed. Two adaptive regulators of the speed have been synthesized using the theory of hyper-stability and using the second method of Lyapunov. As the system is constructed as sensorless, it is necessary to replace the actual speed with speed estimates. Speed assessment is obtained through a neural rstimator and the assessment of flux by a conventional estimator. The neural estimator is characterized by an offline training procedure. Due to the complexity of the mathematical model of induction motor, the large number of input vectors and a significant number of variables in each vector used a three-layer neural network with backpropagation of the error with two nonlinear and one linear layer (Tansig, Tansig, Purelin). The number of neurons in the first two layers is selected experienced, respectively S1 = 8 and S2 = 16 neurons, with a balance between the accuracy and the complexity of the neural model. The number of neurons in the output layer S3=1 is uniquely determined by the number of output variables included in the target vector. Simulation studies have been performed showing that the control system with the synthesized adaptive speed regulators and a neural speed estimator invariably maintains the quality of the transient speed when changing the reference speed, load torque and the total inertial moment in the range: $\omega_{ref}=[-\omega_n \div \omega_n]$; Mc=[0÷1]Mn; J=[1÷3]Jb. The used methods for regulator synthesis guarantee the stability of the speed channel and the stability of the whole system .

[Г 8.2] Marinov E., **Zhekov Zh.**, Adaptive neural sensorless control of asynchronous electric drive, Annual of TU-Varna'10, TU-Varna, Bulgaria, 2010, vol. I pp. 169÷174

The report examined an opportunity for the implementation of asynchronous electric drive with adaptive, sensorless, neural control, based on a two -channel structure of the control system (speed channel and rotor flux channel) and the use of the reference and neural model of the plant, and the iterative estimator of the the speed, rotor flux and the active resistances of the motor. The neural model used to implement direct adaptive control is characterized by a simplified structure. The performance of the system based on simulation tests is shown at change the reference speed and the load torque in allowable range for the motor and at various inertial moments of the drive mechanism.

[Г 8.3] Hristoskov H., Skopchanov M., **Zhekov Zh.**, Draganova E., A Simulink based system for horizontal stabilization of an aircraft, International Conference AUTOMATICS AND INFORMATICS'10, SAI, Bulgaria, 2010, I-125÷I-127.

It is developed two-propelled laboratory model of an aircraft, which enables the study of the processes related to the horizontal position of the apparatus, but without considering the processes related to displacement in the direction of descent or elevation, which occurred as a result of the rotation around the longitudinal axis. Two DC motors are used, which realize the rotation of the arm on which they are mounted. Their control is implemented with pulse-width modulation. The sensor that provides information about the angle of rotation of the arm is an incremental encoder. The interface between the computer and the power unit is based on a microcontroller of the PIC18F25x family. The control program is implemented on the personal computer using Simulink and has the task of submitting the necessary task to the microcontroller interface, receiving information about the reported rotation in response. The performed experimental studies confirm the workability of the system when applying constant and variable (sinusoidal) reference position and disturbing effects were also applied. The speed with which the system can handle a reference position depends primarily on the data transfer rate between the computer and the interface board. The proposed Simulink-based control system allows easy testing of different control laws.

[Г 8.4] Todorov Ts., **Zhekov Zh.**, Atanasov N., Marinov E., Control of a two-link horizontal robot through a feedback linearization, Annual of TU-Varna'12, TU-Varna, Bulgaria, 2012, vol. I pp. 105÷109.

The purpose of this paper is to present an application of the idea of linearizing feedback in the control of a two-joint horizontal robot. The two joints are driven by DC motors through gearboxes. Information about the speed and position of the joints is obtained from encoders coupled to the motors. Simulation studies of the described two-joint robot and the synthesized control were carried out at the following values of the mass of the load: ml=10kg and ml=15kg. When the load increases, the execution of the tasks is related to an increase in the voltages to the two motors and the torques developed by them, and a certain short-term overloading of the motors by torque (current) is observed during the transient process. The selection of the coefficient λ, which determines the speed of the system when the error is corrected, also affects the current load of the motors. In steady state, the voltages and currents of the two motors are zero, since the two joints move in the horizontal plane and no torque is required to maintain the load mass and the robot structure itself in the reached position.In the considered case, the reduced moments of inertia of the motors, as well as the moment of inertia determined by the mass of the motor driving the second joint, are commensurate with the moments of inertia of the joints and the load, which necessitates their consideration.

[Г 8.5] Marinov E., Atanasov N., **Zhekov Zh.**, Todorov Ts., Control of a two-link vertical robot through a feedback linearization, International Conference AUTOMATICS AND INFORMATICS'12, SAI, Bulgaria, 2012, pp. 66÷69.

The essence of the linearizing feedback is an algebraic transformation of the nonlinear dynamics into fully or partially linear, in order to use linear control methods. The purpose of this paper is to present an application of the idea of linearizing feedback in the control of a two-joint vertical robot. The two joints are driven by DC motors through gearboxes. Information about the speed and position of the joints is obtained from encoders coupled to the motors. In contrast to [Г 8.4], in the mathematical model of the dynamics of the robot and in the synthesis of the control, the gravitational forces are taken into account. Simulation studies of the described two-joint robot and the synthesized control were carried out at the following values of the mass of the load: ml=6kg and ml=9kg. A good handling of the angular position and angular velocity tasks by both joints of the robot is observed. The absolute values of the maximum errors by position are respectively: ε_{1max}=0.007rad and ε_{2max}=0.009rad, and by speed – ε'_{1max}=0.166rad/s and ε'_{2max}=0.176rad/s. When the load increases, the execution of the tasks is related to an increase in the voltages to the two motors and the torques developed by them, and a certain short-term overloading of the motors by torque (current) is observed during the transient process. In a steady state, the voltages and currents of the two motors are not zero, since the two joints move in the vertical plane and a moment is required to maintain the load mass and the robot structure itself in the reached position. The moments developed by the motors are comparable to those from [Г 8.4], since the gravitational forces influencing the robot are taken into account here, but in order not to have a significant overload, the mass of the load has been reduced.

[Г 8.6] Marinov E., **Zhekov Zh.**, Todorov Ts., Sensorless direct torque control of an induction motor, Annual of TU-Varna'13, TU-Varna, Bulgaria, 2013, vol. I pp. 191÷195 (Collection of reports from the Jubilee International Conference 50th "ETET" Department - October 4-5, 2013, Bulgaria).

An asynchronous electric drive with sensorless direct torque control is proposed by obtaining the estimates of the motor speed ($\hat{}\omega_r$), the electromagnetic moment ($\hat{}M_e$) and the stator flux vector ($\hat{}\Psi_s$) by means of an iterative estimator based on the phase stator current signals and the input inverter voltage Ud. Based on the conducted simulation studies, the following conclusions can be drawn. When starting directly (without pre-excitation), a transient process is observed, characterized by larger currents and current ripples compared to the set value. With pre-excitation, the magnetization and spin processes occur separately, as a result of which the amplitude and duration of the inrush current are significantly reduced. By means of the limitation introduced in the speed controller, the stator currents are limited to a value of approximately 2Isn except for the initial starting interval in which the motor is excited to the set value. By reducing the hysteresis zones hM and bM of the torque and flux controllers, the magnitude of the ripples of Me and Ψs, respectively, is reduced, whereby the hodograph of the stator flux vector (after its establishment) is close to an ideal circle.

[Г 8.7] Marinov E., Zhekov Zh., Todorov Ts., Sensorless direct torque control of AC drive with motor resistances estimation, International Conference AUTOMATICS AND INFORMATICS'13, SAI, Bulgaria, 2013, pp. I-75÷I-78.

The paper proposes a possibility to build an asynchronous electric drive with sensorless direct torque control by obtaining the estimates of the motor speed ($\hat{}\omega_r$), the electromagnetic torque ($\hat{}M_e$) and the stator flux vector ($\hat{}\Psi_s$) by means of an iterative estimator based on the signals on the phase stator currents and the input voltage of the inverter Ud. In contrast to [Г 8.6] here by evaluating also the active resistances of the stator and rotor windings ($\hat{}$Rs and $\hat{}$Rr), their change during motor operation is taken into account. The research shows that the system is operable in the range Dω=100:1, and at low speeds (ω_{ref} =1rad/s) the steady state load error reaches 5% (0.05rad/s) at nominal load. By means of the limitation introduced in the speed controller, the stator currents are limited to a value of approximately 2Isn except for the initial starting interval in which the motor is excited to the set value. The estimations of the active resistances practically reach their actual values for t<2ms, the accuracy being satisfactory if the estimation is done at zero motor speed. A disadvantage of the estimator is the complexity of the work algorithm by which it is implemented, which would place high demands on the computing device in practical implementation.

[Г 8.8] Zhekov Zh., DC motor control based on digital signal controller TMS320F28335, Computer Science and Technologies journal, vol.2, TU-Varna, Bulgaria, 2013, pp.24÷29 (Collection of reports from the 45th Jubilee Scientific Conference of the Computer Science and Technology Department - September 27-28, 2013, Bulgaria)

In this report, closed-loop DC motor (DCM) control is developed using the eZdspF28335 development board, the core of which is the Texas Instruments TMS320F28335 digital signal controller, which is intended for the construction and research of ED. The built control system consists of the following main blocks: control block (eZdspF28335), power converter (LMD18200 of National Semiconductor), blocks for galvanic decoupling and signal scaling, power supply blocks, DC motor with tachogenerator (TG) type PIVT 6-25/3A. The control program is built as a Simulink model. Blocks from the Target Support Package TC2 libraries are used that are compatible with certain Texas Instruments digital signal controllers, including the one used. Real-Time Workshop (RTW) software from Matlab is used along with Code Composer Studio (CCS) software. From the experimental studies carried out, it is established that the system is operable, observing a good performance of the task at a speed varying in a wide range n_{ref} [$-n_n \div n_n$] and at different times for acceleration and stopping.

[Г 8.9] Marinov E., **Zhekov Zh.**, Petkov N., Controlling the movement trajectory of a two-joint planar robot, Annual of TU-Varna'14, TU-Varna, Bulgaria, 2014, vol. I pp.103-107.

The aim of the present paper is, using linearizing feedback, to synthesize the control actions of the actuators of a two-joint planar robot so that it performs with a certain accuracy for a given law of motion of the operating point R (xR(t), yR(t)) of the robot. Each of the robot's joints is driven by a DC motor. A control based on the linearizing feedback method was synthesized, working out a set trajectory of the robot's movement. Simulation studies are presented, confirming the workability of the system under different laws of motion of the robot end effector. The results were obtained with a base value of the load ml=6kg. The curves of the set and actual values of the angles and their derivatives practically coincide. The position and velocity errors are maximum in the initial section of the processes, which is due to the inaccuracy in determining the initial conditions for the velocity and the acceleration. The implementation of the specified control laws is carried out at currents and voltages below the nominal values of the motors.

[Г 8.10] Marinov E., Todorov Ts., **Zhekov Zh.**, Petkov N., Adaptive vector control of permanent magnet synchronous motor, International Conference on Electrical Machines, Drives and Energy Systems, ELMA 2015, 1-3 October 2015, TU-Varna, Varna, 2015, pp.91 – 94.

This paper consider the opportunity for development of permanent magnet synchronous machine (PMSM) vector control system with desired quality. It is designed model reference adaptive system (MRAS) based on hyperstability theory. Conducted simulation research confirmes the opportunity to maintain the quality of speed transient processes in wide range of reference speed, load and inertia. The research is conducted by Matlab/Smulink/SimPowerSystems and power converter processes are taken into consideration. The results confirm that the quality of dynamic processes of rotation speed is practically independent of load and inertia variations. When the inertia is increased the stator current active component i1q in transition process is increasing, too. The achievement of desired behavior ωm is possible when the current is less than the limit. The current load of motor is affected by the desired dynamics assigned to reference model and the choice of tuning coefficients γ1 and γ2 which specify the reaction time of the system.

[Г 8.11] Zh.Zhekov, E.Marinov, Indirect Adaptive Neural Control of Induction Motor, International Conference AUTOMATICS AND INFORMATICS'18, SAI, Bulgaria, 2018, pp. 45-48.

In this paper is presented design of an asynchronous electric drive based on a two-channel structure of the control system with neural control using model based approach. It is used two neural networks. First of them is used for the neural model and neural controller for the channel of the speed. The second is used for the neural model and neural controller for the channel of the flux. Following mechanism is used for producing the control action by every neural network: 1. Training the neural network as neural model of the plant via back propagation algorithm and neural model weights and biases obtaining; 2. Calculating the neural controller weights and biases by gradient descent rule. This calculation is function of an error between the reference model signal and plant output, and neural model weights and biases; 3. Loading neural controller weights and biases in the same network and producing control signal u(k). The simulation research confirms the system performance at reference speed, load torque and moment of inertia variations. The behavior of the system practical corresponds to the desired quality set by the reference model.

[Г 8.12] Zhekov Zh., Development of a two-joint robot for educational purposes, Computer Science and Technologies journal, TU-Varna, Bulgaria, 2022, vol.2 pp.65-71

The paper discusses the development of a two-linked robot-manipulator and its control system. The developed robot consists of: a working field; two joints rotated by DC servo drives Dynamixel MX-64T and AX-12A from Robotis. The position setpoints for the two servo drives are generated using the Matlab programming environment, and their connection to the personal computer is realized using a USB2Dynamixel converter. In the developed program, coordinates of base points are entered, linear interpolation is performed between these points, and the coordinates thus generated are converted by means of the solution of the inverse kinematic task into setpoints for the two servo drives. Experimental studies of the robot and the developed control system have been carried out. A relatively good match between the task and the execution is observed, with deviations mainly due to: insufficiently precise manufacturing of the mechanical part of the two-jointed robot; backlash in the gear boxes of the servo drives; insufficiently precise attachment of the end effector – pen; insufficiently accurate orientation of the coordinate system of the manipulator relative to the coordinate system of the working field.

[Г 8.13] Zhekov Zh., Simulation research of a coordinated control system of two-motor electric drive, Computer Science and Technologies journal, TU-Varna, Bulgaria, 2022, vol.2 pp.6-13

In the publication, a system for coordinated control of a two-motor electric drive has been modeled, which must synchronize the operation of two axes - master and slave. The system is two-channel, with the first channel (master) being single-loop with closed-loop speed and the second channel (slave) being two-loop with closed-loop speed and position. The purpose is for the first channel to maintain a constant speed of the respective motor and actuator. After exceeding a certain angular position, a position command is applied to the second channel, which is a function of the position of the first actuator. When the command from the second channel is correctly executed, the second executive mechanism catches up with the first and a certain angular path they move together (synchronously), after which a zero position command is sent to the second channel and the second executive mechanism returns to the starting position. Then the cycle repeats. The two channels, master and slave, are set to a modular optimum, and the need to implement combined control and fine-tuning of the second channel to achieve satisfactory quality indicators has been established.

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