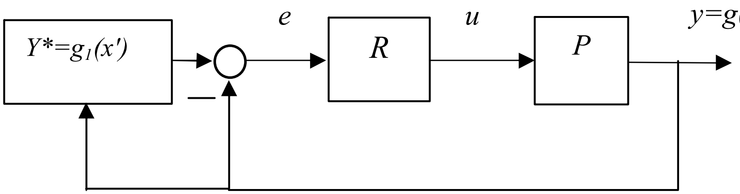

Рисунок 1 – Структура управления

Требуется определить сигнал задания Y^* по критерию оптимальности $Q(x') = Q_{\min}(x')$, где x' - вектор состояния объекта в установившемся режиме. Алгебраические уравнения установившегося режима системы имеют вид

$$0 = f(x') + b(u),\ y = g(x').$$

В задаче минимизации эти уравнения определяют ограничения. Минимизация критерия $Q(x')$ с учетом ограничений дает функциональную зависимость $Y^*=g_1(x')$ такую, что ошибка регулирования e (рисунок 1) остается ограниченной во всем диапазоне изменения переменных, так как разность $g_1(x') - g(x)$ ограничена по абсолютной величине, и это способствует работе регуляторов в зоне линейности.

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ARCHITECTURE OF CONTROL UNIT OF A BRUSHLESS DC MOTOR ON BASE OF NEURAL NETWORK

Keywords: brushless motor, control unit, backpropagation neural network.

Abstract: PID control is used to control the electric motor, which has a simple structure, high reliability and ease of engineering implementation. The paper proposes the development of a forward-propagation neu-

ral network with back-propagation of error for tuning the coefficients of the PID controller when controlling a brushless DC motor.

Main part. The optimal solution obtained by dynamic programming is always the global optimal solution that solves the local optimization problem [1]. Its main principle is to correctly divide the actual problem into thousands of stages and adopt a step-by-step solution to the problem. However, this method does not have a single standard model and requires a lot of data to store. Currently, the most commonly used method is the hybrid method, which combines the gradient descent method and the conjugate gradient method. First, the gradient descent method is used to quickly converge the network near the extreme value, and then the conjugate gradient method is used to overcome the disadvantage of the slow convergence of the gradient descent method near the extreme value [2]. Of course, the key to this method is to find the turning point of the gradient descent method and the conjugate gradient method, which is also the difficulty of this method. The advanced BP neural network combining algorithm is highly displayable but easily amenable to local optimization. Genetic Algorithm (GA), Chaotic Algorithm (CA), and Simulated Annealing Algorithm (SA) do not need gradient, have little dependence on performance index function, wide application range of z1wAQ, good reliability, and are suitable for parallel computing, but not suitable for global optimization . Therefore, an organic combination with a BP neural network can complement each other's strengths and avoid weaknesses [3].

The paper proposes the development of a speed controller based on a back-propagation (BP) neural network. Figure 1 shows the MATLAB/ Simulink blocks used.

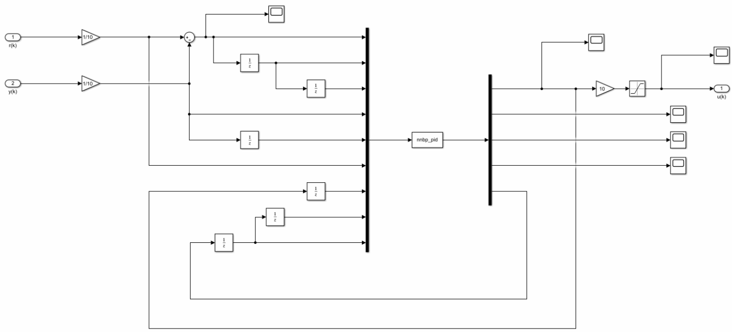

Figure 1 – BP-PID controller

To develop the architecture of a brushless DC motor control unit based on a neural network, we will build an S-fiction as a BP neural network controller based on a mathematical model

$$u(k) = f\,[u(k\text{-}1),\ K_P,\ K_I,\ K_D,\ e(k),\ e(k\text{-}1),\ e(k\text{-}2)]$$

where f [ ] is a nonlinear function related to K_P, K_I, K_D, u(k-1), e(k), etc. BP neural network NN can be used to find such an optimal control law through training and learning.

The S-function of the BP neural network of the PID controller works as follows:

The input of S-function is: u = [e(k); E(k-1); E(K-2); Y(k); Y(k-1); R(k); U(k-1); hidden layer + output layer weight coefficient (K-2); hidden layer + output layer weight coefficient (k-1)] = [u (1); U(2); U(3); U(4); U(5); U(6); U(7); ... U (number of hidden layer weights + number of output layer weights)]. The purpose of returning all weight coefficients from output to input is to update the weight matrix and adaptively adjust the three PID parameters.

This function has four external input variables: T, nh, xite and alfa. T inputs the sampling time, NH determines the number of hidden layers, and the learning rate and inertia coefficient in the weight coefficient correction formula of xite and alfa.

Thus, the neural network controller BP was simulated in MATLAB/Simulink. Control response speed can be optimized by adjusting the BP neural network hidden layer weight and the number of neural network layers.

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