На основании вышесказанного, разработанный автоматизированный электропривод вибрационного стола полностью отвечает предъявляемым к нему требованиям.

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## DEVELOPMENT OF A PID CONTROL SYSTEM SCHEME BASED ON A BP NEURAL NETWORK FOR A BRUSHLESS DC MOTOR

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At present, the drive motors suitable for electric vehicles mainly include: AC induction motor, permanent magnet synchronous motor, and switched reluctance motor. PID control is still used to control electric motors due to its simple structure, high reliability and ease of engineering implementation. When the parameters of the system model change little, the performance of the PID controller is excellent. However, there are many complex control objects and non-linear control objects that cannot be established by exact mathematical models in the industry. If the traditional PID controller is used for control, it is difficult to achieve the perfect control effect. For a brushless DC motor, this is a multivariable and highly coupled non-linear system. A PID controller with fixed parameters cannot provide an ideal indicator of control efficiency. Based on the above reasons, the paper proposes the development of a neural network PID controller applied to a brushless DC motor based on a BP neural network. Neural network has the ability of arbitrary nonlinear expression, and the PID control with the best combination can be realized by learning the system performance. A PID controller with self-tuning parameters KP, Ki and KD can be established by using BP neural network. The structural block diagram of PID control system based on BP neural network is shown in the following fig. 1.

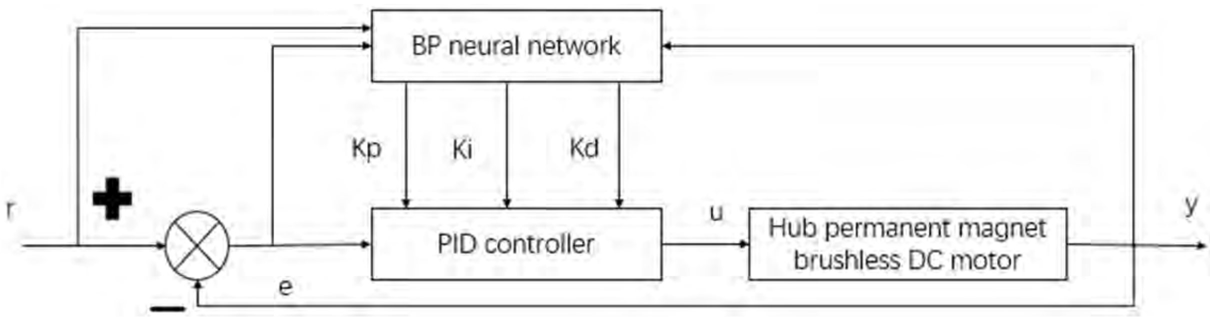


Fig. 1. Structure block diagram of PID control system based on BP neural network.

The controller consists of two parts: classical incremental PID controller; BP neural network.

The control formula of classical incremental digital PID is

$$u(k)=u(k-1)+K_P[e(k)-e(k-1)]+K_I e(k)+K_D[e(k)-2e(k-1)+e(k-2)]$$

where: Kp, Ki and Kd are the proportional, integral and differential coefficients respectively; E (k) is the difference between the expected output and the actual output at the current sampling time; U (k) is the control quantity at the current sampling time.

When KP, Ki and KD are regarded as adjustable parameters depending on the operating state of the system, the above formula can be described as

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

Where f (u) is a nonlinear function related to kp, Ki, Kd, u (k-1), y (k), etc.

Thus, we can conclude: BP neural network NN can be used to find such an optimal control law through training and learning. Although BP network has strong non-linear mapping ability, it has played an important role in many practical applications. Moreover, the parameters such as the number of middle layers of the network, the number of processing units in each layer and the learning factor of the network can be set arbitrarily according to the specific conditions, which makes the network more flexible.