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Single neuron adaptive control and parameter optimization of lower limb rehabilitation exoskeleton

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Abstract

For the bottom position control of the lower limb exoskeleton robot driven by DC motor, a single neuron adaptive control method with parameters selected by the improved whale optimization algorithm is proposed. Since the parameter tuning process existing in traditional control is cumbersome and it is difficult to achieve optimal control accuracy, we present a single neuron adaptive controller to improve the control accuracy. In addition, in order to complete the optimal selection of controller parameters, the whale optimization algorithm is used to select parameters, this algorithm is improved, and the optimization simulation results are displayed. Finally, an adaptive underlying controller is designed, and the simulation results are compared with the traditional PID control. The results show that, compared with the traditional method, the single neuron adaptive control with the optimized parameters of the improved whale optimization algorithm has better control effect.

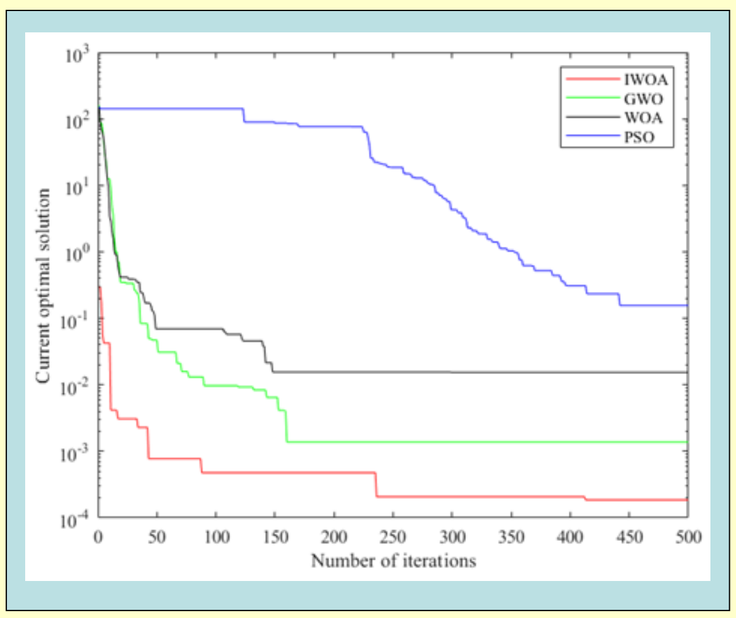

Fig.1 Unimodal Test Function Convergence Curve

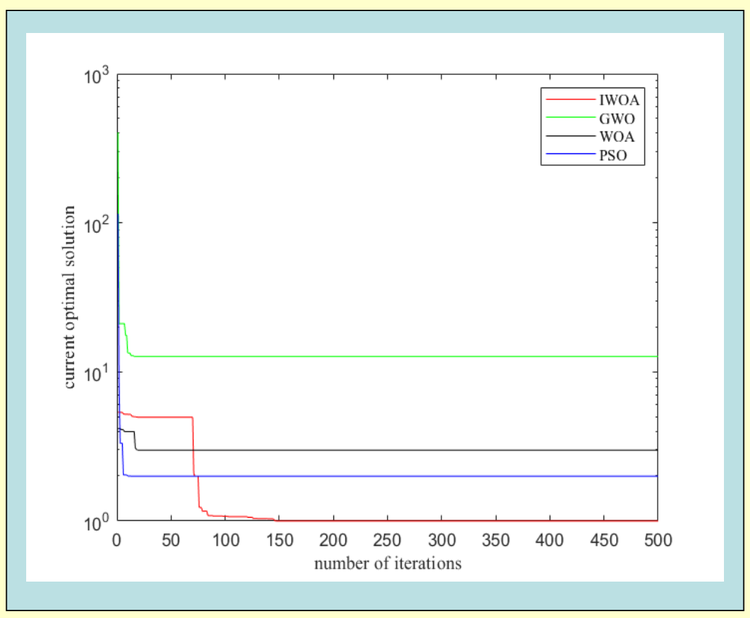

Fig.2 Multimodal Test Function Convergence Curve

Fig.1 and Fig.2 show the convergence of the optimization algorithm under single-peak test function and multi-peak test function respectively.

Fig.3 shows the error comparison between the single neuron adaptive controller(IWSNA) and PID controller in position control using the optimization algorithm to select parameters

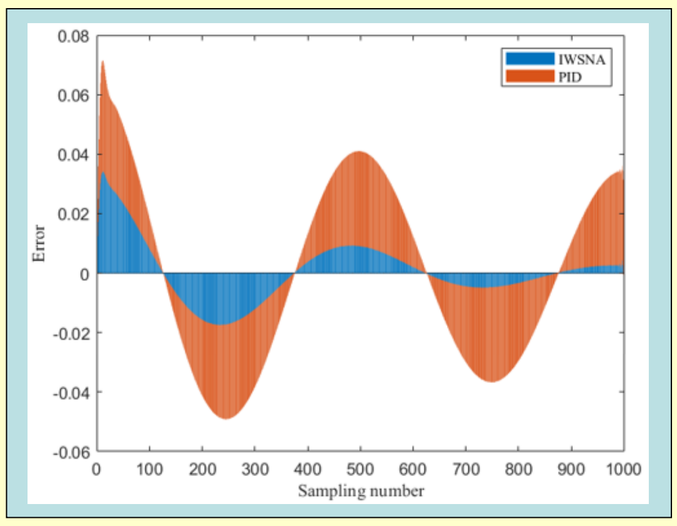

Fig.3 Position Error Contrast Curve

Summary

In this paper, the single neuron adaptive control method is introduced into the bottom position control of the exoskeleton, and the whale optimization algorithm is used to select the parameters. At the same time, in order to make the optimization algorithm suitable for the aforementioned control mode, the optimization algorithm is improved in many aspects, such as initialization population strategy, nonlinear convergence factor and search convergence mode. The results show that the improved optimization algorithm has strong optimization convergence ability, and the single neuron adaptive control method after parameter optimization has better stability and less error.