Optimization of PID Parameters Utilizing Variable Weight Grey-Taguchi Method and Particle Swarm Optimization

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Abstract. Controller that uses PID parameters requires a good tuning method in order to improve the control system performance. Tuning PID control method is divided into two namely the classical methods and the methods of artificial intelligence. Particle swarm optimization algorithm (PSO) is one of the artificial intelligence methods. Previously, researchers had integrated PSO algorithms in the PID parameter tuning process. This research aims to improve the PSO-PID tuning algorithms by integrating the tuning process with the Variable Weight Grey-Taguchi Design of Experiment (DOE) method. This is done by conducting the DOE on the two PSO optimizing parameters: the particle velocity limit and the weight distribution factor. Computer simulations and physical experiments were conducted by using the proposed PSO-PID with the Variable Weight Grey-Taguchi DOE and the classical Ziegler-Nichols methods. They are implemented on the hydraulic positioning system. Simulation results show that the proposed PSO-PID with the Variable Weight Grey-Taguchi DOE has reduced the rise time by 48.13% and settling time by 48.57% compared to the Ziegler-Nichols method. Furthermore, the physical experiment results also show that the proposed PSO-PID with the Variable Weight Grey-Taguchi DOE tuning method responds better than Ziegler-Nichols tuning. In conclusion, this research has improved the PSO-PID parameter by applying the PSO-PID algorithm together with the Variable Weight Grey-Taguchi DOE method as a tuning method in the hydraulic positioning system.

1. Introduction

Hydraulic positioning system has been used in modern industrial applications. This is due to the capabilities of the larger driving force, fast response and high power-to-weight ratio. Hydraulic positioning system is generally categorized in the stabilization and tracking control. This system will always be the driving force to reduce energy consumption and to improve the efficiency and accuracy of the motion control. However, the nonlinearity of the system causes the difficulty for accurate control. Recently, researchers have focused on dynamic characteristics of a hydraulic positioning system for the control purpose. Some of them designed and implemented a suitable controller proper operation with dynamic and nonlinear system [2].