

# Chapter 4

## PID Control Algorithm Based on Genetic Algorithm and its Application in Electric Cylinder Control

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### ABSTRACT

*The traditional PID controller is simple in principle, easy to use, stable and reliable, and it is still widely used in the control field. However, for many nonlinear and lagging objects, the parameter tuning of PID controller is very important. Genetic algorithm provides a new way to optimize the parameters of PID. It uses simple coding techniques and propagation mechanisms to express complex phenomena, which is not restricted by the restriction of the search space. In this paper, the global optimization of genetic algorithm is used to optimize the parameters of PID, which can improve the performance and adaptive capability of PID controller. The mathematical model of the electric cylinder system is established, and the PID controller based on genetic algorithm is used to control the system. The simulation results verify the effectiveness of the proposed control algorithm.*

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## 1. INTRODUCTION

PID controller is the most common type of controller, with the advantages of simple structure, strong robustness and reliability. People is quite familiar with its principle and the physical meaning, because they have established a relatively complete theoretical system. So, it is widely used in process control and motion control, especially to establish precise mathematical model of uncertainty control system (Weier et al., 1998).

In order to meet the needs of different industrial control processes, with the combination of PID control and other control methods, many PID control structures are generated (Deb et al., 2002). How to set the control parameters of the PID controller is a big problem in the practical application of PID. At present, there are many methods for the PID controller parameters of the whole set of research methods. Based on practical experience of parameters setting method, there are many control methods based on logical reasoning and artificial intelligence, such as fuzzy PID, experts PID, composite adaptive fuzzy-PID controller, neural network PID controller. With the control method of various weaknesses, the respective advantage is a research direction of intelligent control (Deb, 2002; Morris et al., 1998).

Genetic algorithm provides a new way to optimize the parameters of PID. Genetic algorithm is a kind of optimization method, which is widely recognized as a global optimal search capability. It only depends on the fitness function, without knowing all the information about the object (Davis & Davis, 1991). In this way, even if in the uncertainty of the object model, it can still according to the output of the object to optimize  $K_p$ ,  $K_i$  and  $K_d$ . Genetic algorithm optimization mechanism can find the global optimal solution.

Genetic algorithm is a simulation of biological genetics and natural selection mechanism, which uses the artificial way to construct a class of optimization search algorithm. It is on the process of biological evolution for a mathematical simulation and evolutionary computation, which also is one of the most important forms. Genetic algorithm and the traditional mathematical model are very different (Bäck, 1997). It points out a solution to the problem that is difficult to find the traditional mathematical model. In 1975, Holland firstly proposed genetic algorithm in his work named *Adaptation in Natural and Artificial Systems*. The book is the more than ten years many of the ideas and the crystallization and describes in detail the theory of genetic algorithm, and to lay the mathematical foundation, developed a set of simulation of the biological adaptive system theory. De Jong did many serious computational experiments (Michalewicz, 1996). The famous De Jong five function test platform is established. He defined the performance evaluation criteria, and took the optimization function as an example to do detailed experiments and analysis the performance and mechanism of genetic algorithm for the six programs. In order to overcome the random error of the random selection operation of De Jong, Brindle studied her doctoral dissertation in 1981 by six replication strategies (Astrom, 1995; Han, 2009).

Since the 1980s, with the symbol system to mimic human intelligence of traditional artificial intelligence temporarily getting into trouble, neural network, machine learning and genetic algorithm, etc. from the bottom of the biological system simulation research of intelligent revived and prospered (Skogestad, 2003). Goldberg plays an important role in the research of genetic algorithms. In 1983, he firstly used the genetic algorithm for optimization of actual engineering system that was gas pipeline. From then on, the research on genetic algorithm theory became deeper and richer, while its application was more extensive and completed. In the nineties, the academic community as the object of complex problems generally recognizes the scientific new paradigm of complex problems (Bouabdallah Noth, & Siegart, 2004). Because the genetic algorithm can effectively solve the problem of combination optimization problem

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