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Particle Swam Optimization based Optimal PID Parameters for Air Heater Temperature Control System

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Abstract

This paper concentrated on the design of PID controller for air heater temperature control system. It is appeared that PID controllers are utilized in many industrial applications. However, the major problem of PID controller design is how to identify the optimal parameters of PID so that the optimal performance of the system can be obtained. Then, this paper proposes the Particle Swarm Optimization (PSO) method for tuning optimal PID parameters for the air heater. The simulation results are achieved that the PSO optimized PID controller is able to provide an improved closed-loop system performances over the Ziegler-Nichols tuning method, and Genetic Algorithm (GA) in the perspectives of transient responses; i.e, the integral of square error (ISE), settling time and overshoot.

Keywords: Particle Swarm Optimization, Air Heater Temperature Control, PID Controller, Tuning Parameters ;

1. Introduction

The Proportional-Integral-Derivative (PID) controller has been successfully adapted in industrial process since it is simply structure and easy design. In addition, this kind of controller is low cost for a services and great performances in several control systems. The applications of PID controller are utilized for example self-tuning PID controller, fuzzy logic control and others [1,2,3]. The advantage of PID controller is easily operate and good stability. However, it still has some weaknesses such as difficulty for tuning the parameters, system with time delay, nonlinearity and high-order system model.

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The structures of PID controller consist the three values of parameters Kp, Ki and Kd. It is the fact that the more appropriate of PID parameter has, the more accuracy the controlled system is.Therefore, the appropriate parameters obtained by Particle Swam Optimization which is based on tuning of the PID parameters for optimal system are necessary to consider. Presently, the tuning method has been proposed by Ziegler-Nichols to identify PID parameters while the other tuning methods are developing to advance and intelligent approaches for example Genetic Algorithm has been applied to tune PID parameter. However, the results of GA tuning method still provide the slow system response with high overshoot and not good in steady state response [2].

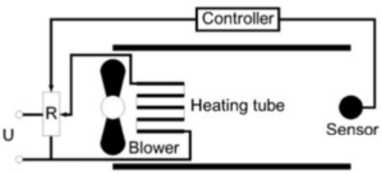
The apparent applications of using the air conditioning system with air heater have been seen in the industrial process especially in clothes dryer, food dryer, incubators and others. Those machines use the basic PID controllers for controlling the temperature. In order to improve the system performance of the air heater system, thus this paper presents the new technique which is based on the particle swarm optimization algorithm to obtain the appropriate of PID parameter. The particle swarm optimization algorithm is computational intelligence technique and it has already been proved in theoretical researches. In this proposed paper, the simulation results are shown that the PSO optimized PID controller is able to provide an improved closed-loop system performances for air conditioning system with air heater.

2. Introduction

Air heater system modeling: The hot air is generated by the heating machine and a blower that is referred as Fig. 1. The air heater system modeling is actually in First-Order Plus Time Delay processes (FOPTD) shown in (1). The step response of a closed-loop air heater system is shown in Fig. 1. According to the proposed system, the transfer function of air heater is as following equation: is given by:

$$H(s) = \frac{Ke^{-sTd}}{1+sTi}\,. \quad (1)$$

where *H(s)* is the open loop transfer function, *K* is the steady state gain, *Td* is the dead time and T_1 is the time constant.



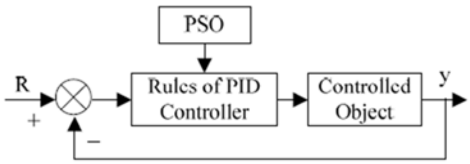


Fig. 1. Air Heater System; Fig. 2. Block diagram of PSO based PID;

PID Controller: The PID controller is based on three-term parameters which are proportional, integral and derivative control transfer function which have been written as following:

$$G(s) = K_p + \frac{Ki}{s} + K_d s = K_p(1 + \frac{1}{T_I s} + T_d s)\,. \quad (2)$$

where KP is the proportional gain, KI is the integral gain, KD is the derivative gain, TI is the integral time constant and TD is the derivative time constant.