PID Controller Tuning by Particle Swarm Optimization on Electrical Discharge Machining Servo Control System

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***Abstract*—Electrical Discharge Machining (EDM) is included in a stochastic process. So maintaining gap between electrode and workpiece is not easy. In order to control the gap, a proportional integral derivative (PID) controller is designed for EDM servo actuator system. The main goal of this work is to get PID parameters through Particle Swarm Optimization (PSO) algorithm to ensure a stable, robust and controlled system. The controller and the model for EDM die sinking are verified by simulation of the control system using MATLAB and simulink program. Simulation results verify the effectiveness of the PID controller in which its parameter determined by PSO to control the electrode position towards workpiece.**

Keywords—Servo Control System, Electrical Discharge Machining (EDM), Proportional Integral Derivative (PID), Controller Tuning, Particle Swarm Optimization (PSO)

I. INTRODUCTION

Proportional integral derivative (PID) controllers are the most common methods in industrial control processes. They are simple in structure, reliable in operation, robust in performances and up to 90% of all control strategies are PID. It is easy to be understood by engineers or operators. Various applications have implemented using this controller, such as process control, motor drives, automotive, flight control[1]. On the contrary, determination of optimal configuration values for PID parameters is very difficult. It is found that more than 30% of the installed controllers are operating in manual mode and 65% of the loops operating in automatic mode are tuned improperly[2]. So new approaches algorithm to adjust industrial PID controllers are needed.

The use of artificial intelligence to improve control system performances have been made by researchers. In the modeling problem for example, papers have used artificial neural network to model the MRR in EDM process. In[3-5] researchers tried to enhance the MRR prediction of EDM die sinking for copper electrode and steel workpiece. Even been proven that Artificial neural networks have advantages compared with the Dimensional Analysis[6].

Tuning methods of PID parameters are classified as traditional and intelligent methods. Conventional methods such as Zigler-Nichols[7] and simplex methods are hard to determine the optimal PID parameters and usually are not caused good tuning, i.e. it produces surge and big overshoot. Recently, intelligent approaches such as genetic algorithm, particle swarm optimization have been proposed for PID optimization but among them, genetic algorithm (GA) has received much interest and has been applied successfully to solve the problem of optimal PID controller parameters. In the past decades, various tuning methodologies of PI and PID controllers have been proposed in literatures such as autotuning, self-tuning and computational intelligence[1, 8, 9].

Unfortunately, it is quite difficult to tune properly the gains of PID controllers since many industrial plants are often burdened with problems such as high order, time delays, poorly damped, nonlinearities and time-varying dynamics. Over the years, several authors have proposed the tuning of PID to control variable processes by optimization methods, such as genetic algorithms[10-16], particle swarm optimization[17], tribes algorithm[18], harmony search[19, 20], evolution strategy [21] and ant colony [22].

In this paper, Particle Swarm Optimization (PSO) is used as a tool for solving the class of multiobjective optimization problems that result from a PID design problem for maintaining the gap between electrode and workpiece in EDM system. The objective functions to be optimized have been carefully chosen as to obtain an automatic method for designing a single-loop PID controller.

II. SYSTEM DESCRIPTION

Electrical Discharge Machining (EDM) is a controlled metal removal process that is used to remove metal using electric spark erosion. The english scientist Priestley found the erosive effect of electrical discharges in 1770. In this process, an electric spark is used as the eroding tool to erode the workpiece to produce finished part (moulding). The metal removal process is carried out by injecting pulsed electrical discharge in high frequency through the electrode to the workpiece. The electrode position is controlled by servo control mechanism. It is placed so as not contact to the workpiece. A proper controller is used to maintain the gap, allowing the spark to discharge its current from the electrode

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