International Journal of
Science and Engineering Investigations vol. 1, issue 9, October 2012
ISSN: 2251-8843

Drilling Machine Performance using PID Controller Tuned with Evolutionary Algorithms

Hamed Mohammadian [1], Alireza Sina [2]
[1,2] Member of Department of Electrical Engineering, Production Technology Research Institute branch of ACECR, Ahwaz, Iran
([1]hm0918@gmail.com, [2]Sina.Alireza@gmail.com, [2]Sina@acecr.ac.ir)

Abstract- Drilling industry, like other industries, has undergone a transformation in recent years, and the technique has many applications. Fortunately, the results of the different aspects of this important industry, has been very positive and helpful. Many large construction projects that seemed impossible until recently they have it easy. In this paper, to increase the efficiency of the drilling process and reducing the error rate has been tried in various ways to adjust the parameters of PID controller (K_P Proportionality coefficient, K_i Integral coefficient, K_d Coefficients derived) is used to optimize the most cones.
PID controller used in this paper, the classical method is designed and analyzed. The work done by the genetic algorithms and simulation results are then compared the two methods is shown.

Keywords- *PID controller, Genetic Algorithm, Drilling Machine, optimization*

I. INTRODUCTION

Tunnels and underground spaces are created for a variety of purposes, among which may be mentioned the following:

For example, transport and access tunnels, water tunnels, large underground spaces (subway stations, power plants, warehouses and workshops underground mineral extraction). Each of these areas will require the design of appropriate access and use of special schemes. In each case, the designer must know the exact condition of the land, in order to improve the quality of the material that is to be drilled in the tunnel, take action. Many tunnels dig in the ground cannot stable, therefore separations that can be used for holding them in place. It seems that the most important factor in the design of the tunnel or underground space, the supply is stable. Placement of such structures in natural materials, namely stone and earth, has caused a major role in the stability of the geological conditions and drilling, to play. Several factors can affect the places, especially for drilling in order to determine the various parameters involved in these spaces. Optimal selection methods can be effective in increasing efficiency. This controller is used to control the drilling process.

II. TUNNEL BORING MACHINE (T.B.M)

One of the important tunneling machines, device of T.B.M that can be complete dig. Evolution and expansion drilling machines has led to increased speed tunnel. Today, the stone is relatively hard to dig a tunnel from the machines they use. After years of trying, in 1957, Mr. Robbins was able to make a machine that could dig a good performance in hard rock to dig a tunnel. These machines were gradually heavier and stronger and their power increased. But their progress was slow in hard rock drilling. For example, the performance of these devices, which were equipped with both shear and disc, digging for limestone in between layers was not satisfied with the strength of 140MPa was found.

Finally the shear systems generally removed and only use the discs systems for tunnel digger continued. We can divide T.B.M: first: open T.B.M, second: single T.B.M and third: d.s T.B.M, and we can divide main parts of T.B.M machine, first: body, second: dig space, third: shear tool, fourth: jack digger driven page.

III. PID CONTROLLER

PID controllers are standard device for industrial automation. Flexibility, ease of resistant features are important to control the possibility of this type of controller used in many devices to provide. Cascade control can be cited as examples. PID algorithms with standard regulators are used to control the process and the base is made of custom control systems (Tailor-Made). One of the important issues intended to increase performance, reduce rise time and integral time absolute error that many studies have been done to improve them. In order PID Tuning using various techniques such as the number of sources [2], [3], [4] and [6] have been performed.

In general, PI controller is more efficient than PD controller, because the PD does not affect the steady state error elimination [3]. But Since PI controller in higher-level systems has not good performance in transient state response then for Improvement and optimization from fuzzy PID controllers are used. Design, construction and maintenance of each systems of engineering, technological and managerial decisions of Engineers to consider a few steps. The ultimate goal of such

decisions can minimize costs and maximize profits. The objective function made of the variables affecting their decisions. Therefore, finding the optimal conditions for the process of finding the maximum or minimum of a function can be defined. In general, we can find the optimal; consider minimizing the meaning, because if point is based on the minimization of this f(x) function then based on the maximum -f(x) function. A unique way to resolve all issues in optimized access does not exist.

IV. The Main Idea Of The Algorithm

In the seventies, scientists from the University of Michigan named John Holland, the idea of using genetic algorithms in engineering improvements made. The basic idea of this algorithm is to transfer the properties inherited by genes. Suppose the characteristic of human by chromosomes are transferred to the next generation. Each gene in the chromosome is representing for a new characteristic. For example, one gene could be eye color, gene 2 could be height, gene 3 Hair and forth. However, all of the chromosomes, to be transferred to the next generation, the next generation of all properties will be similar to the previous generation properties. Obviously that does not happen in practice. In fact, take two events into chromosomes. First happen is mutation, Mutation is the case that some genes are randomly changed. The number of these genes is very low; however, this random variation is important. For example, the gene for eye color can randomly make up the next generation is the one with green eyes, while every generation has had brown eyes. Plus to mutations, are other events that number more than number of mutations. Stick the beginning of a chromosome to end of another chromosome. This problem has name is crossover. [1], [4] Colony or Population is said to be groups of chromosomes. [3]

V. Adjustment of Controller Parameters

The model used in this paper, a model of the drive system fed by spinning and cutting process is used in the drilling industry is highly useful. [1] The function shown below is a conversion function of power supply is a drilling machine. First, the controller parameters using Ziegler - Nichols times and then have to set these parameters using genetic algorithms, and then compare the results of those techniques have.

A. Ziegler-Nichols method

In view of the conversion function of power supply drilling machine is shown. [1].

$$G(s) = \frac{1958}{s^3 + 18.89s^2 + 103.3s + 190.8}$$

PID controller parameters are defined in Figure (1).

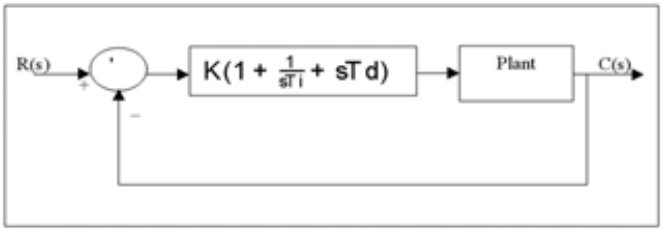

Figure (1): controller parameters

First, the PID controller parameters are calculated using the Ziegler - Nichols method and are given in Table (1). $K_P = 18, K_d = 6.318, K_i = 12.811$

TABLE (1): Table of Ziegler-Nichols

CONTROLLER	K_P	T_i	T_d
P	$0.5K_u$		
PI	$0.45K_u$	$T_u/1.2$	
PID	$0.6K_u$	$T_u/2$	$T_u/8$

Step response of Ziegler - Nichols closed loop system for the transfer function is shown in Figure (2), in this figure: overshoot = 82.9%, settling time = 0.492s, rise time = 0.0098s. And seen the results, especially with the amount of overshoot is relatively high.

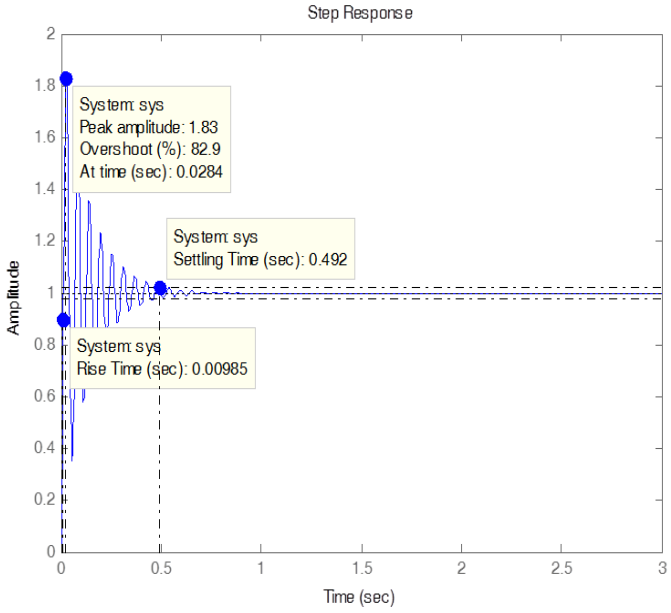

Figure (2): Step response of transfer function (Ziegler – Nichols)

B. Genetic Algorithm method

Setting the genetic algorithm parameters such as crossover rate and the number of initial population and ... Important part of the problem is solved. In this paper, in order to obtain the optimum parameters of a program written using MATLAB software environment and defines the error cost function is used And the most efficient solution for the variables

K_P, K_d, K_i get. Variables of K_P, K_d, K_i was calculated by genetic algorithm and the closed-loop transfer function of the unit feedback that has been placed in Figure 1. A way that by taking fitness function can be optimize of over shoot and rise time values. Then obtain the optimal response. In this paper, the initial population of between 100 to 150 has been modified to obtain the optimal response. Now, if number of initial population is 100 obtained results below, figure (3). In this figure: overshoot = 57.9%, settling time = 1.14s, rise time = 0.04s.

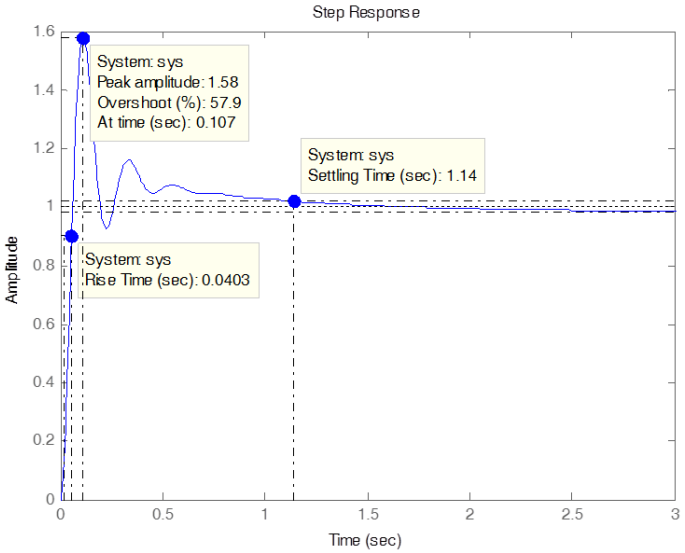

Figure (3): Step response of transfer function (population N.O is 100)

According to the results of the run program can be seen in over shoot declined. The whole system is improved compared to Ziegler-Nichols a response. Now if, the number of initial population increased to 150 the results obtained in figure (4) shown that the increment of population does not change the situation. In this figure: overshoot = 57.9%, settling time = 1.14s, rise time = 0.04s.

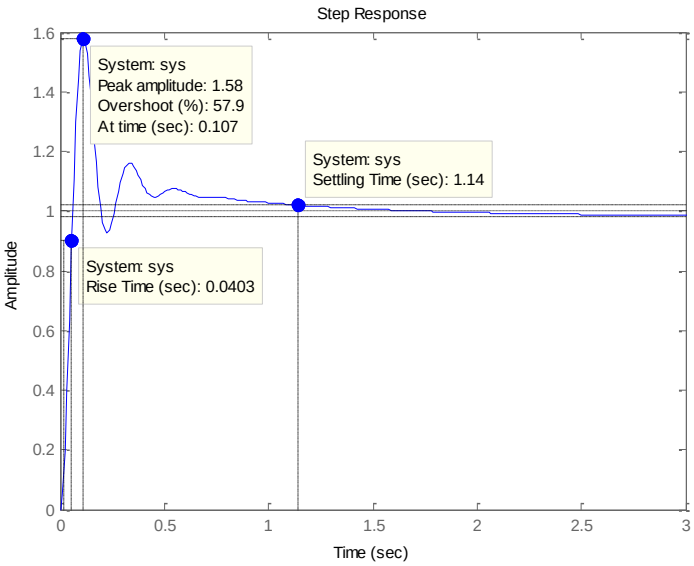

Figure (4): Step response of transfer function (population N.O is 150)

These results indicate the optimal overshoot of the system. And number of populations in improve response had not effective.

VI. CONCLUSIONS

By comparing the results obtained in this paper can be seen. PID controller tuning Coefficients power supply of drilling machines can be adjusted using a genetic algorithm, so that it is more efficient than the Ziegler - Nichols methods, because the reduce of indexes in closed loop control system. Like overshoot, settling and rise time.

REFERENCES

[1] S.M. Giriraj Kumar,Deepak Jayaraj, Anoop.R.Kishan//PSO based Tuning of a PID Controller for a High Performance Drilling Machine// *©2010 International Journal of Computer Applications (0975 - 8887)/Volume 1 – No. 19*

[2] Neenu Thomas,Dr.p.Poongodi //Position Control of DC Motor Using Genetic Algorithm Based PID Controller // proceedings of the World Congress on Engineering 2009 Vol II WCE 2009,july 1-3,2009,London.U.k.

[3] Ermanu A.Hakim,Adi Soeprijanto,and Mauridhi H.P// Fuzzy PID based PSS Design Using Genetic Algorithm//World Academy of Sciences,Engineering and Technilogy 50-2009

[4] Leehter Yao and Chin-Chin Lin //Department of Electrical Engineering National Taipei University//international Journal of Innaovative Computing,Information and Control Volume 5,Number 10(B),October 2009

[5] M. GirirajKumar,R.Jain,N.Anantharaman//Genetic Algorithm Based PID Controler Tuning for a Model Bioreactor//Indian Chemical Engineer-vol 50 No 3 july –september 2008.

[6] L. Gaing, A Paticle Swarm Optimization Approch For Optimum Design of PID Controller in AVR System, IEEE International Conference on Energy conversion, pp. 384-391, Vol.19,Issue2, 2004

[7] M.F. Azeem, A. M. Saad, Modified queen bee evolution based genetic algorithm for tuning of scaling factors of fuzzy knowledge base controller, Proc. of the IEEE I DICO .Vol. 1, pp. 299 – 303, 2004.

[8] M. Koudil, K. Benatchba, A. Tarabet, EI. Batoul Shahraoui, Using Artificial Bees to Solve Partitioning and Scheduling Problems in Codesign, Applied Mathematics and Computation, pp. 1710-1722, Vol. 186, Issue 2, 2007.

[9] D.T. Pham, S. Orti, A. Ghanbarzadeh, E. Koc, Application of Bees Algorithm to the Training of Learning Vector Quantization etworks for Control Chart Pattern Recognition,1629, 2006. - Vol. 1, pp. 1624 Inf. and Comm. Technologies

[10] M. Fathian, B. Amiri, A. Maroosi, Application of honey-bee mating optimization algorithm on clustering, Applied Mathematics and Computation, no.190, pp. 1502-1503, 2007

[11] Ziegler, G. and Nichols, N. B, 1942.Optimum settings for automatic controllers, Trans. ASME, 64,759-768.