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Performance analysis of DC motor speed control by using Genetic Algorithm tuning PID and PID controller

Karam Khairullah Mohammed*, Nurul Ain Binti Mohd Said

Faculty of Electrical Engineering, Universiti Teknikal Malaysia Melaka,
Hang Tuah Jaya, 76100 Durian Tunggal, Melaka, Malaysia

Corresponding e-mail: karam_al_nakieb@yahoo.com

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ABSTRACT – This paper presents a DC motor speed control using two different types of controller; conventional PID controller and Genetic Algorithm tuning PID. The main problem with the PID controller is that it will be unable to cope with process nonlinearities. Therefore, the Close-loop motor control by using PID controller and self-tuning PID controller by using Genetic Algorithm is developed by performing 50% load torque at 1000 rpm. The results obtained demonstrate that the proposed Genetic Algorithm tuned PID provides improved performance as compared to the conventional PID controller in terms of time specification at 0% overshoot, low settling time and zero steady state error.

1. INTRODUCTION

In speed-controlled applications DC motors have been commonly found in used. There has been a rapidly growing interest in DC motor speed control due to their simplicity, simple in structure and high efficiency. Hence, the need to build a staid control system for DC motor speed control is necessary, especially for a system that requires high accuracy. Many control schemes such as PID, adaptive and Genetic Algorithms controllers is being utilized in control applications. Even though the PID controller is simple in structure, however, conventional PID has the disadvantage of dependence on the plant behavior [2].

Moreover, the non-linearity of the control plant and an unstable open-loop system are the elements that contribute to the difficulties of the PID tuning process. Therefore, to overcome the PID issues, this paper will propose a method that is capable of providing minimum overshoot, lower steady state and shorter settling time even when there are disturbances in the system. This paper attempts to address this gap by analyzing the two different control technique for DC motor speed control; conventional PID and self-tuning PID by using Genetic Algorithm. The Genetic Algorithm controller is one of the methods applied in the literatures in overcoming the PID drawbacks.

2. DC MOTOR

The DC or direct current motor works on the principle that when a current-carrying conductor is placed in a magnetic field, it experiences a torque and has a tendency to move. This is known as motoring action. In a shunt motor, the field is connected in parallel (shunt) with the armature windings. The shunt-connected motor provides good speed regulation. The field winding can be separately excited or connected to the same source due to the ability of a variable speed drive to provide independent control of the armature and field [3]. The separately excited DC motor is displayed in Figure 1.

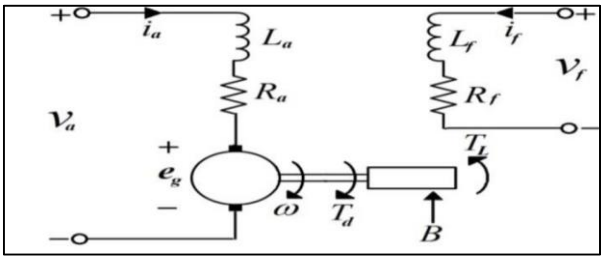

Figure 1. Equivalent circuit of the DC motor.

3. PID CONTROLLER

Despite the fact that sophisticated control methods have been used in the past decades, PID controllers are still commonly utilized in various industrial operations [4]. PID controllers are the predominant type of controllers which are used in almost every industrial process as shown in Figure 2. Their exemplary features which include simplicity in construction, robust behavior and the provision of effective control are the reason why the PID controller is chosen to be implemented. However, the adjustment processes required to find the controller gain K_P, K_I and K_D are conducted based on Ziegler Nichols techniques while adhering to some practical regulations [5].

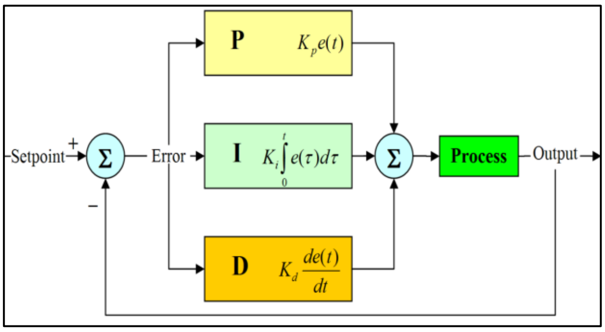

Figure 2. Equivalent circuit of PID controller.

4. METHODOLOGY

Genetic Algorithm is an optimization searching approach that imitates the technique of natural development. It has been successively used to optimize many different complex problems. In this paper, Genetic Algorithm is utilized in finding the optimal values of the PID controller gains which suit the demanded mechanical behavior characteristics of the DC motor drive. This serves to improve the transient response of the system. Performance is evaluated through the use of a fitness function. Basically, Genetic Algorithm consists of three successive stages: Selection, Crossover and Mutation. By applying these three processes will produce new individuals who may be better than their parents. This algorithm is applied repetitively over many generations and finally this process stops when individuals are found to represent the best solution to the problem. [6]. The gains on the PID controller at various loads and reference speeds were calculated using the algorithm shown in Figure3.

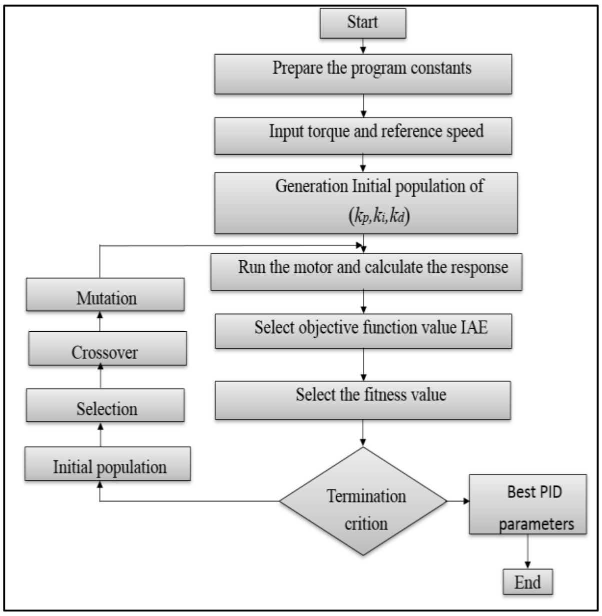

Figure 3. Flow chart for Genetic Algorithm tuning PID.

5. RESULT AND CONCLUSION

The proposed model was simulated in the MATLAB/Simulink environment. The adjustment of the three parameters K_p, K_i and K_d of PID is required for better performance. This adjustment of parameters was done with the help of a Genetic Algorithm which shows better response compared to that of the PID controller exclusively. There results obtained shows that by adapting Genetic Algorithm, the performance of the system is better compared to the PID controller, such as having a smaller overshoot, less settling time and less steady state error.

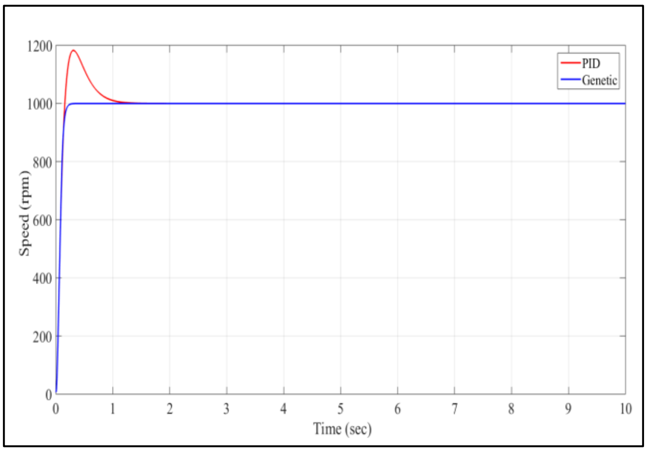

Figure 4. PID and Genetic Algorithm controller responses.

Table1. Comparison of results.

Title	PID controller (Z-N Tuning)	Genetic Algorithm (PID Tuning)
Rise Time (sec)	0.157	0.35
Settling Time (sec)	1.3	0.32
Overshoot (%)	18.25	0
Steady state error	0.38	0

The results lead to the conclusion that the performance of the system by adapting Genetic Algorithm is much better compared to the PID controller. The rise time, settling time, overshoot and steady-state error are improves.

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