Design of Optimal PID Control of DC MOTOR Using Genetic Algorithm

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***Abstract*—Wide amplitude, DC motor's speed and their facile control cause its great application in industries. Generally the DC motors gain speed by armature voltage control or field control. In this paper, by using a combination of Genetic Algorithms, we have tried to optimally control the inverted pendulum by nonlinear equations. The results of this simulation have been mentioned in the conclusion. It seems that the results be acceptable results.**

***Index Terms*—Optimal control, classical PID controller, genetic algorithm.**

I. Introduction

There are variety methods for DC motors control that are presented since now. The presented methods for DC motors control are divided generally in three groups. Classic methods such as PID PI controllers.[1],[2].

Modern methods (adaptation-optimum…)[3]-[5] . Artificial methods such as neural networks and fuzzy[6],[7].theory are the presented methods for DC motors speed control.

The design method in linear control comprise based on main application the wide span ' of frequency, linear controller has a weak application, because it can't compensate the nonlinear system effect completely.

II. Model of A Dc Motor

The direct current motors are different kinds and several methods are presented for controlling of their speed. in this essay DC motor was chosen for speed control and by controlling the supply voltage was controlled it in nominal less speed.

The electric circuit of the armature and

Thefree body diagram of the rotor are shown in fig. 1

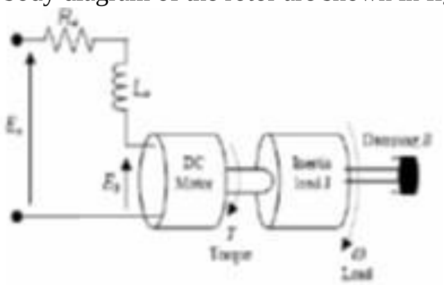

Fig. 1. The structure of a DC motor.

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$$V_t = R_a I_a + L_a \frac{dI_a}{dt} + E_a \quad (1)$$

$$T = J\frac{d\omega}{dt} + B\omega - T_i \quad (2)$$

$$T = K_T I_a \quad (3)$$

$$E_a = K_a \omega \quad (4)$$

$$\frac{d\omega}{dt} = \varphi \quad (5)$$

With the following physical parameters:
Ea: The input terminal voltage (source), (*v*);
Eb: The back emf, (*v*);
Ra: The armature resistance, (ohm);
Ia: The armature current (Amp);
La: The armature inductance, (*H*);
J: The moment inertial of the motor rotor and load, (Kg.m2/s2);
T: The motor torque, (Nm)
w : The speed of the shaft and the load (angular velocity),(Rad/s);
f : The shaft position, (Rad);
B: The damping ratio of the mechanical system, (Nms);
T k: The torque factor constant, (Nm/Amp);
B k: The motor constant (v-s/rad).
Block diagram of a DC motor is shown in fig. 2[8].

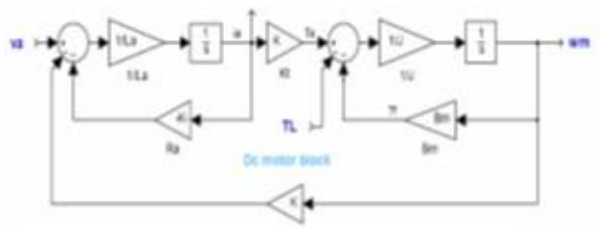

Fig. 2. The block diagram of a DC motor.

At first we control the DC motor by PID controller in fig.3

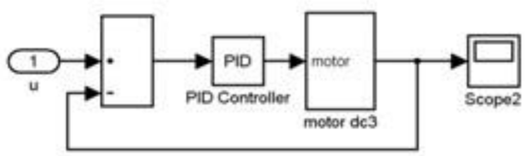

Fig. 3. The block diagram of a PID controller dc motor.

III. Genetic Algorithm

In this algorithm, first of all, we create some random populations. Every individual (gene) In GA is considered in the form of binary strings then, fitness for every individual is chosen with regard to its fitness.

For creating the next generation, three stages is the selection phase, which consists of different phases, including ranking, proportional and... .and the second phase is the combination phase. In this phase, the two parents are combined with pc possibility and the next generation comes in to being.

By considering that during the past phases of gene it may cause noise, infact, this phase is a Random noise which causes a small pc possibility for every bit.

A. Fitness Function

For GA, in every problem, a fitness function must be defined. F functions can be described as follows:

$$F = \text{OverShoot} + \text{Ess} \tag{6}$$

$$F = A \times \text{OverShoot} + B \times \text{Ess} \tag{7}$$

$$F = e^{A\times \text{OverShoot}+B*\text{Ess}} \tag{8}$$

In this problem, the aim is to minimize every function of F .As GA Has the ability to be maximized, hence, fitness function is defined as below.

$$\text{Fitnes} = K - F \tag{9}$$

$$\text{Fitnes} = \frac{1}{F} \tag{10}$$

If the fitness function is selected from an equation (9) constant parameter k must be regulated in a way that causes no harm to the problem. If k is a small number, fitness will be negative and for the capital k, the fitness of all the individuals in the society will be approximated .In this paper, someequations (7, 10) have been used.

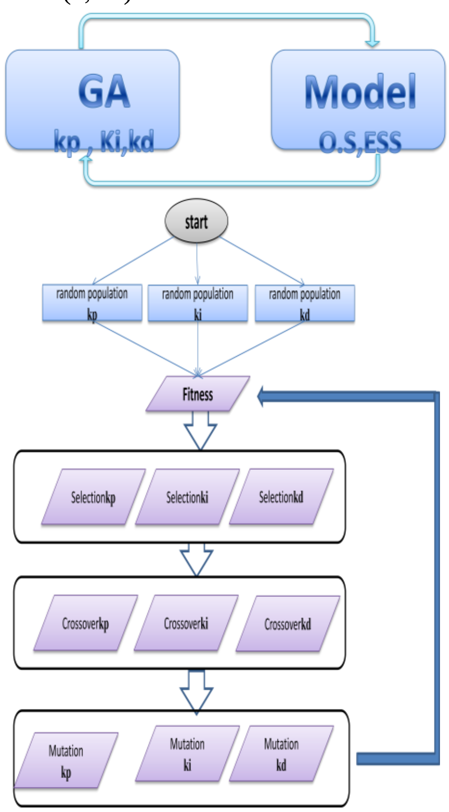

Fig. 4. Chart of genetic algorithm.

TABLE I: GA TUNING PARAMETER

Parameter	Value
Lower bound [Kp Ki Kd]	[0 0 0]
Upper bound [Kp Ki Kd]	[100 100 100]
Stopping criteria (Iterations)	100
Population Size	50 and 25and 15
Crossover Fraction	0.8
Mutation Fraction	0.01
binary strings16bit	

IV. SIMULATION

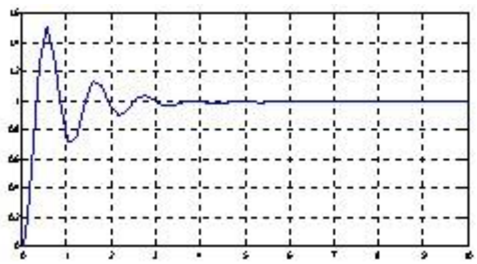

Fig. 4. Simulated results PID controller of DC motor for population size 15.

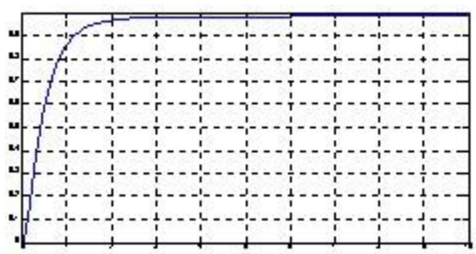

Fig. 5. Simulated results PID controller of DC motor for population size 25.

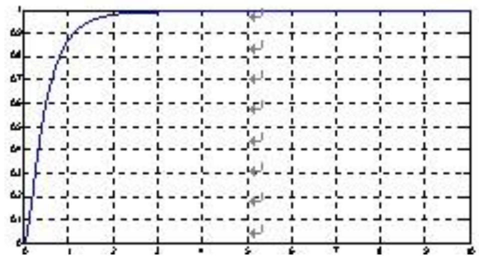

Fig. 6. Simulated results PID controller of DC motor for population size 50.

V. CONCLUSION

Parameters adjustment at different problems takes more time up by hard mathematical calculating. At this paper was tried one simple application from Genetic algorithm considered by control engineering problem. We can find the optimal answer with Genetic algorithm .This answer should be careful and simple rarely acceptable

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