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Performance and Analysis of Optimization Techniques for Speed Control of Dc Motor

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Abstract: Aim of This paper a Performance Analysis of controllers such as PID controller and G.A based PID for speed control of DC motor. Simulation results have established that the use of PID and GA-PID. A DC motor is important for a good dynamic, reliable behaviour of the DC motor, a great speed tracking with lowest overshoot, gives better performance and high strength than those obtained by use of the other controller. The DC motor is broadly used in many applications like steel mills, electric trains, cranes and much more. In this dissertation a separately excited dc motor using MATLAB modelling has been outlined whose velocity might be examined utilizing the Proportional, Integral, Derivative (KP, KI , KD) addition of the PID controller. In this paper is to analyse the execution of Optimization techniques viz. The Genetic Algorithm (GA) for improve PID controllers parameters for speed control of DC motor and list their points of interest over the traditional tuning strategies. The output speed error and its derivative as feedback damping signals. In this we have create three objective function with help of the MATLAB coding m-file, but third objective function is a novel creation for system which gives the better result than conventional objective function.aim of this paper compared all conventional method to proposed genetic algorithm tuning techniques and finds optimum results such as peak time, overshoot and transient response.

Keywords: DC motor, PID, Genetic Algorithm, propose objective function, MSE, IAE.

1 Introduction

Nowadays the DC motor is the generally important motor for the reason that of its dynamic and reliable behavior. The main challenge of DC motor to a control of its speed for performing a desired tasked motor is high-performance motor drive system are its exceptionally important in manufacturing and industrials and additionally other reason applications, for example, electric trains, steel moving plants, and mechanical technology. It is a superior motor drives system than AC motor, have a good dynamic performance which performs speed order following and load regulating response [1, 2]. The DC motor covers the simplicity, no difficulty of application, flexibility, high consistency and favorable cost. Hence, DC motor drive is the important part of industrial applications, home appliances and robot manipulators where position controls of the motor are required and speed. The DC motor drives consist of a smaller amount complexity, with the single force change from AC power to DC power. The DC motor is formed transform into electrical energy to mechanical energy called rotational. Again the speed torque attributes of the DC motor drive are much better to that of AC motors [3]. The DC motor drives give a fabulous control of speed for deceleration, acceleration and regularly less costly for most the horsepower ratings. Along these lines, the DC motor has been utilized generally for flexible speed machines and an extensive variety of the speed control system has developed for this reason. Within this utilization, the motor should be faithfully controlled to give the desired performance [4, 5]. Factor of this paper, a recently tuning method for PID controller parameters in kind of velocity manipulate of DC motor using the Genetic algorithm (GA) method is proposed. The fitness function of the proposed GA is printed in view of the required manage features of the machine in classes [7]. The machine is showing utilizing MATLAB/SIMULINK and the duplicate effects are received and contrasted and people of regular Ziegler Nichols (ZN), GA based integral absolute of the error (IAE) manuscript, and GA based mean of the squared error (MSE) record techniques. The correlation demonstrates the adequacy of the proposed tuning approach as it offers a superior execution and fulfills the predetermined control attributes. Resultant upgrades at the stride reaction behavior of pace manipulate of the DC motor device are appeared for

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two instances. This paper consists as takes after: implement modeling of DC motor is displayed in phase II, PID controller brief describe in section III, short prologue to genetic algorithm is mentioned in element IV, major work of this paper describe in department V as a tuned method and closing segment VI and VII in we opinion describe simulation result and conclusion of this paper speed control of dc motor system.

2 The DC Motor Model

The SEDC motor drive system through armature control and the voltage apply to armature of the motor is familiar without realignment the voltage functional to the field. Fig.1. shows a separately excited DC motor equivalent model (SEDC). It is assemble of the circuit model of dc motor using MATLAB/Simulink as shown in Fig.2.In this a special case through the supply provided a separately to armature winding and field winding. The main a different or distinct form in these types of dc motor is with the main purpose of the field winding in does not flow the armature current because, the field winding is agitated from a separate external source of dc current**.** These systems require programmed control of their principle parameters (position, speed, acceleration, currents) [6].The DC motor is a high performance motor drive. The dc motor drive is based on the principal, when a current carrying conductor is to be found in a magnetic fields, it experience a force which has a tendency to move. This is known as motoring action or rotating function, when magnetic field and electric field work together they produce a mechanical force.

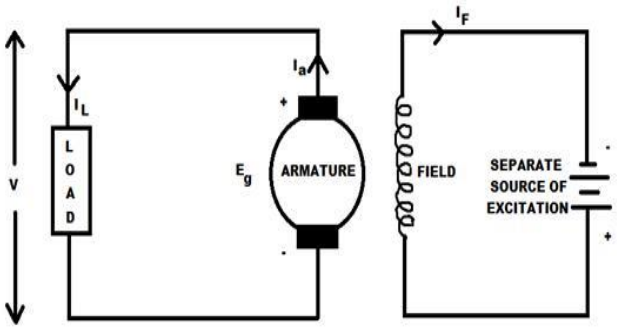

Fig.1.S E DC Motor

$$V_a(t) = R_a i_a(t) + L_a \frac{di_a(t)}{dt} + e_b(t) \quad (1)$$

$$\frac{\omega(s)}{V(s)} = \frac{K_m}{(L_a s + R_a)(J_m s + B_m) + K_m K_b} \quad (2)$$

$$\frac{\theta(s)}{V(s)} = \frac{K_m}{s[(L_a s + R_a)(J_m s + B_m) + K_m K_b]} \quad (3)$$

Here upon

R . I_a= armature current (A).

θ = angular position of rotor

pipe. = rotor inertia

= viscous friction coefficient

= motor torque constant

= back emf constant

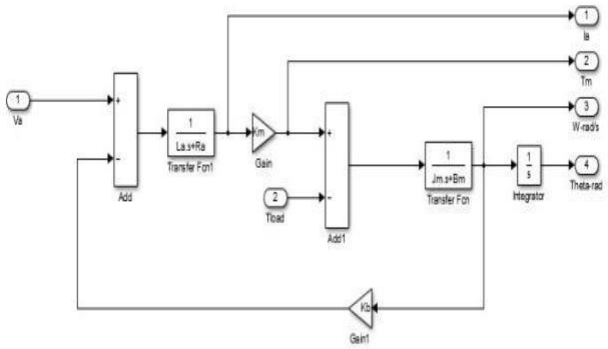

Fig.2. Simulink Modeling of DC Motor

3 Design of PID Controller

The PID Controller is an essential manage loop of feedback gadget and is widely used in control machine. The nonlinear capabilities of a DC motor such on account that, diffusion and invention can shame overall performance of the classical controllers [11]. Controllers use 3 primary forms of parameter or modes: (P) Proportional, (I) vital and derivative (D).even though, proportional and essential control is used as single control approach and a by-product manipulate used is that it improves the transitory response of the machine. On this paper its miles implementing to manipulate the rate of DC motor which on pinnacle of is established in Fig.3. It is working based on the speed blunders among the real velocity and reference speed is designated as input to a PID controller. The PID controller depending on changes the error their yields, to control the course of action enter such that the mistake is decrease. Complete in sequence approximately the idea and tuning of PID controllers is given in beneath [12]. General form of the Transfer function of a the PID controller is specified as,

$$( ) = + \frac{1}{} + \quad (4)$$

Table 1: Special Effects of Increasing the PID Controller Parameters.

Parameter	Rise Time	Overshoot	Settling time	Steady state error

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K_P	reduce	Increase	little change	reduce
K_I	reduce	Increase	Increase	Reduce
K_D	little change	reduce	reduce	little change

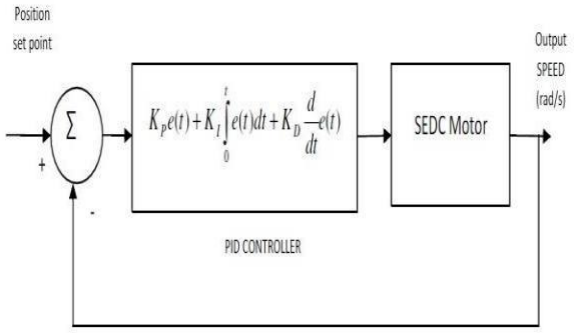

Fig.3 .PID Controller with System

Anywhere
e = Error signal
Kp = Proportional Constant
Ki= Integral Constant
Kd = Derivative Constant

$$u(t) = ( ) + \int ( ) + \frac{( )}{} \quad (5)$$

4 Tuning Methodology

4.1 Conventional PID controller Tuning Method

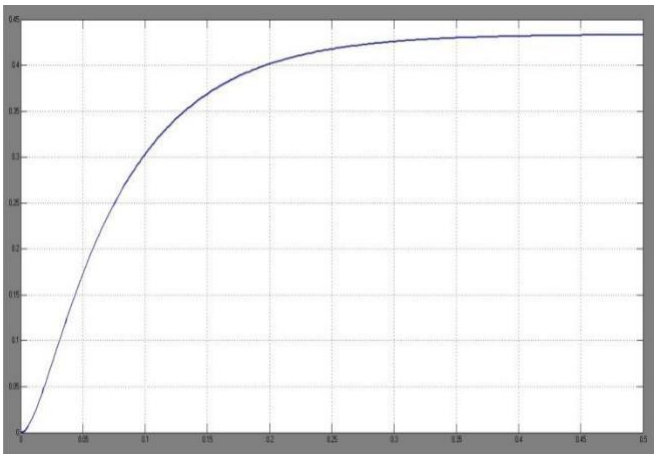

Fig.4. Step input of uncontrolled DC motor drive system.

In this two methods for determination parameters of PID controller known as Ziegler-Nichols tuning techniques. that the uncontrolled DC motor has a reasonable step reaction since the settling time is very poor and not proper working condition second of the reference speed. Then applying PID controller whose speed may be investigated using the Proportional (K_P,) Integral (K_I,) and Derivative (K_D) gain of the PID controller. Since, classical controllers PID are failing to control the drive when load parameters be also changed The most important aim of this paper is to analyze the implementation of Genetic Algorithms (GAs) for optimize PID controllers parameters for speed control of the DC motor and specify their advantages over the traditional tuning methodologies**.** The emphasis point is resolved, the digression line is drawn.

4.2 GA-based optimization

Keeping in mind the end goal to decide the parameters of the routine PID controller utilizing delicate figuring tuning as a part of a MATLAB is created. The stride reaction of uncontrolled the DC motor is appeared in Fig. 4. It is clear

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The genetic algorithms is a procedure for optimize both unconstrained and constrained issues that depend on natural evaluation. A genetic algorithm (GAs) is a search for and advancement procedures which system by copying the developmental morals and chromosomal entertainment of the tenets in characteristic hereditary qualities. A GAs starts its inquiry with an arbitrary arrangement of arrangements when in doubt coded in parallel strings. Each arrangement is passing on a wellness which is in a straight line identified with the fitness function of the inquiry and improvement issues. The Genetic calculation is regularly gathered of two procedures. The primary procedure is the decision of people for the creation of the cutting edge and the second process is the control of the specific individual to shape the cutting edge by transformation and hybrid methods [13].

The fitness function is the important part of to use in the genetic algorithm (GAs) [14]. An essential stride in applying GA tuning strategy is to pick the target work that is utilized to assess the fitness value of every chromosome [15]. In this paper, three objective functions are utilized and their execution is looked at. The first depends on an integral of the absolute error (IAE) index, the second depends on a mean of the squared error (MSE) index, furthermore, the latest one is prescribed (objective function)fitness function, two equation.16,17 underneath fitness function is called traditional methods and a mathematical statement (18) goal is proposed fitness function. In this papers in target work furthermore arrange through the MATLAB coding. The parameters of GAs in this study are set as in Table IV. The GA advancement process based IAE index and MSE index appear in Fig. 6 and Fig.7, individually. For every case, the controller parameters are resolved. The objective function (fitness function) is given as:

$$\int_0^T |e(t)|dt \qquad \overline{MS} \qquad \int_t e(t)^2 dt$$

$$(\text{FOBJECTIVE}) \quad |OS\% - 5| \;\; |T_S - 0.05| \, |T_r - 0.01| \;\; ||E_S - 0.001||$$

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Where
F= proposed objective function
OS%=overshoot
T_S=settling time
T_r-=rise time
& =weights factor

The constants m and n are weights factor furthermore, are taken as (m=100, n=150). The parameters of GAs in this study are set as in Table IV. The GA enhancement process based IAE file, MSE file, and proposed file are appeared result in Fig. 6, 7 and Fig. 8 separately. For every case, the PID controller parameters are resolved.

Table 2. Settings of Ga Parameters Values

Parameter	***Value***
Lower bound [K_P,K_I ,K_D]	[0, 0 ,0]
Upper bound [K_P,K_I, K_D]	[500, 500, 500]
Populations	25
Generations	50
Population type	Double vector
Ranges of PID parameters	0-500
Crossover fraction	0.8
Mutation rate	0.01
Elite count	5
Selection function	Tournament
Plot function	Best fitness, Best individual

5 Simulation Results and Discussion

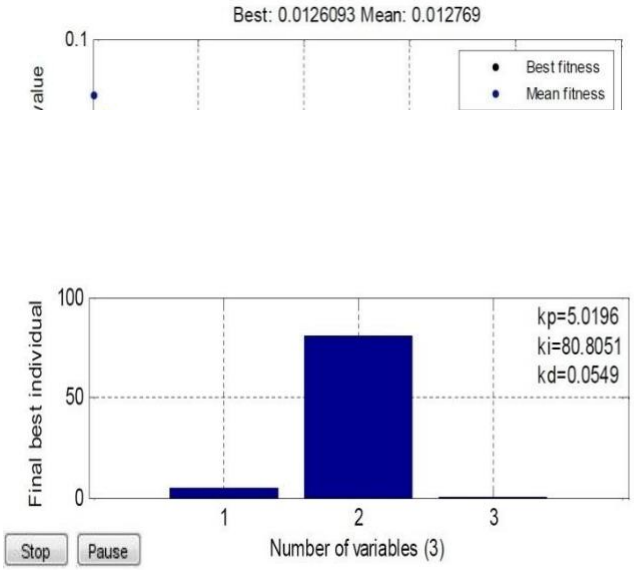


Fig. 5 GA optimization progression based objective function (IAE) index**.**

MATLAB. The range of.KP, KI and KD is preferred between (0-500) respectively. Values of KP, KI and KD are plotted through the extraordinary objective characteristic in Fig.5, 6 and finally suggest objective characteristic/fitness function Fig.7. suggests the dissimilarity of the health of the excellent explanation with technology, somewhere best clarification is its clean as which offers minimal rise time, settling time overshoot and almost zero consistent country blunders in the strength of the quality answer in every technology till it reaches a most ability fee may be diagnosed to the choice procedure followed this is to say combination of match selection by way of way of Elitism manner.

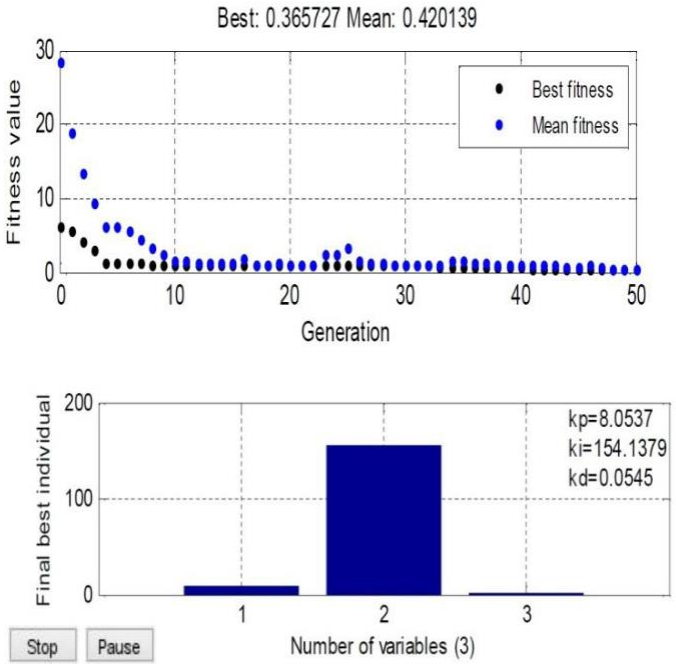
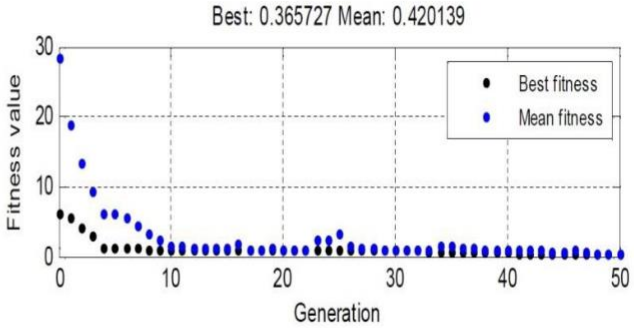


Fig.6. GA optimization progression based objective function (MSE) performance index**.**



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This paper in objective function a committed software using programming language "'C" on for this trouble in

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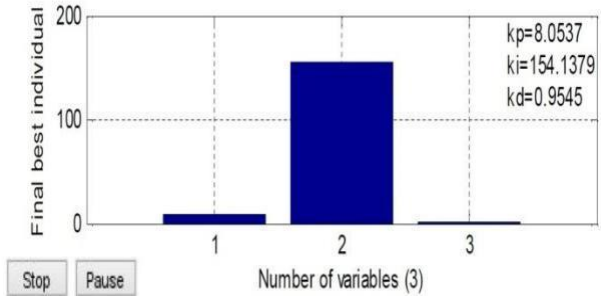

Fig.7. GA optimization process based the proposed objective function.

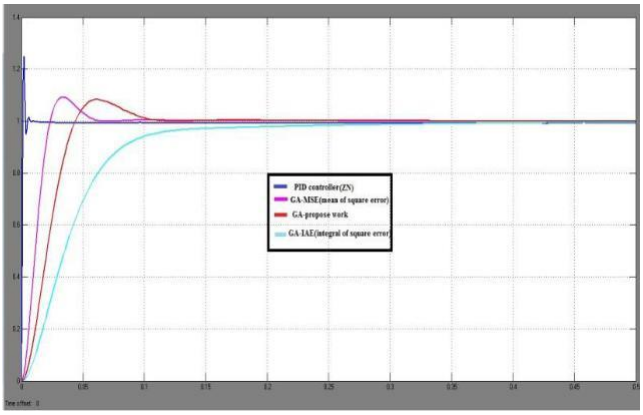

Fig.8. Step input of controlled DC motor drive system

Table 3: Performance Comparison Of Parameters With Pid & Ga

Parameters	*Tuning method*			
	Conventional PID	*Genetic Algorithm*		
		***IAE* objective function**	***MSE* objective function**	***the proposed objective function***
K_P	14.7312	5.0196	8.0537	8.0537
K_I	105.15	80.8051	154.1379	154.1379
K_D	0.547	0.0549	0.0545	0.9545
Rise time(sec)	0.00622	0.0663	0.0499	0.0291
Settling time(sec)	0.0837	0.116	0.117	0.0952
Overshoot (%)	47.4%	0%	2.22%	8.33
Peak	1.41	1.02	0.995	1.08

6 Conclusions

In this paper we have discussed the speed control of DC motor Drive by different approach of controller. It is clear from the result that the ordinary PID controller is not getting the exact result. We have to go another approach such as classical genetic algorithm, but not again optimum tuned & not getting satisfactory result. So, we have been gone a novel tuning approach for PID controller parameter using genetic algorithm for speed control of DC motor. This work in the objective function proposed GA is designed according to characteristic of the controller for DC motor. In this we have to create three objective function help of MATLAB

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coding m-file such as IAE, MSE and proposed GA objective function. The objective of this work of PID parameters upgrades using the genetic algorithm. this tuning technique keeping in mind the end goal to accomplish smallest amount rise time, settling time overshoot and steady state error. The proposed GA is gives the better results than the entire objective function.

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