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Genetic Tuned PID Controller for Speed Control of DC Motor

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Abstract: ***The tuning aspect of proportional integral derivative (PID) controllers is a challenge for researchers and plant operators. Genetic Algorithm is a soft computing technique which is used for optimization of PID parameters. The three basic operators of Genetic Algorithm are selection, crossover and mutation. These parameters have a great influence on the stability and performance of the control system. This paper proposes the tuning of PID controller of a DC motor using Genetic Algorithm and mainly focuses on the Binary coded Genetic Algorithm& finds the value of crossover, mutation of PID controller.***

Keywords: DC motor, Genetic Algorithm, Crossover, Mutation, PID controller

1. Introduction

High performance electrical motor drives are very important in industrial as well as other purpose applications. In general, a better performance of an electrical motor drive system has a better dynamic response. Among all motors, DC motors have been widely used in many adjustable speed drive applications that need high control requirements such as electric vehicles, steel rolling mills, electric cranes, high precision digital tools, and robotics. This is due to their simple, precise, wide range control characteristics. Speed of the DC motors is directly proportional to the armature voltage and inversely to the magnetic field flux. Controlling the armature voltage and/or the field current will adjust the DC motor speed.

2. Model of DC Motor

An electric motor converts electric energy to mechanical energy by using interacting magnetic fields. Electric motors are used for a wide variety of residential, commercial, and industrial operations. As reference the connection for a shunt-type DC motor is illustrated in Figure (1) shunt-wound DC motor consists of a shunt field connected in parallel with the armature. The shunt field winding is made up of many turns of small-gauge wire and has a much higher resistance and lower current flow compared to a series field winding. As a result, these motors have excellent speed and position control.

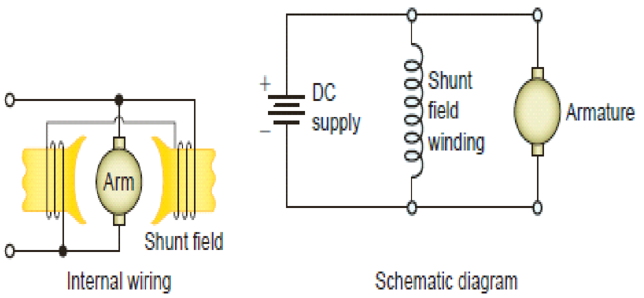

Figure 1: Diagram of Shunt Motor

The Specification of DC Motor are 2HP, 230V, 8.5Amperes, 1500rpm, 2.45Ω (Armature resistance),(Armature inductance) 0.035H, 1.2Vs/rad (Back emf), 0.022 kg (Moment of inertia) (Frictional constant) 0.5* (Nms/rad).

3. PID Controller

The PID controller involves three parameters: the proportional gain (Kp), the integral gain (Ki) and the derivative gain (Kd). The proportional gain provides a control action proportional to the error. The integral action reduces the steady state error. While, the derivative action improves the transient response. The sum of these three actions makes the PID controller

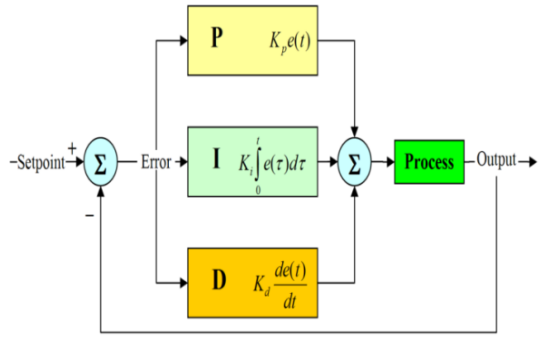

Figure 2: Block diagram of PID controller

At first we control the DC motor by PID controller and we can analyze the following parameter:

- Rise Time, tr
- Maximum Overshoot, Mp
- Settling time, ts

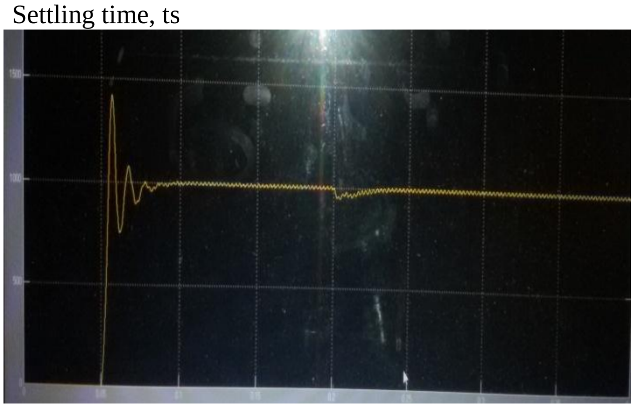

Figure 3: Result without Genetic Algorithm based PID controller

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4. PID Controller Using Genetic Algorithm

A) Overview of Genetic Algorithm

Genetic Algorithms (GAs) are a stochastic global search method that emulates the process of natural evolution. Genetic Algorithms have been shown to be capable of locating high performance areas in complex domains without experiencing the difficulties associated with high dimensionality or false optima as may occur with gradient decent techniques. Using Genetic Algorithms to perform the tuning of the controller will result in the optimum controller being evaluated for the system every time.

The PID controller of the model will be designed using the classical method and the results analysed. The same model will be redesigned using the Genetic Algorithm method. The results of both designs will be compared, analyzed and conclusion will be drawn out of the simulation. Genetic Algorithm is one of the methods used for optimization. John Holland formally introduced this method in the United States in the 1970 at the University of Michigan. The continuing performance improvements of computational systems have made them attractive for some types of optimization. The Genetic Algorithm starts with no knowledge of the correct solution and depends entirely on responses from its environment and evolution operators such as reproduction, crossover and mutation to arrive at the best solution.

1) **Selection:** It is usually the first operator applied on population chromosomes that are selected from the population of parents to crossover and produce offspring's
2) **Crossover**: It is the Genetic Algorithm's primary local search routine the crossover operator is used to create new solution from the existing solution.
3) **Mutation**: The probability of mutation is again predetermined before the algorithm, mutation changes the structure of the string by changing the value of the bit chosen at random changes operation changing from 0to 1 or vice-versa.

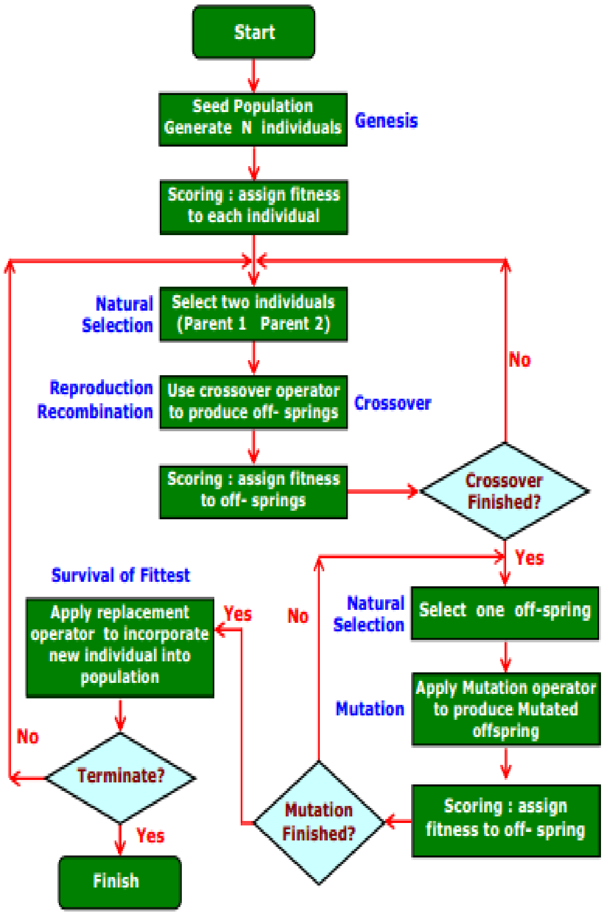

Figure 4: Flow chart of Genetic Algorithm

B. Objective Function of the Genetic Algorithm

The most challenging part of creating a Genetic Algorithm is writing the objective functions. The objective function is required to evaluate the best PID controller for the system. An objective function could be created to find a PID controller that gives the smallest overshoot, fastest rise time or quickest settling time. However in order to combine all of these objectives an objective function is designed to minimize the performance indices of the controlled system instead.

C. Overview of Binary Coded G.A

GA has many variants like Real coded GA, Binary coded GA, Improved GA, Differential Evolution GA. This paper is based on Binary coded G.A. The binary coded Genetic Algorithmis a probabilistic search algorithm that iteratively transforms a set (called a population) of mathematical objects (typically fixed-length binary character strings), each with an associated fitness value, into a new population of offspring objects using the Darwinian principle of natural selection and using operations that are patterned after naturally occurring Genetic operations, such as crossover and mutation

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5. Proposed Work

Implementation of G.A based PID Controller

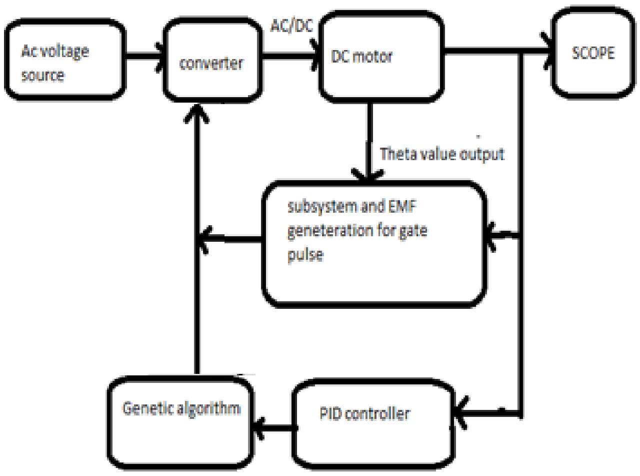

Figure 5: The Block diagram for the Proposed System

In the Proposed system the AC source is used as power input and AC source is converted to DC using converter and it is fed to the DC motor. The theta value generated from the DC motor is taken and it is given to the subsystem and the EMF is generated for the gate-pulses and it is given to the converter. The speed of the DC motor is calculated and it is given to the PID controller the output of the PID controller is given to the Genetic Algorithm and it is fed to the converter and the characteristic of PID controller and the Genetic Algorithm is studied and the improved characteristic is shown in fig 6.

In the proposed work a DC Motor model is called by a program which is coded in MATLAB for a fitness function. In order to use GA to tune the PID controller for DC motor. Variables Kp, Ki, &Kd are coded to solve string structures. Binary coded string having 1"s & 0"s are mostly used.

The length of string is usually determined according to the desired solution accuracy. Here 10 bits are used to code each variable. We can use 8 bit & 4 bit also. Thereafter select the random strings from the population to form the mating pool. In order to use roulette-wheel selection procedure, we calculate the average fitness of the population. Then the mating pool strings are used in the crossover operation. The next step is to perform mutation on strings in the intermediate population . The resulting population becomes the new population. The whole process is coded in MATLAB & after running the program we get the optimized values of Kp, Ki &Kd .

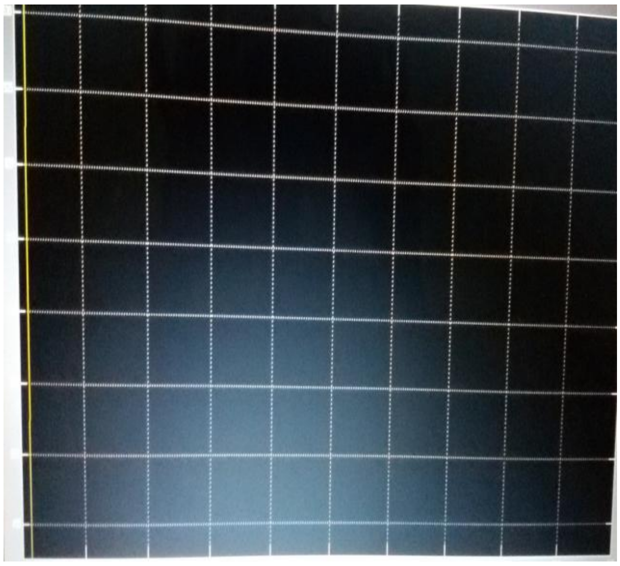

Figure 6: Results of Genetic Algorithm based PID controller

6. Results of GA Based PID Controller

It is clear from both the results fig3and fig6 that the simple PID controller is not getting the accurate results but the Genetic algorithm based PID controller getting the proper optimized gain values of Kp, Ki and Kd and we can also analyse the smallest overshoot, fastest rise time and quick settling time.

7. Conclusion

The work has been carried out to get an optimal PID tuning by using Genetic algorithm. This paper provides the complete original binary coded Genetic algorithm program in MATLAB, which can be directly run through MATLAB 7.14.0 Genetic Algorithm is applied to find optimal solution for the parameter of DC motor with PID controller & indicates that Genetic Algorithm is powerful global searching method. The Genetic Algorithm designed PID controller is much better in terms of rise time, settling time, overshoot then simple PID controller.

References

[1] MeghaJaiswal , MohnaPhadnis " Speed control of DC motor using Genetic algorithm based PID controller" International Journal of Advanced Research in Computer Science and Software Engineering Volume 3, Issue 7, July 2013.

[2] Walaa M. Elsrogy M. A. Fkirin M. A. Moustafa Hassan "Speed Control of DC Motor Using PID Controller Based on Artificial Intelligence Techniques" 978-1-4673-5549-0/13/$31.00 ©2013 IEEE.

[3] S. A. Deraz "Genetic Tuned PID Controller Based Speed Control of DC Motor Drive" International Journal of Engineering Trends and Technology (IJETT) – Volume 17 Number 2 – Nov 2014

[4] AlokRanjanSingh V.K. Giri "Design and Analysis of DC Motor Speed Control by GA Based Tuning of Fuzzy Logic Controller "International Journal of

Licensed Under Creative Commons Attribution CC BY

Engineering Research & Technology (IJERT)Vol. 1 Issue 5, July – 2012.
[5] Manoj Kushwah1 and Prof. AshisPatra "Tuning PID Controller for Speed Control of DC Motor Using Soft Computing Techniques-A Review" Advance in Electronic and Electric Engineering. ISSN 2231-1297, Volume 4, Number 2 (2014), pp. 141-148.
[6] Santosh Kumar Suman1 Vinod Kumar Giri "Implementation of optimization and intelligent techniques for Speed Control of DC Motor -A Review" Vol: 5, 1, Special Issue on 2016 International Conference on Innovations in Information, Embedded and Communication Systems (ICIIECS).
[7] 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.
[8] M'hamedChebre, delkaderMeroufel, YessemaBendaha"Speed Control of Induction Motor Using Genetic Algorithm-based PI Controller vol 8 NO 6 2011
[9] EsmaeilSameni, ElaheEbrahimi, FatemehKoohneshin, and MohamadRezaDastranj "Design of Optimal PID Control of DC MOTOR Using Genetic Algorithm"International Journal of Computer Theory and Engineering, Vol. 4, No. 3, June 2012
[10] TusharChouhanArkajaAgrawal" D.C. Motor Control by Genetic Algorithm" International Journal of Digital Application & Contemporary research (Volume 1, Issue 1, August 2012).
[11] Saurabh Jain Daniel J. Simon "Controller Tuning for DC Motor Speed Control Using Genetic Algorithms" 9-2004

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