

Configuration of PID Controller for Speed Control of DC Motor utilizing Optimization Techniques and innovations strategies

Santosh Kumar Suman, Vinod Kumar Giri

Department of Electrical Engineering, Madan Mohan Malviya University of Technology, Gorakhpur, Uttar Pradesh, India

ABSTRACT

The purpose of this paper showed an appraisal study on movement control of The DC engine drive through PID (relative, essential, subsidiary) controller and using Optimization Techniques and canny developments strategies. In a matter of second's days, DC motor is widely used as a piece of business endeavors as a result of its broad assortment of speed control still if its bolster cost is higher than interchange engine. The speed control of DC motor is uncommonly captivating from investigation motivation behind discernment. Such an assortment of methodologies is arranged around there. The PID controller is all the time used as a piece of cutting edge controller expected for non-direct system. This controller is ability used as a part of a huge amount of divergent districts, for example, balance structure, aeronautics, process control, gathering, outlining, prepare and assembling, designing and train. The tuning of PID parameter is uncommonly mind boggling however there are Optimization Techniques and intelligent strategies which are used for tuning of PID controller to control the speed of the DC motor. Tuning of PID parameter is basic in light of the fact that these parameters plays a basic errand in quality and execution in variety of settling time, rise time, peak time, peak overshoot and transient response of the control system. As a last point is unobtrusive components dialog about each techniques freely analyzed into the point way.

Keywords: DC motor PID controller, genetic algorithm (GA), Differential Evolution (DE), particle swarm optimization (PSO), artificial neural networks (ANN), fuzzy logic.

I. INTRODUCTION

The DC motor drives are a diminished measure of adaptability with a stage exchange from AC to DC. The DC motor is a force actuator which changes over into electrical vitality to automatic vitality since they can be worked over a wide scope of velocities and torques. The DC motor is by and large utilized as a part of a considerable measure of modern applications anyplace. The DC drive eases a critical occupation in commercial enterprises and our everyday life. The exceptional advantage of the DC motor drive is that they exhibit without trouble advantageous individuality. Their primary weakness is a higher starting venture. The DC motor framework still holds a well-assembled damaging position for modern, utility due to their appealing facial appearance and since, it offers a broad scope of pace control. Extensive DC motor can be utilized as a part of device, devices, printing press, electric trains, steel rolling mills, and, hoists cranes, automatic manipulators,

transports, pumps, programmed controllers and other sensible applications, for example, electric trains, steel moving plants, and, derricks cranes, programmed controllers, paper factories [1]. Little DC drives (in portion torque rating) are utilized start as control gadgets, for example, taco-generators for rate see and servo motors for movement and following. In spite of the fact that endeavors are being amid to get expansive reach, movement control with AC motor , as of recently the adaptability and suppleness of DC motor can't be composed by AC motor. In this way, the vital for DC motor might want to continue still in trust. The PID (proportional integral derivative) has been utilized for a couple of decades as a part of the assembling process for control applications. At the equal example of PID controller worried from the inconveniences that is the undesired rate overshoot and the moderate moving activity because of fast alter in burden torque and the sympathy to controller increases KP, KI and KD. The Controller of execution relies on the precision of the

control plan model and parameters. At that point we require systems that can conquer the issues of PID controller.

The DC motor gives extraordinary movement control to deceleration and speeding up. Speed control of DC motor has pulled in huge examined and bountiful strategies have developed. For rate control of DC motor, most comprehensively utilized controllers are customary PID [2]. The controllers of the pace that are considered for expect to control the rate of a DC motor to execute a ton of assignments. Various routine relative essential (PI), PD, PID (proportional integral derivative) yet introduce time has utilized the recently streamlining systems. Which are in this paper think the improvement procedures and savvy systems as particle swarm optimization (PSO) techniques, genetic algorithms (GAs), Differential Evolution (DE) and fuzzy logic controller plays the vital role of the control system and good performance in this world.

II. METHODS AND MATERIAL

A. PID Controller

PID Controller is an essential control circle of input gadget and is regularly utilized as a part of a control framework. The unique side effects of a the DC motor, for example, scattering and development can disrespect the execution of ordinary controllers [3].in these three fundamental sorts of parameter or modes Proportional “P”, Integral “I” and Derivative “D” utilized. This worth can be deciphered as far as time. P relies on upon the present error I on the collection of earlier period error D (subordinate control) am the estimate about up and coming blunder, in light of current rate of progress and enhance the transient reaction of the framework. The speed, blunder between the reference speed and the real rate is given as information to a PID controller [4].The PID controller dealing with the adjustments in blunder its productiveness, to control the procedure data such that the mistake is reduced. Tuning of PID give complete data about the presumption and controllers [5]. The principal structure of a PID control framework is appeared in Fig. 1. A mission of PID controller is otherwise called the three-term of principle controller parameters, whose exchange capacity is as often as possible written in the parallel structure given by

comparison (1) or the perfect structure is given by mathematical statement (2)[6].

General form of Transfer function of a PID controller is specified as,

$$G(S) = K_P + K_I \frac{1}{S} + K_D S \quad (1)$$

$$K_P \frac{K_I}{S} + K_D S = \frac{K_D S^2 + K_P S + K_I}{S} \quad (2)$$

$$= K_P \left(1 + \frac{1}{T_I S} + T_D S\right) \quad (3)$$

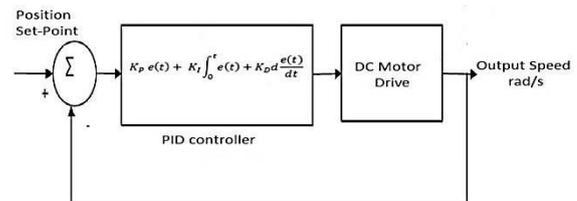


Figure 1. Block Diagram of PID Controller with System

$$U(t) = K_P e(t) + K_I \int_0^t e(t) dt + K_D d \frac{e(t)}{dt} \quad (4)$$

where e = Error signal

Kp = Proportional Constant

Ki = Integral Constant

Kd = Derivative Constant

B. Genetic Algorithms

The genetic algorithms is a procedure for tackling both unconstrained and compelled issues that depend on natural preference. A genetic algorithms (GAs) is a hunt and advancement procedures which system by copying the developmental morals and chromosomal entertainment of the tenets in characteristic hereditary qualities. A GA 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 target capacity 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 second process is the control of the specific individual to shape the cutting edge by transformation and hybrid methods [7]. The GA is utilitarian to any inquiry or advancement calculations that depend on Darwinian standards

"survival" of the fittest as enthusiastic strengths taking after the organic development by common choice. The Genetic Algorithm is a populace in light of inquiry and enhancement technique which is emulating the procedure of normal development, hereditary calculations are great at charming outsized, conceivably immense, seek breathing space and explore them searching for most ideal blends of effects and arrangements which we won't not discover in a lifetime[8]

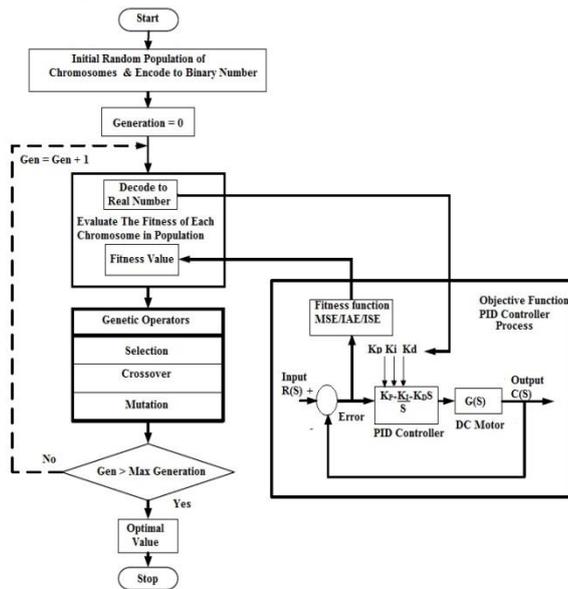


Figure 2. Flowchart of genetic algorithm for PID tuning

K. Sundareswaran et. Al, plane that it is done to search out a Genetic Tuning of PI controller for Speed Control of DC Motor Drive [9], in this paper in plate entire they used of GAs for the diagram of a controller parameter of an autonomously empowered DC motor. The configuration standard is adjusted as a streamlining trouble and the across the board set of laws of the GA are useful. GA intended for a PID controller is abundantly enhanced execution, the control issue is surrounded as an advancement errand with crest undershoot, overshoot and settling time of the dynamic reaction of the drive as the limitation variables. At the arranged GA, a original preference procedure is received by consolidating a Roulette wheel choice with Elitism bringing about prior meeting to the ideal elucidation.

Vishal Mehra et. Al, the game plan of speed control of a DC motor using halfway demand control Fractional math gives remarkable and higher execution increases

for fragmentary solicitation relative essential and backup (FOPID) controller [10]. The effort of this manuscript, the parameters of the FOPID controller are ideally scholarly by utilizing Genetic Algorithm (GA), and the change execution point is picked as the focal of the total goof (IAE). Preoccupation results exhibit that the FOPID controller performs upgraded than the whole number educate the PID controllers.

Walaa M. Elsrogy et. Al, engineered that the configuration of PID with Adaptive Neuro-Fuzzy Inference organization in context of the GA has much speedier reaction than the standard technique [11]. This methodology is unrivalled for liberal us as the preparatory purpose behind what are the PID controller qualities. In any case, Adaptive Neuro-Fuzzy Inference scheme based GA framed PID is staggeringly overhauled in the states of the, settling time, rise times than the customary technique. At long last the Artificial Intelligence offers better than the reaction than the standard techniques. Other than the spoil connected with the Adaptive Neuro-Fuzzy Inference System based the GA is much lesser than the slip learned in the customary structure.

Megha Jaiswal et. Al, took a shot at pace control of a DC motor utilizing a Genetic include based PID controller that it is done to get a flawless PID using keeping in mind the end goal to tune the Genetic calculation. This paper has give apparently the innovative parallel coded acquired include meander MATLAB, which can be obviously grasped or experienced old the establishment of MATLAB, the GA framed PID controller is upgraded the execution to the degree rise time, settling time, overshoot than a standard PID controller. In the likelihood of pace control utilizing a hereditary calculation graph and embedding based PID controller through the twofold coded program for another game-plan of plants.

C. Differential Evolution

Differential Evolution is a vector people in perspective of stochastic progression procedure. In 1995 R. Storn and K. V. Taken a toll envisioned another kind of formative computation furthermore called Differential Evolution (DE) [11]. They displayed their new streamlining computation at the earliest International contention on Evolutionary Optimization techniques in

1996 [12]. This procedure is fit to improved reason limits which are components of discrete variables [13, 14]. An unconstrained progression issue can be taken after as:

Find $=(X_1, X_2 \dots, X_n)$ which minimizes

Where is a n-dimensional vector called arrangement vector and is the target capacity

DE has moreover transformed into a staggering instrument for dealing with improvement issues what can be used for motor blueprint. A segment of the frameworks have needed of given that a sensible beginning stage for the interest system to begin. DE fits in with the class of an innate computations (GAs) which used science stirred operation of decision, half breed, and change in a people remembering the deciding objective to diminish an objective limit over the decision of straight times (Holland, 1975). So also as with other formative estimations program handles growing in order to streamline issues a people of contender plans using an alteration and decision chairmen. DE uses coasting point as a piece of its place of bit-string programming of masses numbers, and calculating operations as a choice of true blue operations in change, in love to incredible GAs. In the knowledge that it's used the practically identical transformative overseers, for instance, decision, recombination, and change associated with that of GA. of course, it is the utilization of these chairmen that collect DE interesting in connection to GA; where in GA of half breed the pace a momentous part, it is the change chairman that impacts the working of DE. It has been viably associated with a generous extent of issues for improvement parameter and what's more Batch Fermentation Process [15]. best propose of the glow exchanges [16], streamlining and mix of the glow consolidated refining system arrangement [17], upgrade of non-direct the motorered structure [18], change of water "pumping" strategy [19]

Vikrant Vishal et. Al, focus on that some streamlining Techniques handiness to DC Motor Control. In this paper, a relative study is asserted out on the progression limit of GA, APSO, DE and CS, with a particular finished objective to in a perfect world arrangement a PI controller for pace control of the DC engine using streamlining systems [20]. The perfect estimations of Kp and Ki of the DC motor drive conduct for set point

taking after got by Differential Evolution (DE) and framework which is ideal execution over getting on techniques.

Ashu Ahuja and Sanjeev Kumar et. Al, suggested that the laid out PID controller for DC motor using transformative headway techniques [21]. The purpose of this paper, an examination of different Evolutionary Optimization (EO) strategies has been investigated for controller tuning PID and fragmentary solicitation PID for pace control of DC motor. Three strategies have been considered, which are: differential advancement (DE), particle swarm change (PSO) and genetic figuring (GA). The Performance of PID and FOPID is broke down using DE, GA, and PSO and for different cases and it is watched that for each circumstance, the FOPID has upgraded the show depiction to the extent rise time, settling time and overshoot. Differential headway has been a better joining than overall perfect, more correct and diminished number of propagations interestingly with other the improvement techniques [22].

D. Particle Swarm Optimization

The Particle swarm optimization is a heuristic advancement strategy set forward firstly by Dr. Kennedy and Eberhart in 1995[23]. The PSO is a populace based stochastic improvement strategy animated by creature swarming conduct in nature [24]. Particle Swarm Optimization (PSO) is a computational technique that streamlines a trouble by iteratively attempting to show signs of improvement and hopeful unravelled with sees to a given measure of worth. PSO advances an issue by having a populace of competitor arrangements; every molecule's development is impacted by its restricted most fabulous recognized place but at the same time, is guided toward the finest perceived position in the inquiry space, which are productive as better positions are found by different particles. This is unsurprising to move about the swarm toward the best arrangements [25]. It is utilized for some sorts of parameter improvement and for the most part in this paper in PID parameter are enhanced. PSO has given a superior ideal quality than ordinary systems shown in fig.5. PSO-based PID controller plane.

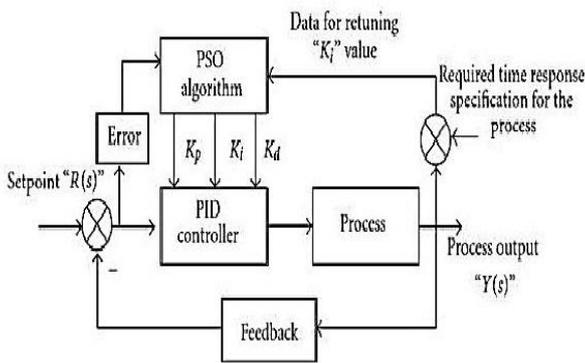


Figure 5. PSO-based PID controller design

Anupam Aggrawal, Akhilesh Kr. Mishra and Abdul Zeeshan, by exertion is to plan a rate controller of a the DC engine by finding an ideal estimation of PID and FOPID parameters utilizing bio-roused enhancement strategy of the Particle Swarm Optimization (PSO).since, Particle swarm Adaptation is an improvement idea that recreates the capacity of human social orders to process information [26]. Here, considered a model of DC motor as a second request framework for rate control. In this paper is looking at a Performance of different controllers has been evaluated and it is begins that Particle Swarm enhancement (PSO) is generally magnificent among the oil strategy which are utilized for tuning the parameter of PID controllers for which settling time and rise is started to be minimized, The routine Controllers however are not offered for higher request and complex frameworks as they can reason the framework to happen to uneven [27].

K, and R.G and other, here a method to find the perfect tuning of the PI controller parameter on Direct present (DC) engine drive using particle swarm change computation (PSO), Ziegler-Nicholas (ZN) is tuning and Modified Ziegler Nicholas (MZN) tuning technique [28]. The speed control of direct present (DC) engine drive is done using PI and PID controller. The execute of PID controllers for DC engine speed control is through using ZN and MZN tuning procedure, foreseen technique is built up totally capable and vivacious in improving the step response of the DC engine drive structure. The most disparaging of this paper is to minimize transient response plan favored as rise time, settling time and overshoot, for improved rate of DC engine drive. In PSO computation technique, PI controller is used to upgrade the execution of rate control of DC engine drive. This paper of target is surprising computational efficiency

and the quick tuning of perfect PI controller parameter regard yields an eminent game plan and differentiated and the traditional ZN strategy.

Poomyos Payakkawan,add to another strategy towards better game plan an AI-develop heuristic headway procedures arranged in light of atom swarm streamlining (PSO) to decide the two sorts of system as affirmation of a DC motor drive, time delays are gained by the second demand trade limit with the looking shafts region gadget in perspective of particle swarm change. This methodology takes after as; first time responses of pace are directed by multi-level step data voltages. The disturbances of time responses are decreased by a wavelet fragile edge of the Second. Finally, the calm helpful responses are dropping by PSO procedure. The tuning of PID controller parameters, the augmentations of P, I, and D are undeterred both disengaged from the net and on-line method, PSO and for On-line process, PSO-gets booking is adaptively adjusting the controller increments to overhaul the speed under changing the rate demand affirmation and tuning necessity of PID controller [29].

E. Fuzzy Logic Algorithm

The fuzzy logic, association depends on the reproduction of individuals' and judgment to control any framework. The operation of the FLC depends on the subjective understanding about the framework being controlled. PID or fluffy rationale controller can be utilized for control framework. The Fuzzy rationale controller has different points of interest over the PID controller. It doesn't require the scientific model of the control system.The Fuzzy Logic controller comprises of four major segments: fuzzification, a surmising engine, learning base, and a defuzzification shown in fig.4. Every segment influences the achievement of the fluffy controller and the conduct of the controlled framework [30]. The imperative part the fluffy rationale controller framework is an established in light of a fluffy control guideline base related by method for a fluffy surmising and the compositional tenets of detailing, fluffy standard control framework are generally defined in etymology term in the of if-then principles [31] Fuzzy rationale control is one of the interfaces among control motorizing and computerized reasoning strategies. The Fuzzy rationale controller (FLC) identified with the conventional PID controller to settle the parameters of

the PID controller as indicated by the change of the sign blunder and change of the mistake [32].

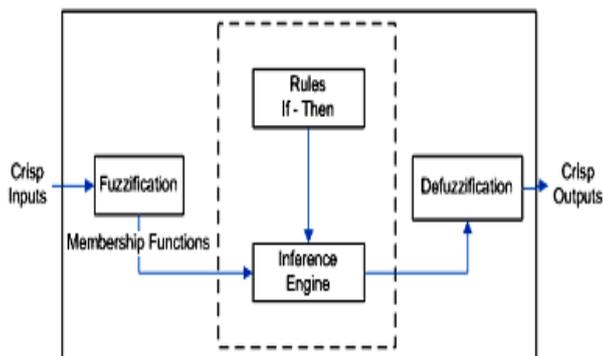


Figure 4. Configuration of Fuzzy Logic Controller

Zhi Liu, say with the point of Brushless DC motors (BLDC) is effective, trouble free administration, and pretty much trustworthy. Regardless, the brushless DC motor could be a multi-variable and framework. amid this paper blessing one in everything about structure methodology of safe reaction provocative malady administration of framework breaking point of T-cells, together with a dynamic term, that is controls reaction speed, ANd an inhibitive term ordinary incendiary ailment controller skill from flawed parameters furthermore the nonlinear of the Brushless DC motor. The framework joins current and rate close circles. The reenactment depicts that best skillfulness and affectability also high precision and inconceivable power square measure gotten by the musical association structure [33]

Farzan Rashid et. Al, discussed with the explanation behind some significant speed standard arrangements for DC engine is shown. In this paper we propose some new systems in order to control the rate regulation of a DC engine drive. These techniques are: Fuzzy self-tuning, GAs-based PID controller, GAs-Based Fuzzy PID Controller and Fuzzy PID Controller using neural framework. All the Control procedures exploit the yield speed misstep and its auxiliary as data damping signals has best execution rather over another methodology. It exhibits that the GAs-Based soft control Algorithm has been overwhelming execution that the Fuzzy-PID controller has exceptional after execution of the DC engine using made by the neural system (NN)[34].

F. Artificial Neural Networks

A typical start of the subject of simulated neural systems is given and the occupancy relationship of neural systems to the organic neuron design of the sound judgment (mind) is likewise for a brief timeframe delineated. An Artificial Neural Network (ANN) normally called 'Neural Network's shown in fig.3. it is a computational model that tries to reproduce the administrative body and valuable parts of organic neural systems. It contains an interconnected combination of fake neurons and procedures in arrangement utilizing a connectionist way to deal with calculation. Normally Artificial Neural Network is an adjustment understanding that progressions its arrangement in light of outer or inward in a succession that courses through the system amid the learning section. In spite of the fact that ANN can be demonstrate still to a great degree non - direct frameworks, it is not utilized as a part of control because of restricted relevance in PID controllers [35]; the neural system control has a couple of disadvantages for the reason that of some intrinsic deficiencies of ANN suspicion.

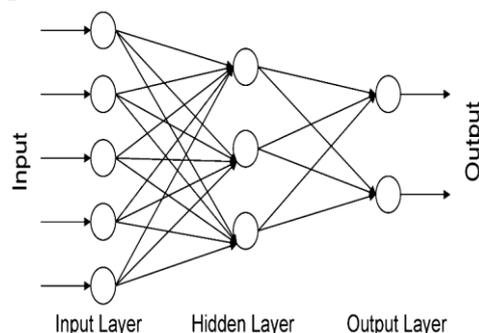


Figure 3. Structure of ANN

Heng-Ming Tai et.al, the course of action of inspecting the usage of the back-expansion neural framework for the activity control and speed regulation in the mechanical servo structures. The desire is to set up an astute controller or controller which has flexibility the same to that focused by a human head. This paper discovers the usage of neural frameworks to engine control and speed regulation fight. We recommend two neuro controller structures and consider their chance for ceaseless control. It is like manner considers framework presentation as a segment of the amount of covered units and the effect of get ready sets propose on framework theory and total taking care of limits of the accompanying neural framework model [36]

III. CONCLUSION

Point of this paper gives an exertion has been made to survey different written works for the utilizing optimization techniques and innovations strategies which is presented by the divergent exploration researchers for tuning of PID controllers of parameter for velocity control of DC motor drive to advance the best result. This audit article is additionally depicted the late status of tuning of PID controller for speed control of DC motor using optimization techniques and innovations strategies.

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