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Speed Control of DC Motor Using Artificial Bee Colony Optimization Technique

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ABSTRACT: The aim of this work is to design a speed controller of a DC motor by selection of PID parameters using bio-inspired optimization technique of Artificial Bee Colony Optimization (ABC). Here, model of a DC motor is considered as a second order system for speed control. In this work bio-inspired optimization technique in controllers and their advantages over conventional methods is discussed using MATLAB/Simulink. This proposed optimization methods could be applied for higher order system also to provide better system performance with minimum errors. The main aim is to apply ABC technique to design and tune parameters of PID controller to get an output with better dynamic and static performance. The application of ABC to the PID controller imparts it the ability of tuning itself automatically in an on-line process while the application of optimization algorithm to the PID controller makes it to give an optimum output by searching for the best set of solutions for the PID parameters.

KEYWORDS: Artificial Bee Colony Optimization; PID Controller; DC speed control

I. INTRODUCTION

Due to its excellent speed control characteristics, the DC motor has been widely used in industry even though its maintenance costs are higher than the induction motor. As a result, speed control of DC motor has attracted considerable research and several methods have evolved. To reduce the loading effect and minimize time delay, a Proportional-Integral-Derivative (PID) controller is added. The PID controller is by far the most dominating form of feedback in use today. Due to its functional simplicity and performance robustness, the proportional-integralderivative controller has been widely used in the process industries. The standard PID control configuration is as shown in Figure below.

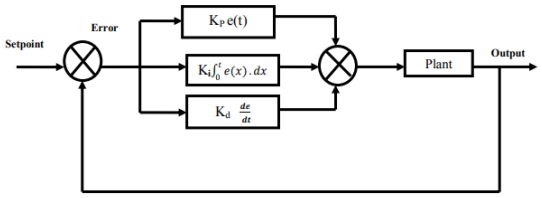

Fig .1. PID control system

This is a type of feedback controller whose output, a control variable, is generally based on the error between some user-defined set point and some measured process variable. A PID controller attempts to correct the error between a measured process variable and a desired set point by calculating and then outputting a corrective action that can adjust the process accordingly. So by integrating the PID controller to the DC motor were able to correct the error made by the DC motor and control the speed or the position of the motor to the desired point or speed. However, PID controllers cannot be tuned in such way that the optimum step response is achieved for different inertia, load and speed reference, to achieve the desired step response of the system has minimal rise time and without overshoot.

For design and tuning of PID controller parameters K p , Ki , Kd , an optimization methods are used. There are a variety of PID controllers tuning methods have been developed such as Ziegler-Nichols rules, Cohen-Coon rule and so on. These methods are applied directly since they provide simple tuning rules to determine the PID parameters. However, since they rely on a minimum amount of dynamic information by making a certain assumption about nature of the controlled process, such as linearity, weak interactions within the process, absence of noise, etc. The realized closed loop response is less than optimum since the real world processes are non-linear and very complex. Since the PID controllers are usually poorly tuned for the systems with above said features, a higher degree of experience and

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technology are required for tuning. Recently, the inspiration from natural developed a host of natural-inspired algorithms in evolution (genetic algorithms, etc.), neurology (artificial neural networks), immunology (artificial immune systems), social networks (ant colony optimization, particle swarm optimization, bees algorithm, etc), and more as opened paths to a new generation of advanced process control. Among the techniques found out, stochastic search techniques, particle swarm optimization and genetic algorithms optimization techniques have found themselves a place in tuning of the parameters. As intelligent algorithms, genetic algorithm and particle swarm optimization have great superiority in tuning the parameters of PID controllers. One of the new developed nature inspired algorithms is the artificial bees colony optimization algorithm has been particularly appealing various scientific circles.

II. LITERATURE SURVEY

The point of work proposed by Akhilesh Kumar Mishra and et al is to structure a speed controller of a DC engine by choice of PID parameters utilizing bio-roused streamlining procedure of Artificial Bee Colony Optimization (ABC). Here, model of a DC engine is considered as a moment request framework for speed control. In this work bio-enlivened enhancement strategy in controllers and their points of interest over traditional strategies is talked about utilizing MATLAB/Simulink. This proposed streamlining techniques could be connected for higher request framework additionally to give better framework execution least mistakes. The primary point is to apply ABC method to structure and tune parameters of PID controller to show signs of improvement dynamic and static execution. The use of ABC to the PID controller gives it the capacity of tuning itself consequently in an on-line process while the use of advancement calculation to the PID controller makes it to give an ideal yield via scanning for the best arrangement of answers for the PID parameters. [1]

AnguluriRajasekhar and et al proposed another method for structuring input control of a DC engine speed utilizing fragmentary request relative vital subordinate (FOPID controller). DC engine is regularly utilized in mechanical technology and different fields of control and in this manner speed control is significant. FOPID controller's parameters are made out of the proportionality steady, vital consistent, subordinate consistent, subsidiary request and indispensable request, and its plan is more mind boggling than that of customary whole number request proportionalintegral-subsidiary (PID) controllers. Here the controller combination is figured as a solitary target advancement issue and dependent on Integral Time Absolute Error (ITAE) model. A changed Artificial Bee Colony Algorithm is been utilized to tune the FOPID controller parameters. [2]

Because of its amazing velocity control qualities, the DC engine has been broadly utilized in industry despite the fact that its upkeep expenses are higher than the enlistment engine. Thus, speed control of DC engine has pulled in impressive research and a few strategies have developed. PID controllers have been broadly utilized for speed control of DC engine. In this paper the utilizing Artificial Bees Colony (ABC) improvement calculation for guideline parameters of PID controller of DC engines. The point of the proposed strategy is to improve following execution of DC engine. Toward the finish of the investigation, ABC calculation demonstrated preferred execution over the other populace based improvement calculation. [3]

DC drive frameworks has a wide region of uses in modern part like paper, Power, steel enterprises. However, is apply autonomy and activation, position control is exceedingly required. Tuning technique for PID is essential for the procedure businesses. As Proportional Integral Derivative controllers is basic in structure, great steadiness and high consistency. Thus, PID controllers are utilized to control yields in criticism framework, especially for frameworks with careful numerical models. Be that as it may, a central point which impact yield of PID controllers is its exact and effective tuning of parameters. The point of this paper is to contemplate the Position control of DC engine utilizing Artificial Bee Colony Algorithm. To take care of this issue Artificial Bee Colony Algorithm with self–tuning is connected in PID controller, which can accomplish high and productive position control. The viability of Control Algorithm is spoken to through reproduction and henceforth contrasted and the prevalence of PID controller. The proposed technique is contrasted and Ziegler Nichols strategy. It is seen that the Artificial Bee Colony Algorithm with the proposed PID parameters is giving preferred outcome over the Ziegler and Nichols' technique. [4]

The article exhibits an auto-tuning strategy for state input voltage controller for DC-DC control converter. The punishment networks utilized for figuring of controller's coefficients were acquired by utilizing nature-roused counterfeit honey bee state (ABC) enhancement calculation. These defeats the principle downside of state input control identified with tedious experimentation tuning methodology. The streamlining calculation considers imperatives of chose state and control factors of DC-DC control converter. So as to meet all control goals (i.e., quick voltage reaction

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and babbling free control signal) a proper exhibition record is proposed. Legitimate determination of state input controller (SFC) coefficients is demonstrated by reproduction and exploratory trial of DC-DC control converter. [5]

The point of work proposed by Akhilesh Kumar Mishra and et al is to plan a speed controller of a DC engine by choice of PID parameters utilizing bio-propelled enhancement system for example Molecule Swarm Optimization (PSO). Here, model of a DC engine is considered as a moment request framework for armature voltage control technique for speed control. In this work bio-enlivened advancement strategy in controllers and their favorable circumstances over traditional techniques is talked about utilizing MATLAB/Simulink. This proposed advancement strategies could be connected for higher request framework additionally to give better framework execution least mistakes. The primary point is to apply PSO procedure to plan and tune parameters of PID controller to show signs of improvement dynamic and static execution. The utilization of PSO to the PID controller gives it the capacity of tuning itself naturally in an on-line process while the use of enhancement calculation to the PID controller makes it to give an ideal yield via looking for the best arrangement of answers for the PID parameters. [6]

Mehdi GhazaviDozein and et al exhibits another methodology for plan a speed controller of a DC engine by determination of PID parameters utilizing Particle Swarm Optimization (PSO) technique. Due to amazing control attributes of DC engine, it has been generally utilized in the goal capacities. So it is critical to acquire the best execution of DC engine. Because of leading recreation dependent on PSO, cost capacities with various situations are considered. Additionally, the impacts of various cost works on execution of framework were examined. To demonstrate the productivity of PSO to finding the worldwide ideal parameters of PID controller, recreation results were contrasted and Genetic Algorithm (GA) strategy. By contrasting two techniques, we acquired that PSO has great execution to locate the ideal PID controller to speed control of DC engine. Additionally, we acquired that to speed control of DC engine, Time space cost capacity has great productivity to finding the most proper PID controller because of the significance of time area parameters in execution of DC engine. [7]

The elite of DC engine speed control framework is required under certain circumstances, while the speed control framework dependent on the stage bolted circle innovation has its one of a kind bit of leeway in the unfaltering rate accuracy. In view of the regular programming stage bolted speed control framework, the paper structures the improved programming stage bolted speed control arrangement of DC engine. The trial demonstrates that the insulin siphon with the control calculation of DC engine has enough implantation accuracy to meet the structure prerequisites. [8]

The tuning part of corresponding fundamental subsidiary (PID) controllers is a test for analysts and plant administrators. This paper proposes the tuning of PID controller of a DC engine utilizing hereditary Algorithm .Genetic calculation is a delicate processing system which is utilized for enhancement of PID parameters. The Algorithm capacities on three essential hereditary administrators of determination, hybrid and transformation. In light of the sorts of these administrators GA has numerous variations like real coded GA, Binary coded GA, and these parameters affect the steadiness and execution of the control framework. This Paper centers the Binary coded GA and finds the estimation of hybrid, change of PID controller. [9]

The control and computerization has been quickened to its cutting edge with the presentation of AI calculations and propelled registering ability of current processors, in control frameworks for different applications. Numerous looks into are experiencing in the field of controller structure and tuning utilizing the profound learning calculations. This paper tends to a correlation contemplate on viability and execution between a corresponding essential subsidiary controller and a neural system controller which was planned utilizing the current devices and libraries from Matlab/Simulink bundle. At first, the relative fundamental subsidiary controller was tuned for a DC engine model with a harmony among strength and quicker reaction. Afterward, the neural system controller was prepared for a similar model pursued by enhancement of the controller. At that point the two controllers were tested utilizing a similar model of DC engine by reproduction in Matlab/Simulink. Pursued to this, another experimentation was finished by changing the qualities for snapshot of latency of rotor pursued by reenacting the controller reaction without re-tuning the controller for fresher model. Result investigation was finished by contemplating the reaction for both controller from the plotted diagram and root mean square blunder computation. Reproduction investigations and correlation between the controllers show that the controller with AI calculations is better in charge frameworks for a more drawn out period. [10]

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III. PROPOSED SYSTEM

In Bees Algorithm, the colony of artificial bees consists of three groups of bees: employed bees, onlookers and scouts. First half of the colony consists of the employed artificial bees and the second half includes the onlookers. For every food source, there is only one employed bee. In other words, the number of employed bees is equal to the number of food sources around the hive. The employed bee whose the food source has been abandoned by the bees becomes a scout. The position of a food source represents a possible solution to the optimization problem and the nectar amount of a food source corresponds to the quality (fitness) of the associated solution. The number of the employed bees or the onlooker bees is equal to the number of solutions in the population.

1. Initialize the population of solutions xi,j, i = 1. . .S N, j = 1. . .D.
2. Evaluate the population.
3. Cycle=1
4. Repeat
5. Produce new solutions xi,j for the employed bees by using (4) and evaluate them.
6. Apply the greedy selection process.
7. Calculate the probability values Pi,j for the solutions xi,j by (4 & 3).
8. Produce the new solutions xi,j for the on looking from the solutions xi,j selected depending on Pi,j and evaluate them.
9. Apply the greedy selection process.
10. Determine the abandoned solution for the scout, if exists, and replace it with a new randomly Produced solution xi,j by (4& 5).
11. Memorize the best solution achieved so far.
12. Cycle = Cycle+1.
13. Until Cycle = MCN.

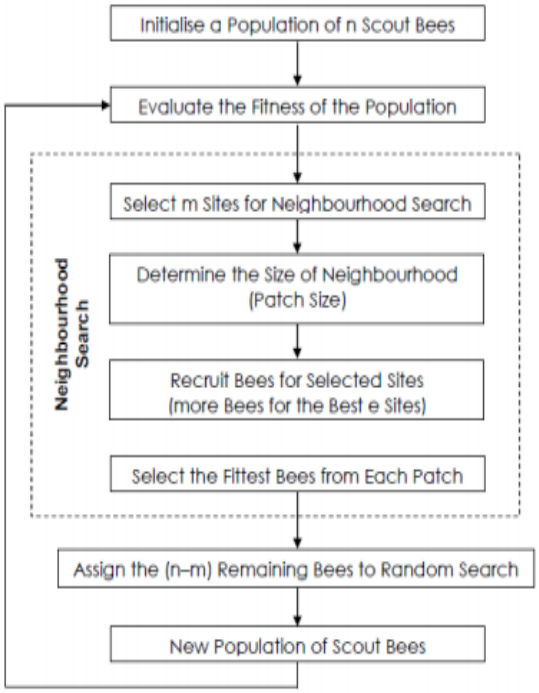

Fig.2. flowchart of proposed system

IV. CONCLUSION

Performance comparison of different controllers has been reviewed and it is found that Artificial Bee Colony Optimization is best among the all methods which are used for tuning the parameter of PID controller for which settling time and rise is found to be less. The conventional controllers however are not recommended for higher order and complex systems as they can cause the system to become unstable. Hence, a heuristic approach is required for choice of

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the controller parameters which can be provided with the help of Bio inspired methods such as Artificial Bee Colony Optimization, where we can define variables in a subjective way.

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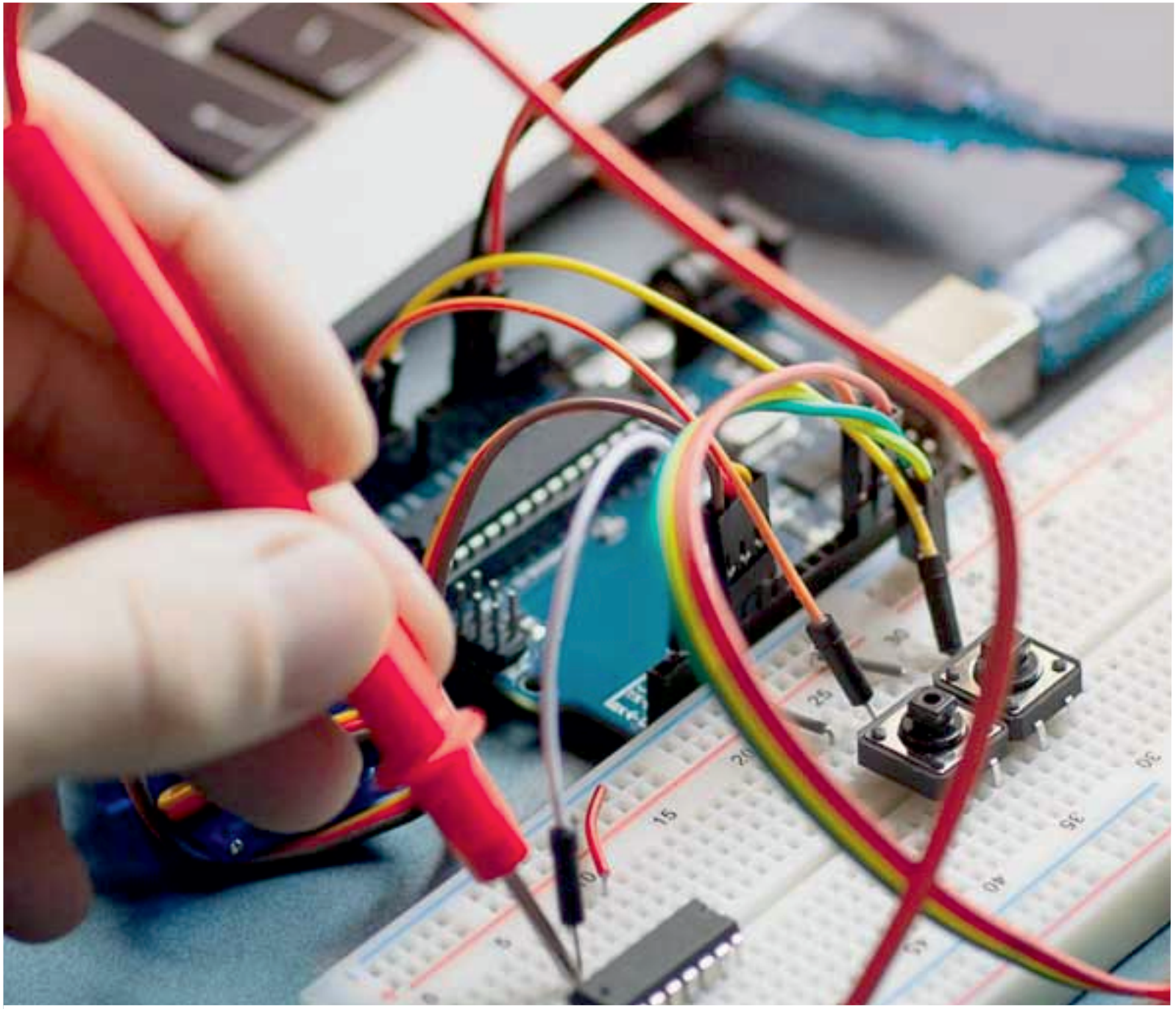

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