Artificial Bee Colony Optimization Technique Based Speed Control of DC Motor

P. S. Vikhe, M. S. Patil, C. B. Kadu, V. V. Mandhare

Abstract: ***This work deals with Fractional Order Proportional-Integral-Derivative (FOPID) based controllers designing using Bio-inspired Artificial Bee Colony (ABC) algorithm. The operating principle of bio-inspired optimization techniques are originated from various biological systems. Thus, ABC algorithm works similar to working principle of bees. In this work, second order system model of a DC motor has been considered for speed control of DC motor. The proposed optimization method can be used for higher order approaches, to provide minimum error with efficient system performance. The aim of this research work is to design and tune parameters of FOPID controller, for effective static and dynamic performance. The automatic controller tunning ability for PID is possible using ABC algorithm and fractional order system provides effective solution set for search output parameters of PID.***

Keywords: ***Control of Speed, Artificial Bee Colony Optimization, PID Controller***

I. INTRODUCTION

The use of DC motor has been increased in industries because it has better characteristics required for speed control, though induction motor has low maintenance cost compare to DC motor. This resulted considerable involvement of DC motor in research and many approaches were developed. The PID controller is used to reduce the time delay and loading effect. In recent days use of PID controller for feedback is most influencing form. As, it have robust performance and simple working principle it is commonly used in application of process industries. The schematic representation of control configuration of PID is demonstrated in Fig. 1.

This is controller with feedback output, where variable to be controlled is error between measured variable of process and set point defined by user. The error correction is carried based using PID controller, computing error and taking action for correction to adjust the process variable as per the

requirement. Thus, combining PID controller with DC motor error can be corrected achieve the desired speed and position of motor. Here, tuning of PID controller is not possible for better step response having variation in load, inertia and reference speed, to obtain required response for system has response without overshoot and minimum rise time [14].

An effective technique is used for designing and tuning of PID controller parameters *Kp*, *Ki*, *Kd*. The approaches like Cohen-Coon, Ziegler-Nichols rules etc. are develop to tune the PID controller. To find parameters of PID above mention techniques can be directly used as it provides simple solution for tuning. As, it depend on mean amount of active information, based on assumptions of control process nature, like weak interaction, noise free, linearity, etc. Since, actual processes are complex and non-linear in nature the response of closed-loop is less optimum.

II. LITERATURE SURVEY

Point of research presented by A. Kumar et al. [1] is to structure a speed controller of a DC engine choosing PID parameters utilizing bio-roused streamlining procedure for ABC algorithm. In this DC engine model is examined as a moment request framework for control of speed. The primary point is to use ABC method for structure and tune parameters, to show signs of improvement dynamic and static execution.

A. Rajasekhar et al. [2] proposed method for structuring input control of a DC engine speed utilizing fragmentary request relative vital subordinate (FOPID controller). Here the controller combination is figured as a solitary target advancement issue and dependent on Integral Time Absolute Error (ITAE) model. Mohammed E [3] utilized changed Artificial Bee Colony algorithm to tune FOPID controller parameters. DC engine has been broadly utilized in industry though it is expensive compare to enlistment engine. Thus, speed control of DC engine has pulled in impressive research and a few strategies have developed. In this work utilizing ABC improvement calculation for guideline parameters of PID controller for DC engines. Tuning technique for PID [4] is essential for the procedure businesses. As PID controllers have common structure, great steadiness and higher stability. This controller is utilized for control yields in criticism framework, especially frameworks with careful numerical systems. This work deal with position control of DC engine utilizing ABC algorithm. The proposed technique is contrasted and Ziegler Nichols strategy. It is seen that ABC algorithm with proposed PID parameters provides preferred outcome over Ziegler and Nichols' technique.

The research work in [5] 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.

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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 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.

Mehdi et al. [6] exhibits another methodology for DC engine speed controller, determining parameters of PID utilizing PSO technique. Due to amazing control attributes for DC engine and generally utilized goal capacities. Thus, is critical in acquiring best execution for DC engine. Because of leading recreation dependent on PSO, cost capacities with various situations are considered. To demonstrate productivity for PSO to identify worldwide ideal for controller parameters, recreation results was contrasted using GA strategy.

The elite of speed control in DC engine framework Zhou, J., and Li, X [7] is involved under certain circumstances, while control speed of framework dependent on stage bolted circle innovation has its one of a kind bit of leeway in the unfaltering rate accuracy. The tuning part of corresponding fundamental subsidiary controllers has to test for analysts and administration of plant. This work states PID parameter tuning of DC engine utilizing hereditary approach. Genetic computation, delicates processing system that has been utilized to enhance parameters of PID. The research work presented by M. Jaiswal et al. [8] centers the binary coded GA and finds the estimation of hybrid, change of PID controller.

The control and computerization has been quickened to its cutting edge with presentation of AI calculations and propelled registering ability of current processors, in control frameworks for different applications. J. A. Abraham and S. Shrivastav [9] 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. At first, the relative fundamental subsidiary controller tuning was carried for DC engine model having harmony among strength with quicker reaction. Furthermore, neural based control strategy was used to similar model followed for enhancing the controller.

The significant variation sorts are spread due to PID controllers. As, PD and PI are having ability of enhancing transient and execution of unsurprising state reactions respectively. However, combination can be used to apply for reaction time of given structure. Since, PID has non complex control structure and cost effective [10]. The use of GA approach for fine tuning of parameters was the main goal of research work. H. Senberber et al. [11] gives an exchange on the exhibition of the partial request relative essential subsidiary (FOPID) controllers structured by utilizing fake honey bee settlement (ABC) calculation for fragmentary request frameworks. A few proportions of the progression reaction, i.e., necessary of time weighted outright blunder (ITAE), coordinated squared mistake (ISE), settling time, and overshoot, are utilized to assess the exhibition of the FOPID controlled frameworks. Reproduction tests are contrasted and the accomplishment of the old style PID controllers streamlined by the ABC calculation, and with different strategies given in writing. The outcomes show that ABC calculation based FOPID controlled frameworks perform altogether preferable execution over different ones.

III. PROPOSED SYSTEM

The requirement of specification range must be wider for satisfactory control of industrial plant. Thus, techniques used must have wide range. For controlling applications in process industries controller having integer order is commonly used. To enhance control performance, FOPID control strategies are presently used in industrial application. $PI^{\lambda}D^{\mu}$ is commonly used form of FOPID controller. Thus, excess degrees of freedom other then controller design gains (*k_p, k_i, k_d*) along with orders of derivative and integral designing can also be obtained using FOPID controller. The orders of derivative and integral may not be integer, but may be real number. The traditional integer PID controller is an extension of generalization FOPID controller. This approach is provides adoptability in designing of PID controller. Thus, transfer function of such a controller has the following form [13].

$$G_c(s) = k_p\left(\frac{k_i}{s^{\lambda}}\right) + k_d s^{\mu}$$

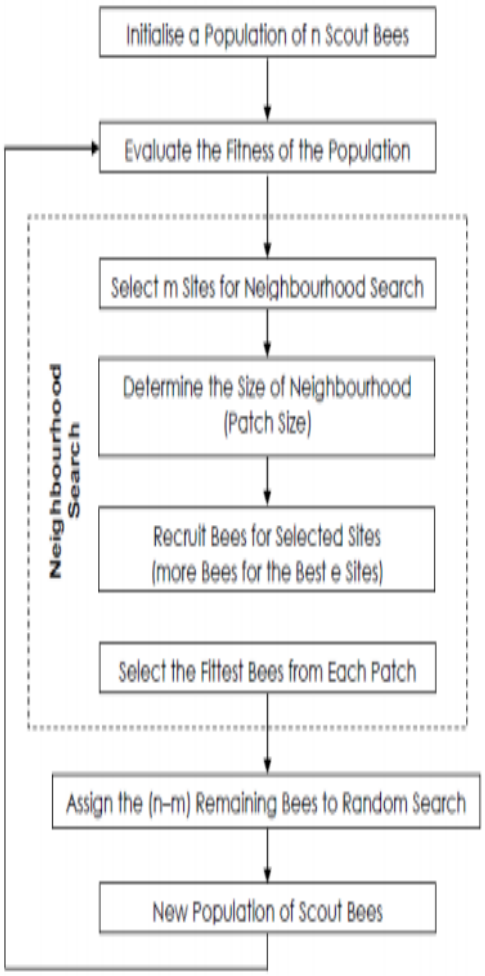

Fig 2. Flowchart of proposed system.

The onlookers, scouts and employ bees are the three categories for artificial bee colony in bees approach. In this, artificial bees employ and scouts and onlookers consist in first and second half respectively.

In this only single employed bee is present for each source food. Thus, across hive employed numbers of bees are equal as food source number.

Scout is the bee from the employed bee, whose source of food is abandoned.

Food resource position presents probability solutions for effective problem and fitness of the solution is related to nectar quantity of food source. Thus, number of solutions is equal to number of onlooker or employed bees from the population [12].

1. The solution of population should be initialize first $y_{i,j}$, $i = 1...SN, j = 1...M$.
2. Then population should be evaluated.
3. Cycle is equal to *1*
4. Carry out Repetition
5. Thus, using step 4 new solution is produced $y_{i,j}$ for employed bees for evaluation.
6. The selection applied should be greedy.
7. $P_{i,j}$ probability value is computed using steps 3 and 4 for $y_{i,j}$ solutions.
8. $y_{i,j}$ new solution are produced for $y_{i,j}$ looking from solutions selected depend on $P_{i,j}$ for evaluatation.
9. Repeat step 6.
10. For scout abandoned solution is determined, if present replace it by new random generated solution $y_{i,j}$ using steps 4 and 5.
11. Store the best solution obtained as far.
12. Cycle = Cycle+1.
13. TIL CYCLE = MCN.

IV. RESULTS

The result clearly shows that the open loop response completely fail to achieve desired value. While PID and PID with ABC algorithm achieves desired value.

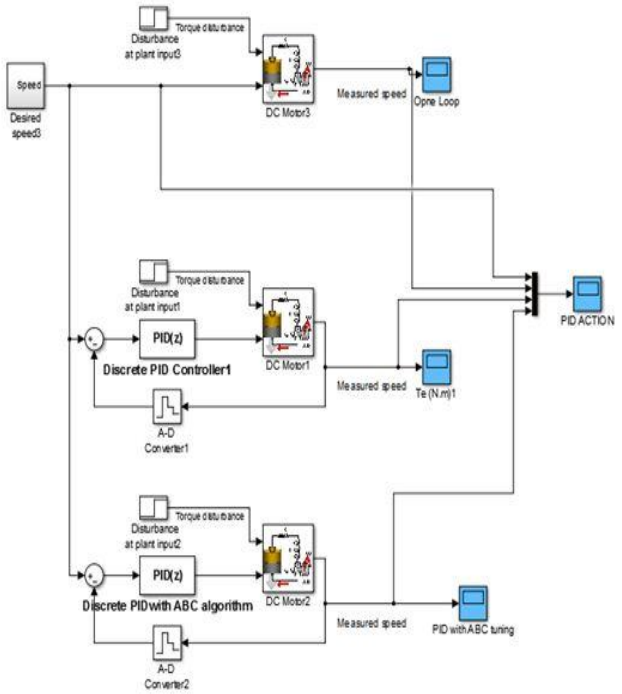

Fig 3. Simulation block for speed control of DC motor.

Now to test results with disturbance, the disturbance signal at $t = 5$, is applied to observe response. The response with disturbance is illustrated in Fig 4.

It clearly indicates that at t=5 open loop response becomes further worst, while PID with ABC algorithm gives quick recovery and gives smooth response further. It significantly indicates that peak time, rise time and oscillations for PID response are higher than PID with ABC algorithm.

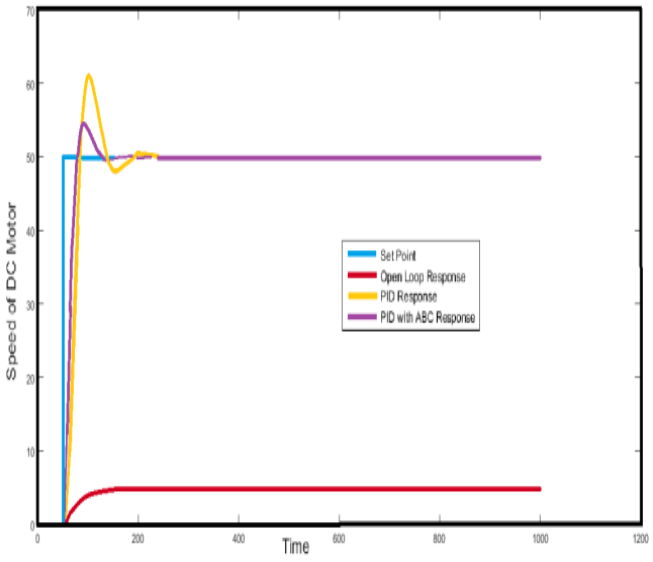

Fig 4 Combined response of open loop, PID control action and PID with ABC algorithm.

.Also the disturbance does not affect much when one controls the speed of DC motor with ABC algorithm tuning. Hence, we can conclude that for controlling speed of DC motor PID with ABC algorithm is good choice

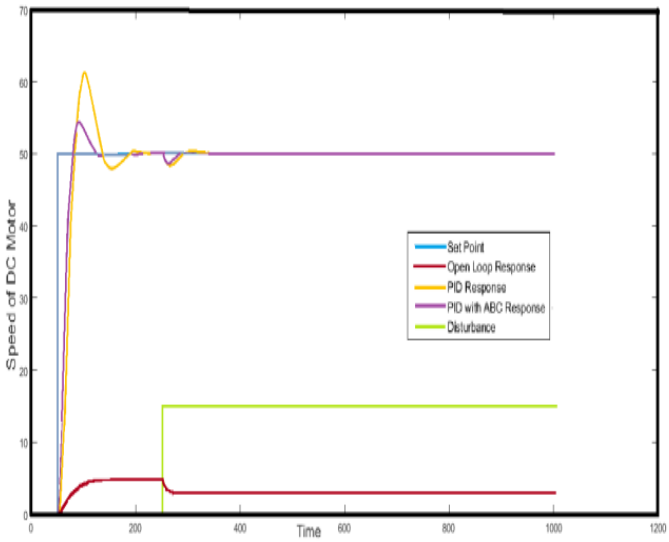

Fig 5. Combined response with disturbance at t = 5 of open loop, PID control action and PID with ABC algorithm.

V. CONCLUSION

The performance comparison of PID controller has been examined and based on results obtained for PID controller parameter tuning ABC optimization approach is found to be best. In this approach rise and settling time required is less. Since, for higher order and complicated systems traditional controllers are not suitable and recommended. The reason behind this is problem of stability arises. Hence, a heuristic approach is required for choosing controller parameters that provide help of bio inspired approach such as ABC optimization.

In which variables are defined in a subjective way. It is obvious that closed loop responses of the systems having fractional model based FOPID controllers are more desirable than other systems using integer models. Nevertheless, results obtained using proposed algorithm is better.

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