International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 06 Issue: 08 | Aug 2019 www.irjet.net p-ISSN: 2395-0072

Speed Control of DC Motor using PID Controller - A Review

Ms. Priti Sathe[1], Ms. Snehal Tetambe[2], Mr. Sahil Jadhav[3] Mr. Tejharsh Khedekar[4] Ms. Mayor Joshi[5]

[1]*Ms. Priti Sathe Professor, Dept. of Electrical Engineering, VPM's Maharshi Parshuram College of Engineering, Velneshwar, Maharashtra, India*
[2]*Ms. Snehal Tetambe, Student, Dept. of Electrical Engineering, VPM's Maharshi Parshuram College of Engineering, Velneshwar, Maharashtra, India*
[3]*Mr.Sahil Jadhav, Student, Dept. of Electrical Engineering, VPM's Maharshi Parshuram College of Engineering, Velneshwar, Maharashtra, India*
[4]*Mr.Tejharsh Khedekar, Student, Dept. of Electrical Engineering, VPM's Maharshi Parshuram College of Engineering, Velneshwar, Maharashtra, India*
[5]*Ms Mayuri Joshi, Student, Dept. of Electrical Engineering, VPM's Maharshi Parshuram College of Engineering, Velneshwar, Maharashtra, India*

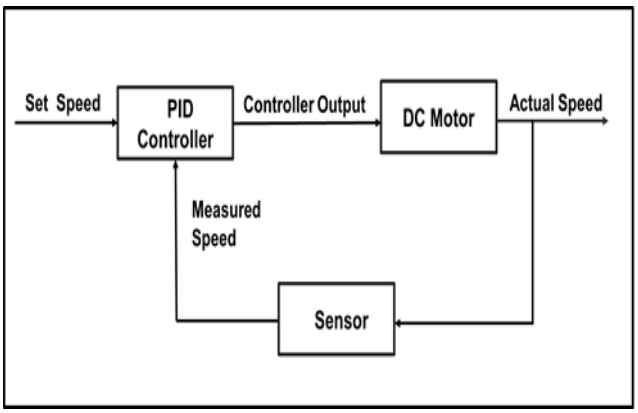
Abstract - *DC motors are widely used because of their ease in controllability and reliability. They are used in industrial applications like rolling mill, steel plants, electric train, and cranes. DC motor can be represented by nonlinear model for taken into account of uncertainties and nonlinearities like magnetic saturation in the control design. Here dc motor is considered as third order system. Speed of dc motor is controlled by PID controller. Performance of PID controller is improved by using tuning methods like, Genetic algorithm, Ziegler Nichols Method, Adaptive Neuro-Fuzzy Interference system ANFIS. These tuning methods are compared for making selection of PID parameters.*

***Key Words*: Keywords- DC Motor, PID controller.**

1. INTRODUCTION

DC motors are widely used in industries and domestic applications because of its wide range of speed control, high starting torque, high transient response and compactness [4].Addition of proportional-integral-derivative controller is called as PID controller.PIDcontroller are mostly preferred in industry, because of their low cost and benefits. It minimizes the error between measured speed and desired set speed. When PID is used motor reaches to desired speed smoothly and in certain time limits [6]. For tuning of PID controller various methods are used. In Ziegler-Nichols tuning method, Integral and Derivative methods are kept constant and proportional constant is only varied. MATLAB simulation shows that the performance of PID controller [1]. From this method maximum overshoot Mp and settling time Ts is specified. Genetic algorithm is repeated many times until optimum values occurred for Mp and Ts. This algorithm contains three stages selection, crossover and mutation. Adaptive Neuro-Fuzzy Inference system (ANFIS) is based on GA method. In this Fuzzy logic toolbox set the parameter of PID Controller [1]. This method gives optimum values of Mp and Ts.

Based on Microcontroller, close loop speed control system is developed. Microcontroller is a reliable instrument to control speed of the motor. This system is applicable for different sizes of motors and it precisely controls the speed of the motor [3]. Sliding mode control technique is robust and desired speed is perfectly tracked. [26]



1.1 PID Controller

PID means proportional–integral–derivative controller.

Most of Industry used PID controller for good efficiency. Approximately 95% of t he closed loop ope rations of industrial automation sector use PID controllers. Proportional–integral–derivative controllers are combined in such a way that it produces a control signal. The PID control function can be mathematically expressed as:

$$u(t) = Kp*e(t) + Ki*\int_0^t e(t')dt' + Kd$$

A PID controller circulate signal and it gives an accurate output, which corrects t h e e r r o r b e t w e e n t h e

process output and the desired set point that adjusts the process accordingly and rapidly. The output of the controller is manipulated variable and is obtained by adding P, I and D components and their associated coefficients.

2. SEVERAL METHODS OF SPEED CONTROL OF DC MOTOR

A Ziegler-Nichols method

Walaa M. Elsrogy et al. [1] suggested that, in Ziegler- Nichols tuning method only, proportional constant is varied and other two are kept constant. Kp is increased by the factor of 2 until continuous oscillations is not getting. Period of oscillation and gain is known as ultimate period and gain. From this method maximum overshoot Mp and settling time Ts is specified.

Siddhesh Dani et al.[5] suggested that, PID controller the values of KP, TI and TD are determined by using Ziegler-Nichols method. LQR is used for linear plants for optimum control.MPC is an optimal control method for linear and nonlinear systems. Based on the process model it predicts responses of the system in moving or receding horizon.

V. Antanio [16] discussed that, Ziegler Nicholas method is straight forward method which is used for tuning of PID controller. Ziegler Nicholas and Modified Zeigler Nicholas tuning method is used for implementation of PID controller for DC motor speed control. The transient response specifications such as rise time, Settling time and percentage overshoot can be minimized for better speed response of DC motor. The PI and PID controllers are used to measure the speed of DC motor.

Walaa M. Elsrogy et al. [17] presents, in Ziegler Nicholas method speed is measured and it gives response to the system using closed loop system. Initially, the integral and derivative parameters will be set to zero. The proportional coefficients are slowlyincreased from zero to such a value at which the system begins to oscillate continuously. The proportional coefficients at this value is called as ultimate gain (Ku) and the period of oscillation at this value is known as ultimate period (Tu).

Walaa M. Elsrogy et al. [1], [29] presents that; when the controller is in proportional mode the gain of controller (Kp) have small value initially for which the response will be sluggish. By increasing Kp by factor of two the response become oscillatory. It is finally adjusted until the response produces continuous oscillation.

Ziegler-Nichols Tuning Rule are obtained from the following table.

Table -1:

Controller Type	Kp	Ki	Kd
PID	Ku/1.7	Tu/2	Tu/8

B Genetic Algorithm method

Santosh Kumar suman and Vinod Kumar Giri [2] presents, Genetic Algorithm method for speed control of DC motor. Here separately excited dc motor is taken and its circuit model using MATLAB is created. Firstly, parameters of PID controller are decided by conventional method by increasing Kp. So the systems parameters like maximum overshoot and settling time are not tuned to its optimum. GA is hereditary calculation approach.

Wai-Min Qi and Wei-Youcai [6] discussed about genetic algorithm method for non-linear PID controller. Because of non-linear nature of each gain parameter can change error signal more attention is given to them.GA gives optimum values of the three PID constants.

Yingfa Wang and Chang Liang [9], [23], discussed that, adaptive speed control approach focused on genetic algorithm tuning radial basis function (RBF) neural network controller for brushless DC motor. In this approach, the RBF neural network whose structure and parameters of hidden-unit have been trained by genetic algorithm off-line constitutes a speed loop controller.

Xiu Juan Ma et al. [10] Suggested that, Brushless DC Motor is taken to plant, to compare the traditional PID controller with genetic algorithm back propagation neural network PID controller. It proves that by adopting genetic algorithm optimization back propagation neural network PID controller, to calculate the PID parameters has made the kinetic characteristic and the strong and good condition of the system much better.

Sumana Chowdhary [12] discussed about, problem solution generic algorithm required coding. Most of binary coding used in generic algorithm. The solution of an optimization problem in the form of strings can be done by implementing genetic algorithm which requires encoding. Generally, binary coding of parameters is done. The more efficient result is given by floating point representation. The chromosome of particular individual in a population is represented by the coded parameter in a string.

Megha Jaiswal and Mohna Phadnis[21] discussed about, genetic algorithm consists three stages like Selection, Crossover and Mutation. In genetic algorithm, coding is expressing the individual by the binary strings of zero and one. The chromosomes from the current generation to be parents for next generation is selected by the selection operator. The two offspring for each parent pair given from the selection operator is computed by the crossover operator. Mutation is the occasional introduction of new

features into the solution strings of the population pool to maintain diversity in population.

C Fuzzy-Neuro method

Sumana Chowdhary [12] suggested that, fuzzy logic deals with output with respect to input. Error of the output with respect to input considering a signal is a long process then Fuzzy logic treat set the future value. When an exact mathematical relation of the output variable with the input variable cannot be formulated, Fuzzy logic can be employed for its evaluation. It deals with linguistic variables. The input variables characterized by a membership function such that each variable belongs to a Fuzzy set with certain degree of Fuzziness. It can be graphically represented by the membership function.

Walla M. Elsrogy et al.[17] discussed that, this fuzzy controller method is divided into four components. These four components are Fuzzification, Inference engine, Rule base, Defuzzification.

Abhishek D. Gandhi et al. [20] Fuzzy logic is multi valued logic. Fuzzy logic defines the value like Yes/ No, True/False, etc.

Amit Kumar Sahoo and Sweet Suman [25] presented Fuzzy logic create path of system to more sharp. Fuzzy logic consists four types like Fuzzification, Fuzzy inference system, rule base and diffusificaton.

Nikhil Tripathi et al. [28], discussed that, model of Fuzzy logic s logical mathematical procedure based on "IF- THEN" rule system.

Vijay Singh and Vijay Kumar Garg [30] presented, to control brushless DC motor, improved Fuzzy PID controller is used.

D Neuro PID method

Huaji Wang and Zhaiyong Li [7] discussed that, integrates organically neural network and the tradition a PID to constitute brushless DC motor speed control system based on BP neural network self-tuning parameters PID control is used for the performance and accuracy requirements of brushless DC motor speed control system. In the beginning several seconds, the traditional PID controller is used, and then after training for seconds, another parameter self-tuning PID controller based on BP neural network. MATLAB/SIMULINK.So is established for simulation model.

Maohua Zhang and Changliang Xia [8] discussed that, brushless DC motor is difficult to get a satisfying result for BLDCM using the conventional linear control method because, the brushless DC motor (BLDCM) is a non- linear and multi-variable system. This paper presents, focuses on BLDCM because of single neural PID adaptive control for based on wavelet neural network on-line identification. The single neuron PID to construct the adaptive controller of BLDCM is method used. Also, a wavelet neural network (WINN) is built to construct the on-line reference model of BLDCM, and then identify the output of the motor.

Yingfa Wang and Changliang Xia [9] suggested that, the research about the high performance of BLDCM is important because of the brushless DC motors (BLDCM) are a nonlinear and multi-variable system. Normally, neural network is used for control method.

Ali Bekir et al. [19] discussed that, separately excited a DC motor apathetic by DC to DC converter is used to speed control by using a Neuro PID controller.

E PWM Technique

S. E. Ali et al.[3] presented, the microcontroller with chopper is used for speed control of dc motor. DC- to- dc chopper is driven by PWM signals generated by microcontroller. Changing PWM duty cycle means changing motor terminal voltage, which in turn controls the motor speed. This is Microcontroller based adjustable closed-loop of DC motor speed control system. Microcontroller is a reliable instrument to control speed of the motor. This system is applicable for different sizes of motors and it precisely controls the speed of the motor.

F *Jaya optimization algorithm (JOA)*

Ravi Kiran Achanta and Vinay Kumar Pamula [4]presented, Jaya Optimization Algorithm (JOA) is used forspeed control of dc motor. This technique reduces disadvantages of traditional method. JOA based PID controller in compared with particle swarm optimization (PSO) based PID controller. All the optimization algorithms like GA, ANFIS, PSO etc requires specific parameters and these parameters are application dependent. Whereas Jaya optimization algorithm (JOA) is simple and requires no specific parameters. Here for different set of values of KP, KI, KD specifications like Tr, Ts, Mp, Ess are found. And the JOA algorithm is repeated until we get best values of parameters. PSO gives better steady state error where as JOA gives better rise time. Transient response is improved by using JOA.

G Back stepping of DC motor

Chen Lanping et al. [13] discussed that, they had discussed back stepping method of DC motor control design. Back stepping control technique is used to control speed of DC motor. In nonlinear system back stepping techniques are new added for speed control. Reconstruction technique is firstly transferred into Cascade form of DC motor. Back stepping technique is easy to handle with nonlinearity and uncertainty so unknown parameter can be calculated.

3. CONCLUSION

Based on present literature review authors concluded that PID controller is very effective and powerful controller and has better control approach in order to sustain speed of the motor. The parameter values of PID controller are set up by tuning methods. ANFIS has faster response than response of other traditional methods. [1] It is better in rise time, settling time and less steady state error. All tuning methods are compared to optimize the values of parameters like Mp, Tr, Ess and Ts. Some new methods like JOA, PSO, LQR and MPC also give better and smoother response than traditional methods.[5]Still there is much scope in improving the PID controller design to make it more simple

REFERENCES

1. Walaa M. Elsrorgy, M. A. Fkirin, M. A. Moustaa Hassan "Speed control of DC motor using PID controller based on artificial intelligent techniques,"IEEE, 2013.

2. Santosh Kumar Suman, Vinod Kumar Giri" Speed control of DC motor Using optimization techniques based PID controller"2nd IEEE International Conference on Engineering andTechnology(ICETECH), March 2016.

3. S.E .Ali, S. B.M. Noor, S.M. Uashi, M. Hassan "Microcontroller Performance for DC Motor Speed control system "National Power and Energy Conference (PECon), IEEE 2003.

4. Ravi Kiran Achanta,Vinay Kumar Pamula "Dc Motor Speed Control using PID ControllerTuned by Jaya Optimization Algorithm"IEEE International Conference on Power, Control, Signals and Instrumentation Engineering (ICPCSI-2017).

5. Siddhesh Dani, Dayaram Sonawane, Deepak Ingole Sanjay kumar Patil "Performance Evaluation of PID, LQR and MPC forDC Motor Speed .

6. Wei-MinQi, Wei-youcai, "A Design of Nonlinear Adaptive PID Controller Based on Genetic Algorithm" IEEE 2006.

7. HuaJi, Zhiyong Li. "Design of Neural Network PID Controller Basedon Brushless DC Motor".IEEE 2009.

8. Maohua Zhang, Changliang Xia. "Speed Control of Brushless DC Motor Basedon Single Neuron PID and Wavelet Neural Network"IEEE 2007.

9. Yingfa Wang, Changliang Xia "Adaptive Speed Controlfor Brushless DC Motor sBased On Genetic Algorithmand RBF Neural Network"IEEE 2007.

10. Xiu juan Ma, Yi Liu, Ling Li "Research and simulationon PID control method for BrushlessDC Motor basedon genetic algorithmand B Pneural network. "IEEE 2008.

11. A.M. Sharaf, S M & Mark Masry, "Nonlinear Speed Control of Large Industrial Dc Motor Drives with an Energy Efficiency Enhancement Loop".

12. Sumana Chowdhuri, "An Evolutionary Approachto Optimize Speed Controller of Machines, "IEEE 2000

13. Chen Lanping, Ma Zhenghua, Duan Suolin, "Adaptive speed controller design based on backstopping of DC motor system with parameter Uncertainties" IEEE 2009

14. Abasin Ulasyar, Haris Sheh Zad, Adil Zohaib, "Intelligent Speed Controller Design for Brushless DC motor", IEEE 2008

15. ZushuLi, Hao Yang,"Speed Control of Brushless DC Motor Using Human-Simulated IntelligentControl",IEEE2009

16. V. Antanio, "Research Trends for PID Controllers", ACTA Polytechnicia Vol. 52,IEEE 2012

17. Walaa M Elsrogy, Naglaa K Bahgaat, MI El- Sayed, MA Moustafa Hassan, "Speed Control of DC Motor using PID controller Based on Changed Intelligence techniques", 2018 Elsrogy.

18. Purushottam Kumar, Prabhakar Kumar Prabhat, Mithun Kumar, Dr.S.D.Choudhary, "Speed Control of DC Motor using PID and Smart controller."International Journal of Scientific and Engineering Research, Volume 5, November 2014.

19. Ali Bekir Yildiz and M.Zeki Bilgin, " Speed control of Avaraged DC motor Drive System by using Neuro-PID controller",KES 2006.

20. Abhishek D. Gandhi, Surprakash Singh, Bhavi Tik M. Daxini, " Speed Control of Brushless DC Motor Using PID and Fuzzy Controller", ETCEE 2015.

21. Megha Jaiswal, Mohana Phadnis," Speed Control of DC Motor Using Genetic Algorithm Based PID Controller", IJARCSSE July 2013.

22. Pragya Jain, Shriyansh Jain and Amol Barave," Comparison of Different Controlling Schemes (PI, PID and IP) For Speed control of DC Motor", International Journal of LNCT.

23. Savita Sonoli, K. Nagabhushan Raju" Implementation

of FPGA based PID Controller for DC Motor Speed Control System", WCECS 2010.

24. G. Venu, S. Tara Kalyani, "DESIGN OF FOPI CONTROLLER FOR SPEED CONTROL OF BLDC MOTOR", October 14, 2018.

25. Amit Kumar Sahoo, Sweet Suman, "Speed Control of DC motor Using Hybrid Fuzzy-PID Controller ", IJAREEIE 2017.

26. T.Venkatesh, M. Tarun kumar, B.Jayanthi, B. Ramesh, P. Chaitanya, "Speed Control of DC Motor and Performance is Compared with PID and SMC Controller", IJESC 2016.

27. Chandra Shekhar Gohiya, S.S.Sadistap, S.A.Akbar, B.A.Botre, "Design and Development of Digital PID Controller for DC Motor Drive System Using Embedded Platform for Mobile Robot", IEEE 2013.

28. Nikhil Tripathi, Rameshwar Singh, Renu yadav, "Analysis of Speed Control of DC Motor –A Review study", IRJET November 2015.

29. Vijay Singh and Vijay Kumar Garg, "Tuning of PID Controller for Speed Control of DC Motor Using Soft Computing Techniques", IJAER 2014.

30. Ashwaq Abdulameer, Marizan Sulaiman, MSM Aras, Dawood Saleem, "Tuning Methods of PID Controller for DC Motor Speed Control"' IJEECS August 2016.