International Journal of Research in Science and Technology
Volume 7, Issue 4: October - December, 2020
ISSN 2394 - 9554

SPEED CONTROL OF DC MOTORS USING NEURAL NETWORK

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ABSTRACT
A multilayer neural network parameter tuner (NNPT) for PI controllers is employed in this project to improve Dynamic response of DC motors in terms of speed and torque. The DC motor is subjected to intensive development, but it still has nonlinear properties which require more complex control systems. By developing adaptive motor control systems, the problem of nonlinear structures can be solved. A traditional PI controller's working performance cannot be relied upon to control the speed of DC motors. A multilayer neural network parameter tuner for PI controllers is developed in this project to adjust the speed and other parameters of the DC motor by making adjustments of the values like Ki and Kp. In comparison with traditional PI controllers, the NNPT is expected to provide superior performance

Keywords*: matlab, NNPT, jupyter notebook , PI controller*

I. INTRODUCTION
A deep learning system uses layers of neural networks in order to accomplish its task. Deep learning adopts a conceptual approach similar to the way the human brain processes data in order to identify speech, translate languages, recognize objects, detecting objects and for making the decisions. In order to simulate human intelligence, Deep Learning uses NN. Neurons are arranged in three layers of a neural network: the Input Layer, the Hidden Layer, and the Output Layer. A feedforward NN is a network where there is no cycle in the connections between nodes. Here nodes are nothing but neurons. In this network, the information moves in one direction i.e from the input nodes, through the hidden nodes and to the output nodes. The weights applied to the inputs are then applied to an activation function, along with the bias, of the signals that are transmitted between neurons. The delta rule is Backpropagation algorithm. Backpropagation algorithm calculates the error based on a known and desired output for each input value, it is usually classified as a type of supervised-learning . This project uses back propagation algorithm to train and implement the feed forward neural network tuner.

II. LITERATURE SURVEY

*A. TUNING PID CONTROLLERS FOR DC MOTOR BY USING MICROCOMPUTER .(ALI HUSSEIN MOHAMED ALHILI):*INTERNATIONAL JOURNAL OF APPLIED ENGINEERING RESEARCH 2019:
This paper present a review study of tuning of PID controller for speed control of DC motor. PID parameters like kp ,ki ,kd are tuned using the different methods. Here in this paper, Tuning is done by the Ziegler-Nichols method using MATLAB programming as well as python programming technique. Raspberry pi is one of the microcomputer ,was taken into consideration as it supports Linux based operating system and it is programmed using python. As part of the conventional closed loop control system, the User Interface Unit, Feedback Circuit, Error Detector, PID controller circuit, and the control signal generator are integrated into the hardware circuits. Here, all these hardware functions are integrated using a single Raspberry Pi. The logic for the PID controller can be implemented on Raspberry Pi by using Python.. When Python programming was compared to other techniques, the results showed that the former had better parameters for performance.

B. ARTIFICIAL NEURAL NETWORK FOR ADAPTIVE PID CONTROLLER. (FRANTISEK KUDLACAK) IEEE CONFERENCE 2018:
The paper explains the design of adaptive PID controller and back propagation. Here PID controller is tuned by perceptron neural network and back propagation is done. As the simplest neural network, the perceptron represents a representation of a single neuron. Each perceptron connection is weighted by calculating the weight.. It is generally used an online approach to learn, where weights on artificial neural networks are updated after each sample, causing them to adapt over time It is possible to use gradient descent for differentiable error functions Single-layer neural network tuners are only capable of approximating linear functions, and not solving non-linear problems.

C. PERFORMANCE COMPARISON OF FUZZY LOGIC AND PID CONTROLLER FOR SPEED CONTROL OF DC MOTOR(ODIDEM ALTUN) IRJET 2019

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The performance of fuzzy logic and PID controllers is compared in this paper for separate excited DC motor speed control implementation in MATLAB/Simulink.. It demonstrates how to adjust the fuzzy logic controller and PID controller by setting the steps accordingly. A fuzzy logic controller is developed to keep shaft speeds constant in varying loads by employing the IF-THEN rule and the speed errors are lowered to acceptable amounts as a result. Similarly, the PID controller's gains are adapted according to the ZN method. A comparison is made between the performance of FLC and PID based on their settling times and overshoot rates at the end of this paper

D. **SPEED CONTROL OF DC MOTOR BY OPTIMIZATION TECHNIQUES . (SANTOSHKUMAR SUMAN) IEEE CONFERENCE 2016**

A DC motor speed controller is illustrated in this paper by using a GA decision. It is a stochastic global search technique that mimics the natural evolution . Achieving better tuning PID using evolutionary algorithms was the purpose of this project. The genetic algorithm was initialized with several number of population started with 20. It then initialized with population size of 40, 60, and 80. After updating determined values to GA some iterations have been done , after iterating four to five values precise gain values are obtained. On the other hand, PID controller is tuned with the help of Ziegler-Nichols method and ki , kp , kd ,values are determined .Finally ki , kp , kd values obtained from Ziegler-Nichols and genetic algorithm are plotted in graph and variations can be seen. This paper concludes that Genetic algorithm tuning technique gives least zero steady state when compared to Zeigler-Nichols method.

III. BLOCK DIAGRAM

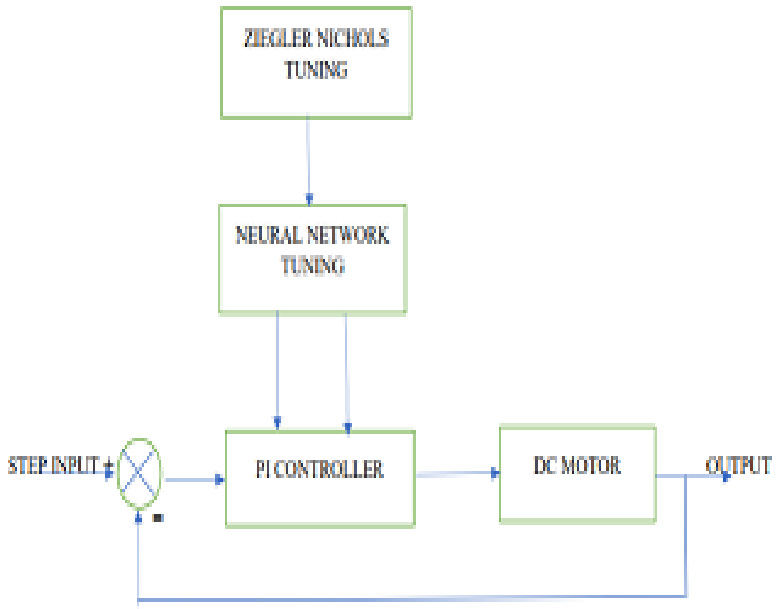

Fig.1. Block diagram

IV. METHODOLOGY

Initially the PI controller is tuned by ZN method .During this tuning process, the step response values and ultimate gain values are noted, which later used as reference values for training neural network Tuner for PI controller based on neural network parameters is developed. Because of its high learning speed, efficiency, and simplicity, feed-forward neural networks are used in this application for the control system of DC motors. The reference tuning method is used to train neural networks.. The NNPT can correct the steady-state error of PI controller after successful training.

- **PI CONTROLLER**

PI controllers calculate the error signals by comparing the system outputs to the set point obtained through a feedback control loop. A negative feedback proportional integral controller, and a closed loop unity negative feedback system are mapped onto the block diagram above

ISSN 2394 - 9554

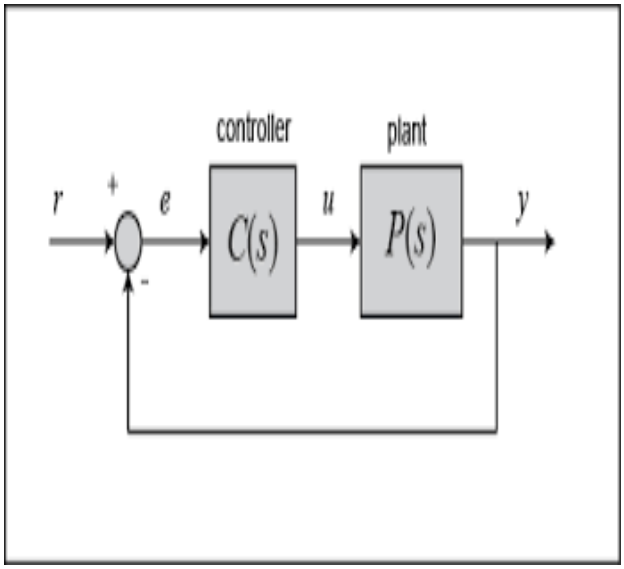

Fig.2. System of closed loop control

This is accomplished by combining the proportional and integral controllers to produce an output.

$u(t)=Kp\ e(t)+Ki \int e(t)dt$

- **ZIEGLER NICHOLS METHOD**
  The ZN tuning method is a traditional form of tuning the controller. This method was built by G Ziegler and N B Nichols. PID tuning rule attempts to produce good gain values for tuning the controller, the gain parameters are: Kp - the controller path gain. Ti - integrator time constant. Td – derivative time constant. Controller tuning means adjustments of the tuning parameters (proportional gain, integral gain and derivative gain) to ensure the best response of the controller. In this project, initially PI controller tuned using this method in matlab and gain values are determined.

Controller Parameters

	Tuned	Block
P	165.7921	449
I	491.8475	269
D	r/a	n/a
N	r/a	n/a

Performance and Robustness

	Tuned	Block
Rise time	0.368 seconds	0.22 seconds
Settling time	1.42 seconds	3.8 seconds
Overshoot	10.4 %	0 %
Peak	1.1	0.998
Gain margin	Inf dB @ Inf rad/s	Inf dB @ Inf rad/s
Phase margin	60 deg @ 3.55 rad/s	65.7 deg @ 7.08 rad/s

Fig.3. Tuned parameters

ISSN 2394 - 9554

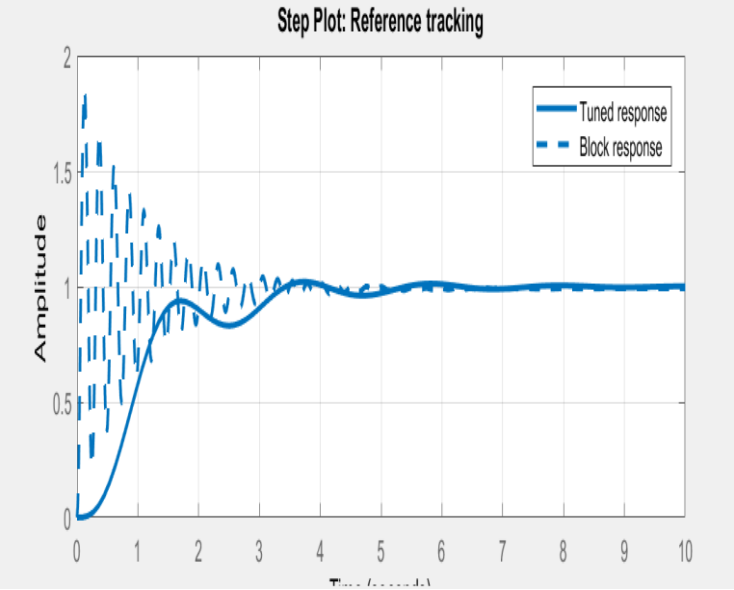

Fig.4. Tuned response from matlab

- **INTRODUCTION TO DEEP LEARNING AND NEURAL NETWORKS:**

An extension of machine learning, deep learning makes use of multiple-layer neural networks. An artificial intelligence is deep learning that mimics the working of the human brain in processing data to recognize the sounds, translate languages, and detect objects in real time. The three layers of neurons are Input Layer, the Hidden Layer and the Output Layer. In a feed-forward neural network, nodes are not connected in a cycle. Here nodes are nothing but neurons. In this network, information is passed from input nodes to hidden nodes and then from hidden nodes to output nodes. Weights are applied to inputs and used in conjunction with bias when the inputs are transmitted between neurons. In this demonstration, one delta rule is the only learning rule utilized by neural networks. The delta rule is Back propagation algorithm. Backpropagation algorithm calculates the error based on a known and desired output for each input value, it is usually categorized as supervised learning. Here in this project ,the feed forward neural network tuner is developed and trained using back propagation algorithm and this gives out controller gain values.

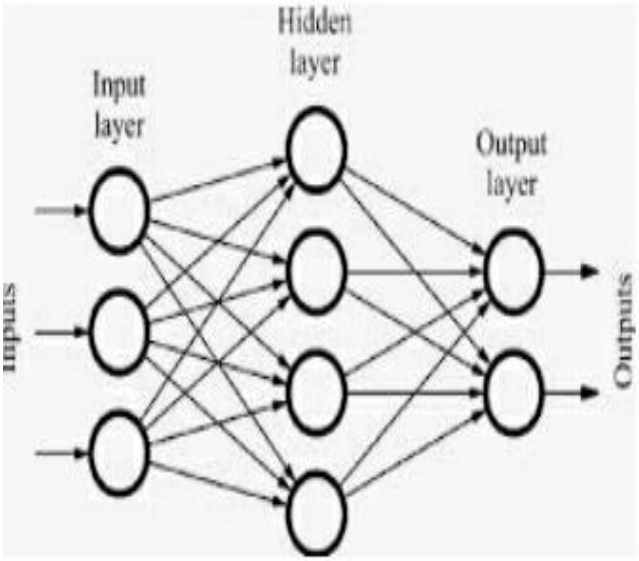

Fig.5. Neural Network

- **JUPYTER NOTEBOOK**

Researchers can use Jupyter notebook to convey the combination of software code, computational output, and explanation in a single document using free, open-source software. In this project Gekko package is imported to jupyter notebook.GEKKO is a package of python for machine for learning and optimization problems .GEKKO Python is developed for large-scale optimization and accesses solvers of unconstrained, constrained, discrete , and continuous problems.

ISSN 2394 - 9554

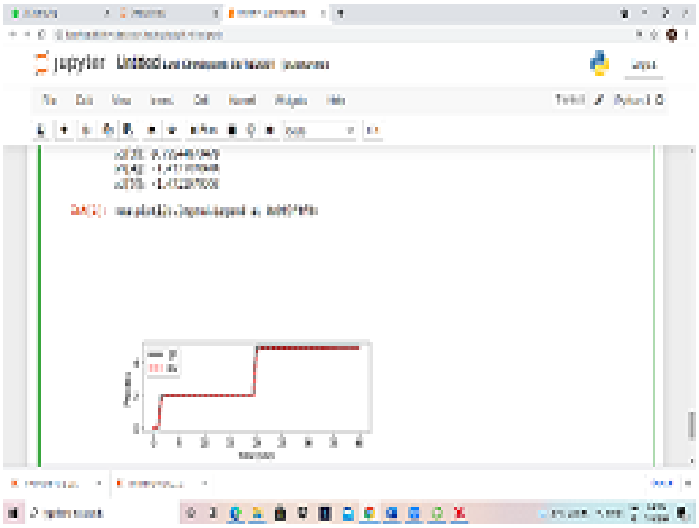

Fig.6. Tuned response from neural network model

V. HARDWARE IMPLIMENTATION:

Components Required:

1) Arduino board: It is an open-source electronics platform which has physical programmable circuit board and IDE, which is used for writing and uploading code to the boards.

2) Motor driver: A motor driver is responsible for interfacing the motors with control circuits. Unlike motors which require high current, controllers operate under low current signals.

3. Motor encoder : Various sensors, such as encoders, detect rotations or linear displacements. Encoders are used in devices that need to operate in high speed and with high accuracy.

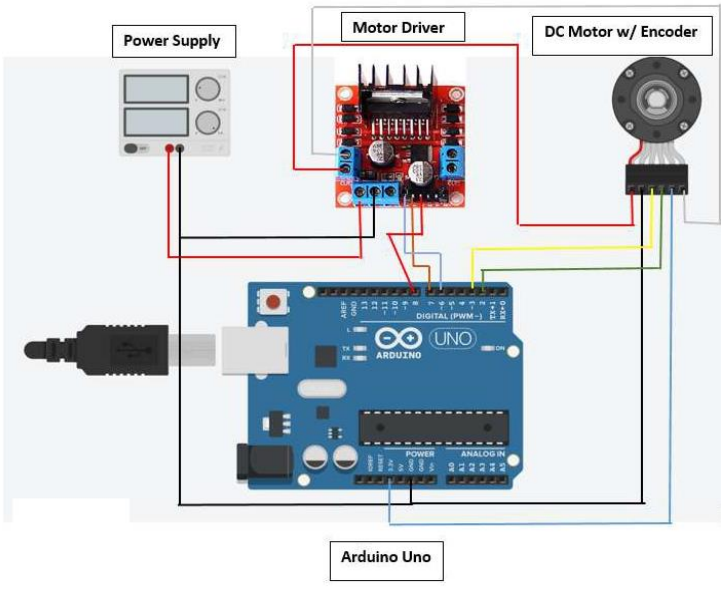

Fig.7. Connection Diagram

VI. RESULT

A multi layer Neural Network Parameter Tuner (NNPT) is used to implement DC motor control using the PI controller. After successful training ,the NNPT gives the value of ki and kp of the PI controller which reduces the steadystate error, settling time and overshoot.

Simulated results indicate that the NNPT PI controller has better dynamic characteristics than ZN PI controllers. The comparison brings to light the various disadvantages of the existing methods and how they can be rectified. Hence drawbacks of ZN matlab tuning method are completely eliminated by this neural network parameter tuner .

ISSN 2394 - 9554

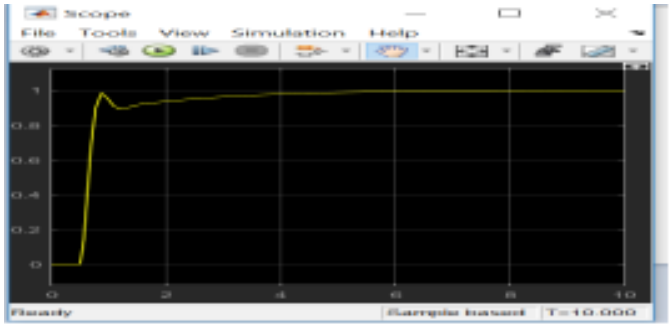

Fig.8.Speed response from matlab

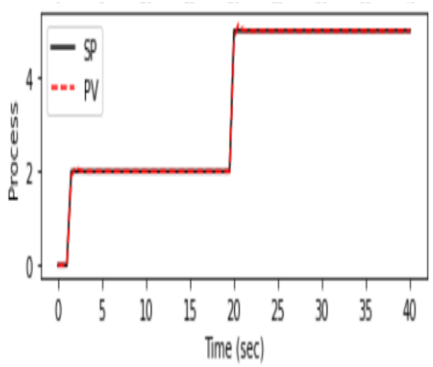

Fig.9. Tuned response from neural network model

VII. CONCLUSION

The results demonstrate how machine learning, and in particular neural networks, can be used to extend existing systems. Furthermore, we make neural network design and implementation as simple as possible to make it easy to implement this technology. When the implementation is implemented as a library, this technique can be employed without extensive knowledge of either control engineering or neural network theory. As far as we know, this is the first study to use neural networks, pushing the state-of-the-art in neural networks for tuning PI parameters. We show that our approach performs better than the traditional PI controller in a detailed analysis .

So this project is a critical step towards increasing the acceptance of real-world applications based on machine learning

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