DC Motor Speed Control using Artificial Neural Network

Yogesh, Swati Gupta, Mahesh Garg

Abstract— **This paper presents an insight into the speed control of D.C motor using a Artificial neural network controller to meet the desired speed. The Neural Network scheme consists of two parts: one is the neural estimator, which is used to estimate the motor speed and the other is the neural controller, which is used to generate a control signal for a converter. These two neural networks are trained by feed forward neural network algorithm. Standard three layer feed forward neural network with sigmoid activation functions in the input and hidden layers and purelin in the output layer is used. Simulation results are presented to demonstrate the effectiveness and advantage of control system of DC motor with ANNs in comparison with the conventional control scheme. For the comparison we used PID control. The purpose of this study is to control the speed of direct current (DC) motor with Artificial Neural Network (ANN) controller using MATLAB application. The Artificial Neural Network Controller will be design and must be tune, so the comparison between simulation result and experimental result can be made. The scopes includes the simulation and modelling of direct current (DC) motor, implementation of Artificial Neural Network Controller into actual DC motor and comparison of MATLAB simulation result with the experimental result. This research was about introducing the new ability of in estimating speed and controlling the self excited DC motor. In this project, ANN Controller will be used to control the speed of DC motor. The ANN Controller will be programmed to control the speed of DC motor at certain speed level. The data from ANN Controller is sent to the DC motor through an interface circuit or a medium called DAQ card. The sensor will be used to detect the speed of motor. Then, the result from sensor is fed back to ANN Controller to find the comparison between the desired output and measured output.**

***Index Terms*— DC motor, MATLAB, DAQ card, ANN Controller.**

I. INTRODUCTION

Nowadays, the field of electrical power system control in general and motor control in particular has been researching broadly. The new technologies are applied to these in order to design the complicated technology system. One of these new technologies is Artificial Neural Network (ANNs) which based on the operating principle of human being nerve neural. It is composed of a large number of highly interconnected processing elements (neurons) working in unison to solve specific problems. ANNs, like people, learn by example. An ANN is configured for a specific application, such as pattern recognition or data classification, through a learning process. Learning in biological systems involves adjustments to the synaptic connections that exist between the neurons. This is true of ANNs as well.

There are a number of articles that use ANNs applications to identify the mathematical DC motor model. Then, this model is applied to control the motor speed. The inverting forward ANN with two input parameters for adaptive control of DC motor ANNs are applied broadly because all the ANN signal are transmitted in one direction, the same as in automatically control system, the ability of ANNs to learn the sample,

From the very beginning, it has been realized by systems theorists that most real world dynamical systems are nonlinear. However, linearization's of such systems around the equilibrium states yield linear models, which are mathematically obedient. In particular, based on the superposition principle, the output of the system can be computed for any arbitrary input, and alternately, in control problems, the input, which optimizes the output in some sense, can also be determined with relative ease. In most of the adaptive control problems, where the plant parameters are assumed to be unknown, the fact that the latter occur linearly makes the estimation procedure straightforward. The fact that most nonlinear systems thus far could be approximated satisfactorily by linear models in their normal ranges of operation has made them attractive in practical contexts as well. It is this combined effect of ease of analysis and practical applicability that accounts for the great success of linear models and has made them the subject of intensive study for over four decades. In recent years, a rapidly advancing technology and a competitive market have required systems to operate in many cases in regions in the state space where linear approximations are no longer satisfactory. To cope with such nonlinear problems, research has been underway on their identification and control using artificial neural networks based entirely on measured inputs and outputs.

Problem Statement

When commerce with DC motor, the problem come across with it are efficiency and losses. In order for DC motor to function efficiently on a job, it must have some special controller with it. Thus, the Artificial Neural Network Controller will be used. There are too many types of controller now a days, but ANN Controller is chosen to interface with the DC motor because in ANN, Non-adaptive control systems have fixed parameters that are used to control a system. These types of controllers have proven to be very successful in controlling linear, or almost linear, systems.

Problems encountered and solutions

Problem encountered:-

i) Control of DC motor speed;

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ii)Interface of DC motor with software (MATLAB/SIMULINK);
iii) To acquire data from the DC motor

Solutions:-

i) Use of ANN controller to the system;
ii) Implementation of DAQ card to the control board;
iii) Use of encoder from the DC motor to the control board;

Objectives

The objective of the Artificial Neural Network Controller Design for DC motor using MATLAB an application is it must control the speed of DC motor with Artificial Neural Network controller using MATLAB application which the design of the ANN controller is provided and can be tune. Each of the experimental result must be compared to the result of simulation, as a way to attain the closely approximation value that can be achieved in this system.

II. SIMULATION AND RESULT

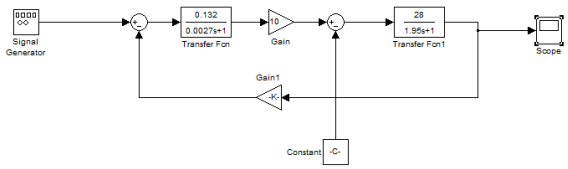


Fig. Simulink Block of separately excited DC Motor

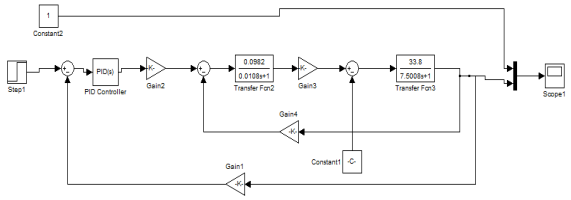


Fig. - Simulation block of DC Motor With PID Controller

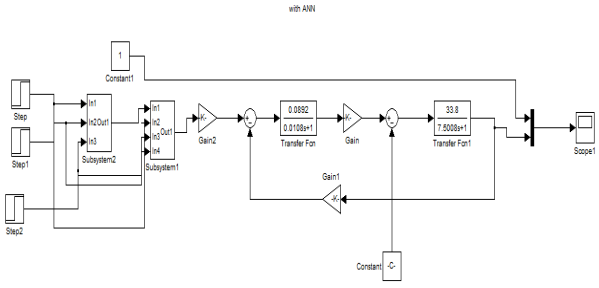


Fig.- Simulation block of DC Motor With ANN Controller
Following diagram is show that the DC Motor simulink diagram with ANN and PID Controller. To varying the different parameter we find the response and compare to improve settling time with Adjusting gain value with respective controller, Also it can be observed that the speed overshooting of the ANN based controller is significantly lower than the other controllers. This critically damped speed response has been achieved using the adaptive leaning rate feature in the ANN based controller Also it can be observed that the speed overshooting of the ANN based controller is significantly lower than the other controllers. This critically damped speed response has been achieved using the adaptive leaning rate feature in the ANN based controller.

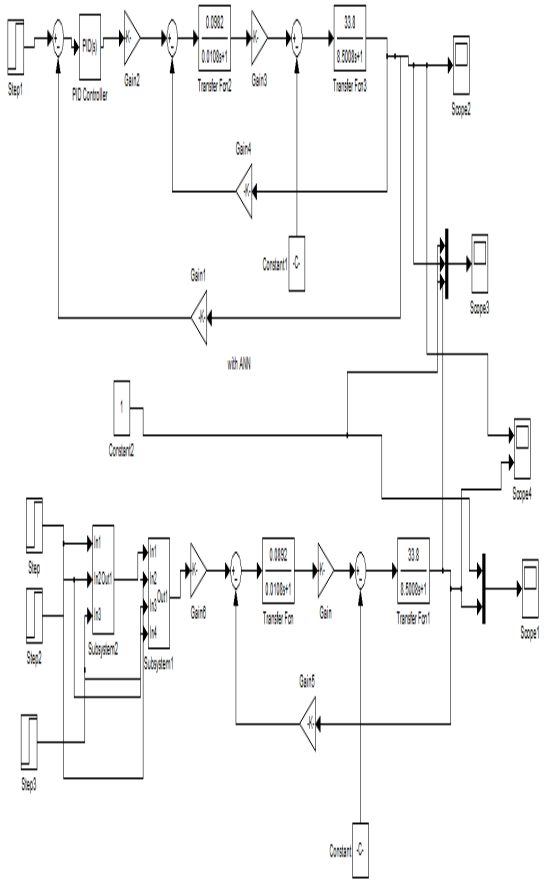
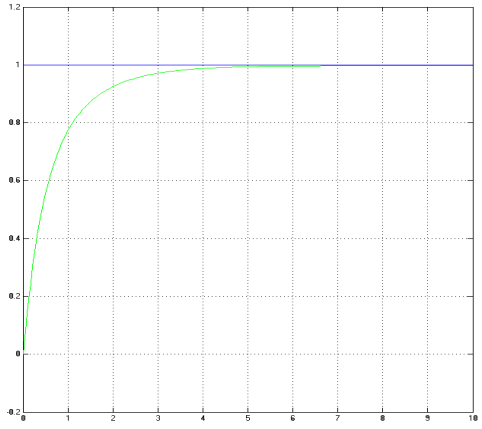


Fig-simulink block diagram of Artificial Neural Network and PID Controller

III. RESULT

SPEED



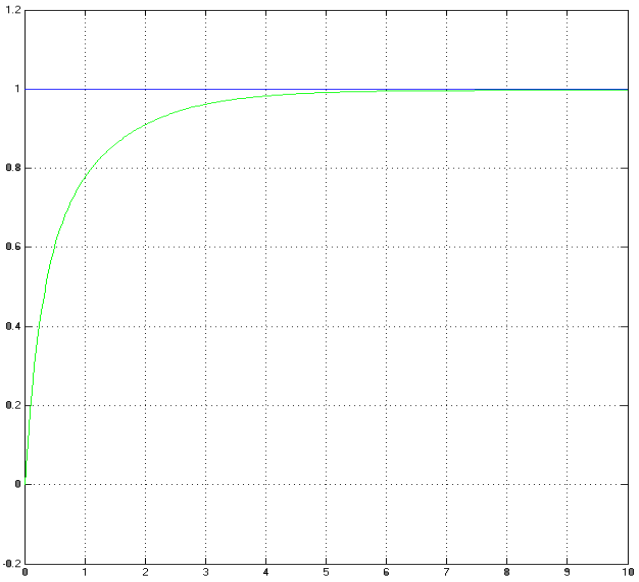
Time(s)

Fig.1- response of speed of DC Motor with PID Controller

The above figure show the response of speed of DC Motor without using Artificial Neural Network .tantalize the better result we need to apply a controller as Artificial Neural

Network. to design a controller we used a simple feed forward neural network with reference signal.

SPEED

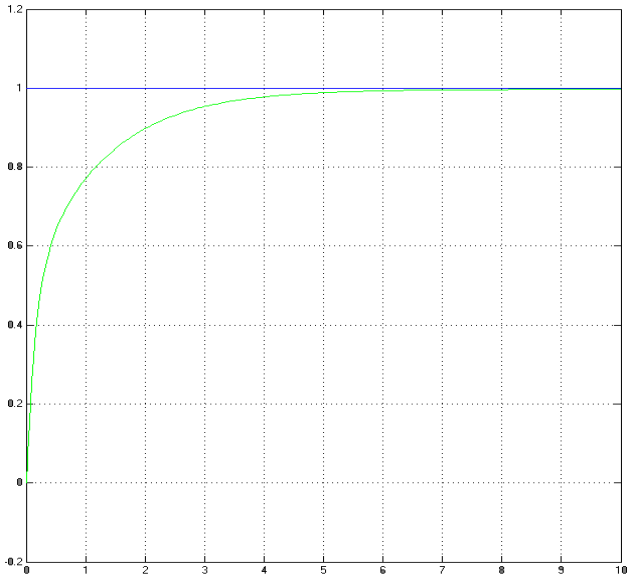


Time(s)

Fig.2- response of speed of DC Motor with PID Controller with Tm1=75%Tm

The above figure shows the response of speed of DC Motor without using Artificial Neural Network .with sully voltage to analyse the better result we need to apply a controller as Artificial Neural Network. To design a controller we used a simple feed forward neural network

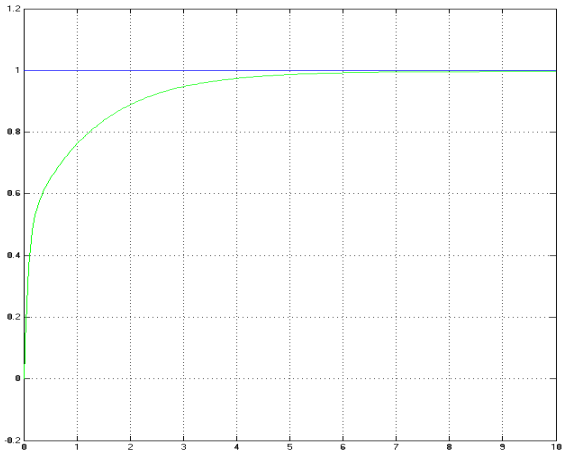
SPEED



Time(s)

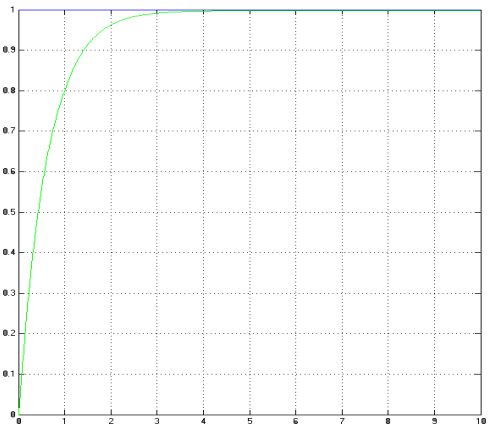
Fig3.- response of speed of DC Motor using PID with Tm2=50%Tm

SPEED



Time(s)

Fig4- response of speed of DC Motor using PID with Tm3=30%Tm

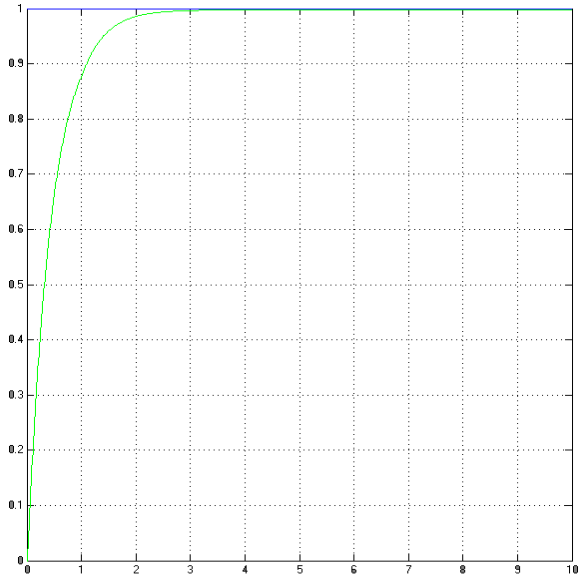


SPEED

Time(s)

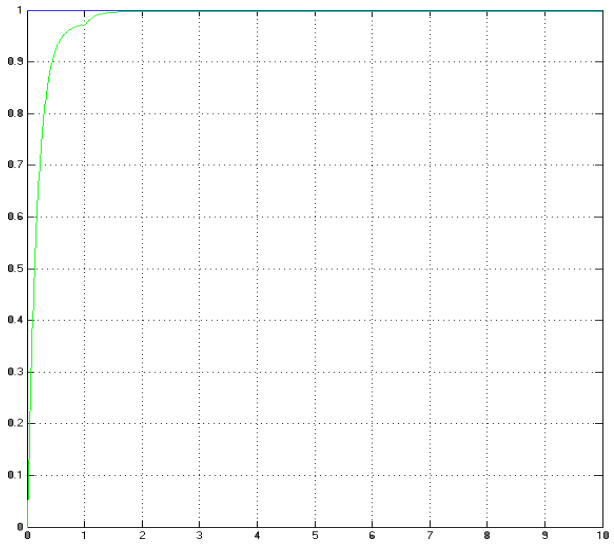
Fig.- response of speed of DC Motor using ANN

SPEED



Time(s)

Fig5.- response of speed of DC Motor using ANN Controller with Tm1=75%Tm

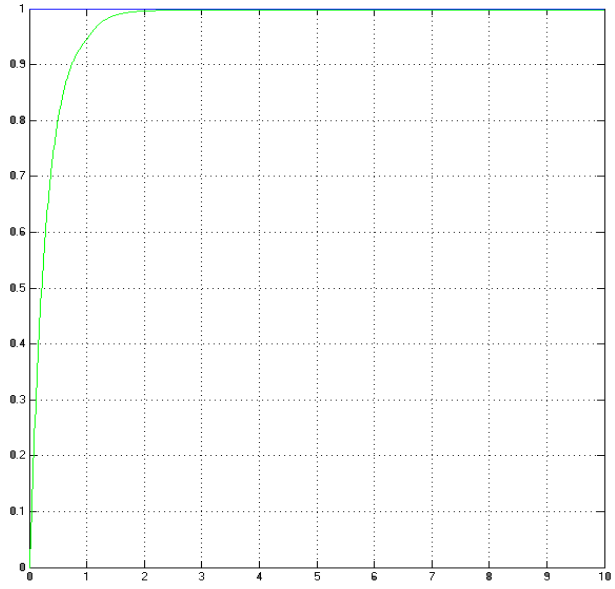


Time (s)

Fig6- response of speed of DC Motor using ANN with Tm2=50%Tm

From the above figure we can say that the response of DC Motor speed using ANN

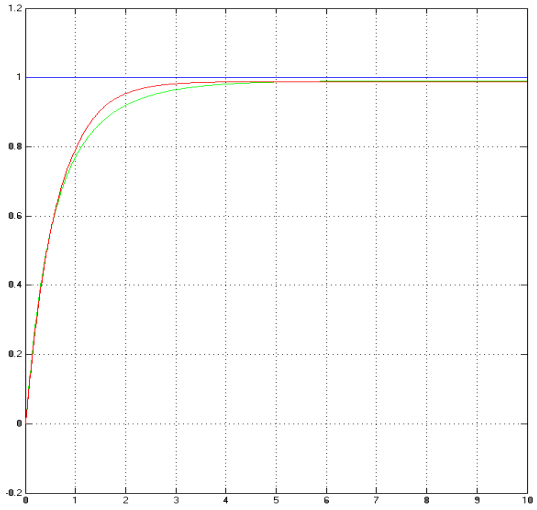
SPEED



Time(s)

Fig7.- response of speed of DC Motor using ANN with Tm3=30%Tm

Response with PID
Response with ANN
SPEED



Time(s)

Fig8- response of speed of DC Motor using ANN and PID From the above figure we can say that the response of DC Motor speed using ANN is better than PID Controller

Response
SPEED

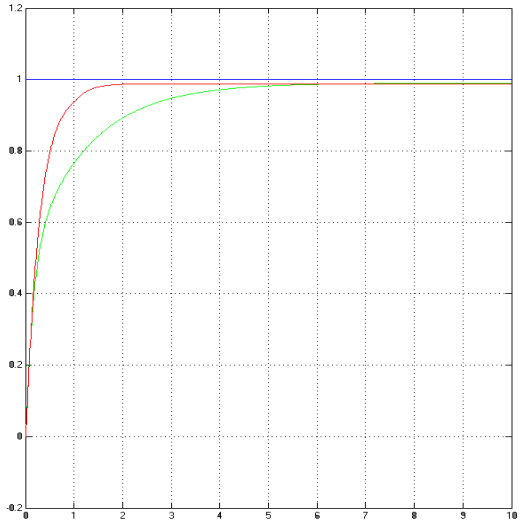
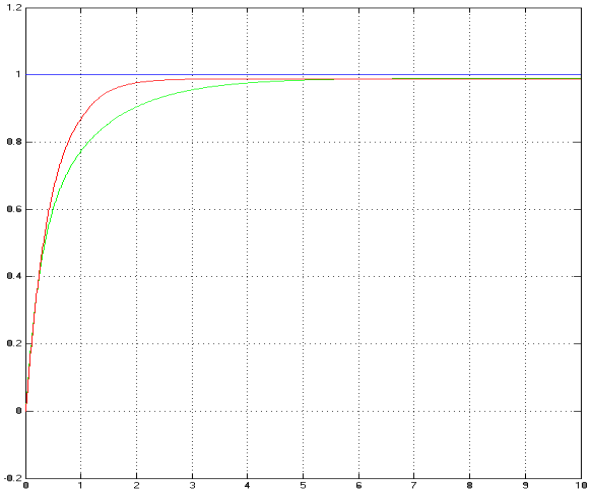


Fig9



PID Response with ANN

Fig10.- response of speed of DC Motor using ANN and PID with Tm1=75%Tm

SPEED
Response with PID
Response with ANN
Fig.- response of speed of DC Motor using ANN and PID with Tm2=50%Tm

SPEED
Response with PID
Response with ANN

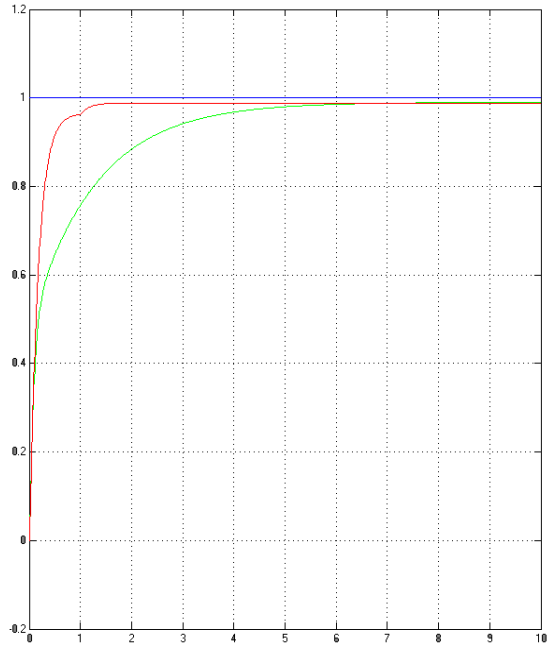


Fig11.- response of speed of DC Motor using ANN and PID with Tm3=30%Tm

IV. CONCLUSION

The DC motor has been successfully controlled using an ANN. Two ANNs are trained to emulate functions: estimating the speed of DC motor and controlling the DC motor, Therefore, and so ANN can replace sensors speed in the model of the control systems. Using ANN, we don't have to calculate the parameters of the motor when designing the system control. It is shown an appreciable advantage of control system using ANNs, when parameters of the DC motor is variable during the operation of the motors. The satisfied ability of the system control with ANNs . ANN application can be used in adaptive controlling in the control system machine with complicated load. Nowadays, in order to implement the control systems using ANNs for DC motor on actual hardware, the ANN micro processor is being used.

Artificial Neural Network was used as a trainable non-linear mapping system. The speed of a self exited dc motor was controlled using the proposed ANN based adaptive controller. The details of development of the proposed controller were presented, including all analytical derivations. Programming and implementation details including hardware interfacing were given as well, for both the computer setup and the physical experimentation.

To controlled speed of DC Motor we used PID Controller for tuning the ANN to improve accuracy of speed. During the experimentation and after observing the results it has been proved that the proposed ANN based controller has a good ability to control the speed of the Separately excited dc motor, which shows the non-linearity behavior. Experimental results verify that this ANN and PID controllers both are controlled of speed of DC Motor with comparatively result.

The tracing error to less that . We can come to a conclusion that the proposed artificial neural network based adaptive controller is clearly superior, particularly in the case of non-linearities, parameter variations and load disturbances. The on-line weights and biases updating feature of the ANN can compensate for both parameter changes and disturbances during operation

FUTURE SCOPE

While the research reported in this thesis shows that an ANN based adaptive controller performance is superior it still lacks with some limitations, which provides room for improvement. Such possible improvements are indicated below, as possible directions for further work.

In the present work the number of hidden layers and the number of neurons in the hidden layer are chosen by trial and error, bearing in mind that the smaller the number, the better it is in terms of both memory and time taken to implement the ANN. Further research can be done to find the optimum number of hidden layers and number of neurons in the hidden layer. weights and biases updating feature of the ANN can compensate for both parameter changes and disturbances during operation. The uses of the adaptive learning rate in the proposed controller reduce the possibility of overshooting particularly during the transient conditions. The feedback provision in the modified ANN motor structure also enhances the stability of the system.

Appendix

Calculation
Parameter
P= 5HP,
V= 240V,
Speed=1750 RPM,
Field voltage =150V,
J=0.02215 Nm2,
KF=1.976 NmA-1,
B=0.002953Nms,
Ra=11,2 Ω,
La=0.1215 H
1/B=0.0892
1/Ra=0.0108
Tm=J/B
Tm=7.5008
Ta=L/Ra
Ta=0.02953

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