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Speed control of Direct Current motor using Artificial Neural Network

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***Abstract*- Direct current motors (DC Motors) are widely used in many industrial applications and traction due to its straight forward and comparatively easy speed control ability. The purpose of this paper is to implement a speed control mechanism using artificial neural network (ANN) to achieve accurate control of the speed, especially when the motor and load parameters are unknown.**

***Index Terms*— Artificial Neural Network, Direct Current Motor.**

I. Introduction

Due to the advancement o Speed control of a DC motor can be obtained by using techniques such as

- Varying the armature voltage.
- Varying the field flux to achieve speed above the rated speed.

Choosing and designing a proper speed control mechanism is a real task due to practical issues such as unavailability of motor hardware details. In these conditions it is almost impossible to develop a speed control mechanism for Direct Current motor applications with conventional methods.

Artificial neural network technology can be used to avoid the practical problems that occur in designing conventional speed controlling methods when the motor details are unknown. In this approach a MATLAB simulation is carried out to simulate the speed control of DC motor using ANN method.

II. ARTIFICIAL NEURAL NETWORK

The artificial neural network is capable of making decisions with respect to prior information provided to the system. According to the provided information the system will generate an output for any given test input. The architecture used for this approach is shown in Fig 1.1.

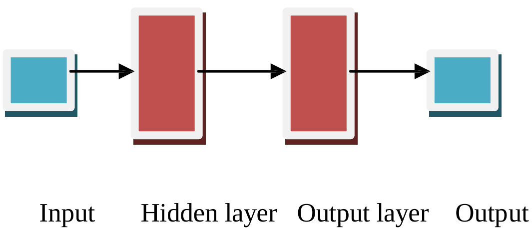

Fig. 1. **Architecture of ANN**

It is a two layer feed forward network with sigmoid hidden neurons. Levenberg –Marquardt algorithm is used to train the network for the known pattern of inputs and outputs.

III. DIRECT CURRENT MOTOR

DC motors can be classified as DC shunts and DC series motors depending on the connection of armature and field winding. For this approach a DC shunt motor is used for the testing purpose of neural network control system. In this configuration armature current is independent from the field current. Fig 1.2 shows the model of DC motor used for the approach.

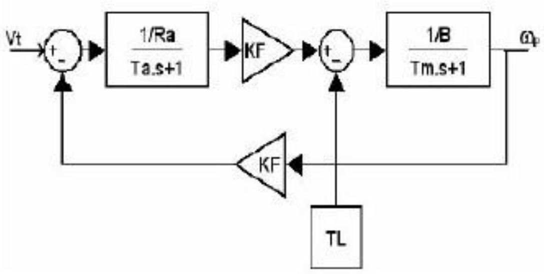

Fig. 2. **DC motor model**

IV. TEST CONFIGURATIONS

TABLE I. Artificial Neural Network

Number of hidden neurons	10
Number of training samples	100
Training Epochs	400
Training function	trainlm

TABLE II. Direct current motor

J, rotor inertia	0.068 kgm2
K, torque and back EMF constant	3.475 NmA-1
Ra, armature resistance	7.56 Ω
La, armature inductance	0.055 H
B, viscos friction	0.03475 Nms
Ta, armature time constant	La/Ra (s)
Tm, mechanical time constant	J/B (s)
TL, load torque	1 Nm

Figure 1.3 shows the MATLAB system block diagram used to simulate the speed control of direct current motor. NARMA L2 control block is used as the controlling system and plant represent the direct current motor with hardware details of TABLE I.

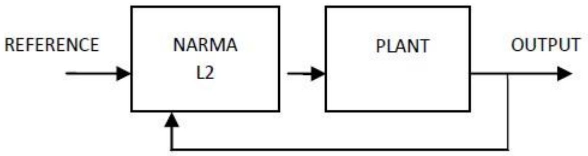

Fig. 3. System block diagram

V. TEST OUTPUTS

To obtain the test outputs a MAT LAB simulation is carried out. The design is tested for reference values through NARMA L2 controller. The speed of the motor and the terminal voltage was measured in the simulation. Plots were generated using MATLAB software when the system was running. The test results are shown in below figures.

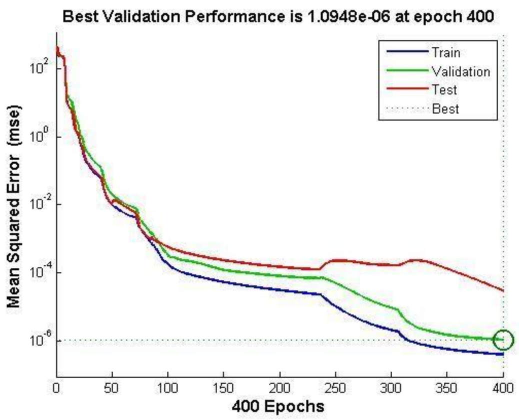

Fig. 4. Training performance of ANN

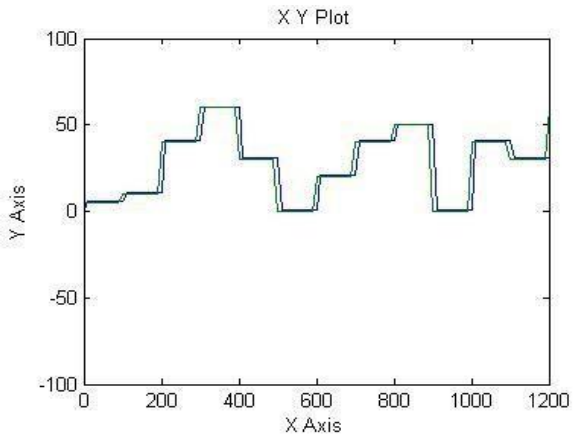

Fig. 5. Plant output and reference input.

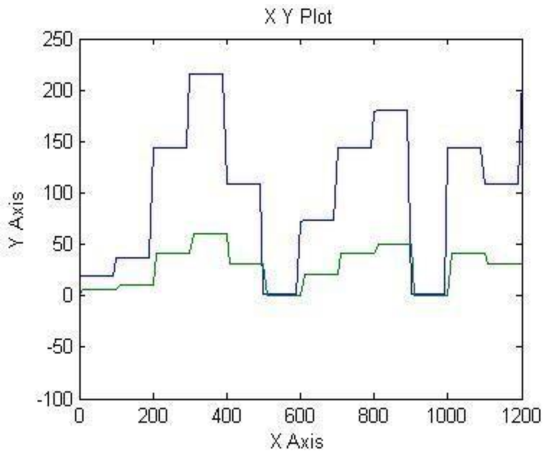

Fig. 6. Speed and Voltage variation.

VI. CONCLUSION

Test outputs were generated using MATLAB software. Fig 1.4 clearly indicates that the mean squared error decrease with the epochs. Fig 1.5 indicates that the output of the plant follows the reference value and the Fig 1.6 shows the voltage variation of the armature and the speed variation with respect to the armature terminal voltage. The direct current motor was successfully controlled by using artificial neural network method. Training samples were generated only by observing the input and output characteristics of the motor. It is possible to design a ANN control system for direct current motor controlling without the motor parameters hence it can overcome the designing problem in conventional motor controlling methods.

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