Study of Fuzzy and Neurofuzzy controller for speed control of BLDC motor

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ABSTRACT:DC drive systems are often used in many industrial applications such as robotics, actuation and manipulators. Brushless DC motors have a permanent magnet rotor, and the stator windings are wound in a way that the back electromotive force (EMF) is trapezoidal. It accordingly obliges rectangular-molded stator phase currents to create steady torque. The Motors have high torque/weight proportion, work at rapid speed, are extremely conservative and are electronically controlled. The key point of these motors is the evacuation of brushes, prompting wipe out numerous issues connected with brushes. BLDCM drives have been centered around the motor control methodologies. However, the vast majority of these converter topologies utilize the hard-switching method which causes high switching losses and extreme electromagnetic obstruction. The purpose of this research work is to control the speed of Brushless DC (BLDC) motor by using Fuzzy logic controller (FLC) and Neuro-fuzzy controller in MATLAB /SIMULINK model. The scope includes the modeling and simulation of Brushless DC motor, application of fuzzy logic controller to actual DC motor. This examination is going to present the new capacity of assessing speed and control of the Brushless DC motor. By utilizing the Neuro-fuzzycontroller, the rate can be tuned until it gets like the desired output that a user wants.

1. INTRODUCTION

1.1 Overview

In most of the industrial processes like electrical, mechanical, construction, petroleum industry, iron & steel industry, power sectors, development sites, paper industry, beverages industry, etc. the need for higher productivity is placing new demands on mechanisms connected with electrical motors. They lead to different problems in work operation due to fast dynamics and instability. That is why control is needed by the system to achieve stability and to work at desired set targets. The robust speed and position control of electrical motors is of outmost importance due to various non-linear effects like load and disturbance that affected the motor to deviate from its normal operation[3]

The direct current (DC) motor is a gadget that utilized as a part of numerous businesses so as to change the characteristic of electrical energy into mechanical energy. This is all result from the availability of speed controllers is wide range, easily and many ways. In most applications, speed control is very

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important. For example, if we have DC motor in radio controller car, in the event that we simplyapply a static power to the motor, it is impossible to maintain the desired speed. It will go slower over rocky road, slower uphill, faster downhill and so on. In this way, it is paramount to make a controller to control the speed of DC motor in wanted velocity.

DC motor plays a significant role in modern industry. The purpose of a motor speed controller is to take a signal representing the demanded speed, and to drive a motor at that speed. There are numerous applications where control of speed is required[2], as in rolling mills, cranes, hoists, elevators, machine tools, transit system and locomotive drives. Usages stated above may request fast control exactness and great element reactions.

1.2 Objective

The control of DC motor uses the digital signal processing system. The main objective of this research work is to design a control scheme using fuzzy logic controller (FLC) and Neuro-Fuzzy controller which are used to generate a control signal for speed control of Brushless DC Motor. Additionally, BLDC motor step responses are also compared for the fuzzy logic controller (FLC) and Neuro-Fuzzy controller.

2. PROPOSED METHODOLOGY

2.1Modelling of BLDC Motor

Brushless DC motors have the field coil in parallel (Brushless) with the armature. The current in the armature and field coil are free of each other. Therefore, these motors have fabulous speed and position control. Henceforth BLDC motors are commonly utilized that oblige five or more HPs (Horse Power). The equations depicting the vibrant performance of the BLDC motor are given as under.

$$v = Ri + L\frac{di}{dt} + e_b \quad (4.1)$$

$$T_m = K_T i_a(t) \quad (4.2)$$

$$T_m = J\frac{d^2\theta(t)}{dt^2} + B\frac{d\theta(t)}{dt} \quad (4.3)$$

$$eb = e_b(t) = K_b\frac{d\theta(t)}{dt} \quad (4.4)$$

Where, R = Armature resistance in ohm.

L = Armature inductance in henry.

$i = i_a$ =Armature current in ampere.

v = Armature voltage in volts.

eb = Back EMF voltage in volts.

K_b = Back EMF constant in volt / (rad/sec).

K_T = Torque constant in N-m/Ampere,

T_m = Torque developed by the motor in N-m.

$\theta(t)$ = Angular displacement of shaft in radians.

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J =Moment of inertia of motor and load in Kg-m^2/rad.

B = Frictional constant of motor and load in N-m / (rad/sec).

2.2Fuzzy Logic Controller

Figure 1exhibits the basic block diagram for proposed Fuzzy logic controller based BLDC motor speed control system.

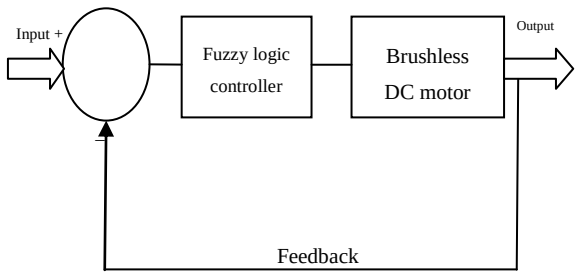

Figure 1: Basic block diagram for proposed Fuzzy logic controller based BLDC motor speed control system

A fuzzy controller is a superior fuzzy framework that can be utilized as a controller part within a closed loop framework[1]. In a fuzzy framework incorporated with a closed loop, unique accentuation is put onto the exchange conduct of fuzzy controllers, which are dissected utilizing distinctive arrangements of standard membership functions. Transmits data like an ordinary controller with inputs containing data about the motor to be controlled and a yield that is controlled variable. From outside, there is no uncertain data watched. Both the outcome and data qualities are fresh values. The data estimations of a fuzzy[5]controller contain measured qualities from the motor that are either motor output values or states of motor, or control errors coming about because of the set point qualities and the controlled variables.

Figure abovedemonstrate the fundamental design of a Fuzzy Logic Controller (FLC). A FLC comprises of the accompanying parts:

- Fuzzification Interface
- Knowledge Base
- Decision Making Logic
- Defuzzification Interface

2.3 Neuro-Fuzzy Controller

Figure below exhibits the basic block diagram for proposed Neuro fuzzy controller based BLDC motor speed control system

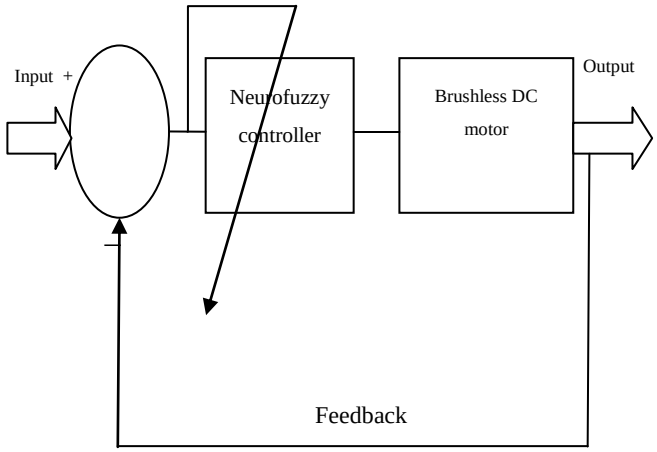

Figure 2: Basic block diagram for proposed Neuro fuzzy controller based BLDC motor speed control system

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To get the favorable circumstances of fuzzy and neural networks and to beat their limitations, it is wised to utilize the mixture of both, which prompts Neuro-Fuzzy Controllers (NFC). The on-line supervised learning algorithm performs exceptionally well when the training information is accessible on-line. Theerror between the reference and BLDC motor output is utilized to change the weights. This controlleris an Adaptive Network-based Fuzzy Inference System (ANFIS) .

3.SIMULATION RESULTS

Simulation is carried out using MATLAB/SIMULINK.

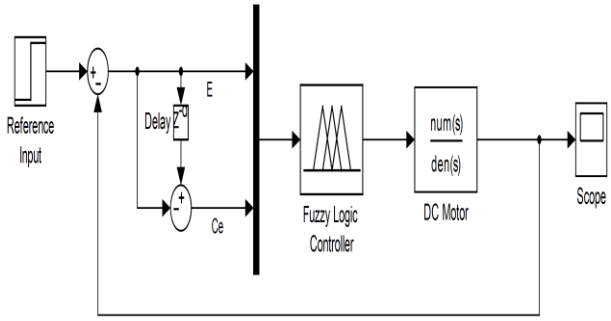

Figure 3: Simulink model for DC Motor controlled by Fuzzy Logic controller

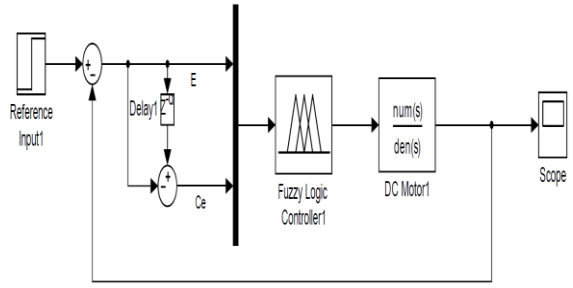

Figure 4: Simulink model for DC Motor controlled by Neuro-Fuzzy controller

4.CONCLUSION

Fuzzy logic controller (FLC) and Neuro-Fuzzy Contoller have been employed for the speed control of DC motor drive and analysis of the performance for both of the controller schemes is studied. This research work proposes a model for speed control of brushless DC motor drive using Fuzzy Logic Controller (FLC) and Neuro-Fuzzy Contoller. The speed of a separately excited BLDC Motor can be successfully controlled by using Neuro-Fuzzy Contoller controller technique. It was analyzed that the Neuro-Fuzzy Contoller controller gives better results rather than the Fuzzy logic controlle

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