Review of Neuro Fuzzy Controller for Speed Control of a Separately Excited D.C. Motor

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Abstract— we are familiar about the features of D.C. motor. It is applicable for not only the simple home task but also it is used in the industrial purpose. main cause of that its speed can be changed by various technique. Speed can be changed by either vary the generated voltage or the flux created by the field winding. because of the residual flux the torque never becomes the zero. When the field winding is open circuited, the residual flux in the pole is 5-10% of the rated flux. their fore back EMF reduced and the value is only due to residual flux. Armature control technique is used for the huge size DC motor because it is very costly method. By controlling the armature voltage below the rated value speed can control below to the rated speed. Flux control method used for the speed control above to the rated speed. hear we adopted the neuro fuzzy technique for speed control.

Key words: D.C. Motor, Flux Control, Back EMF, Commutator, Speed Regulation, Armature Control, Neuro Fuzzy Technique

I. INTRODUCTION

A. Overview

Especially when applied to higher order systems, he proposed two types of fuzzy logic controllers that take out appropriate amounts of accumulated control input according to fuzzily described situations in addition to the incremented control input calculated by conventional fuzzy PI controllers. The structures of the proposed controller were motivated by the problems of fuzzy PI controllers that they generally give inevitable overshoot when one tries to reduce rise time of response especially when a system higher than one is under consideration.[5]

II. D.C. MOTOR

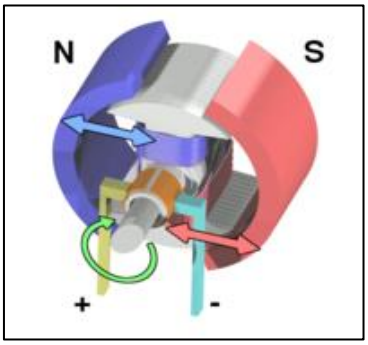

Fig. 1: D.C Motor

It is the electromagnetic device which convert the DC electrical energy into the mechanical energy.

A. History of Dc Motor

Electric motors exist to convert electrical energy into mechanical energy. This is done by two interacting magnetic fields -- one stationary, and another attached to a part that can move. DC motors have the potential for very high torque capabilities (although this is generally a function of the physical size of the motor), are easy to miniaturize, and can be "throttled" via adjusting their supply voltage. DC motors are also not only the simplest, but the oldest electric motors.The basic principles of electromagnetic induction were discovered in the early 1800's by Oersted, Gauss, and Faraday. [7]In 1819, Hans Christian Oersted and Andie Marie Ampere discovered that an electric current produces a magnetic field. The next 15 years saw a flurry of cross-Atlantic experimentation and innovation, leading finally to a simple DC rotary motor. A number of men were involved in the work. Below are 3 of the most famous people to have experimented about DC motor.[2]

Fabled experimenter Michael Faraday decided to confirm or refute a number of Speculations surrounding Oersted's and Ampere's results. He set to work devising an experiment to demonstrate whether or not a current-carrying.[1]DC machines may also work as brakes. The brake mode is a generator action but with the electrical power either regenerated or dissipated within the machine system, thus developing a mechanical braking effect. It also converts some electrical or mechanical energy to heat, but this is undesired. The major advantages of DC machines are easy speed and torque regulation. The major parts of any machine are the stationary component, the stator, and the rotating component, the rotor.[3]

B. Construction of DC Motor

Main difference between the induction and the DC motor is that the DC motor having the commutator, which make it differ from the induction motor. Main parts of DC Motor are as following-

a) magnetic frame
b) pole core
c) pole shoe
d) armature core
e) commutator
f) brush
g) armature winding.

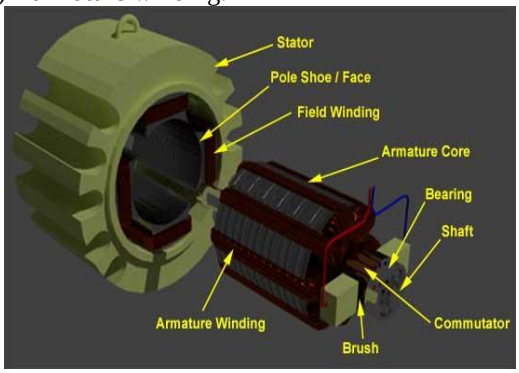

Fig. 2: Construction of Dc Motor

Yoke is made with the cost iron material. Lamination is not required, modern machine is laminated to reduced the iron losses. So the efficiency of the machine is enhanced which is desirable.

Both the pole core and pole shoe is made with cost iron pole shoe is laminated but pole core doesn't need for that. When load changed the copper loss is vary, armature current changed, flux changed which link the pole shoe and which cause the eddy current .but the pole core exited with the field winding.

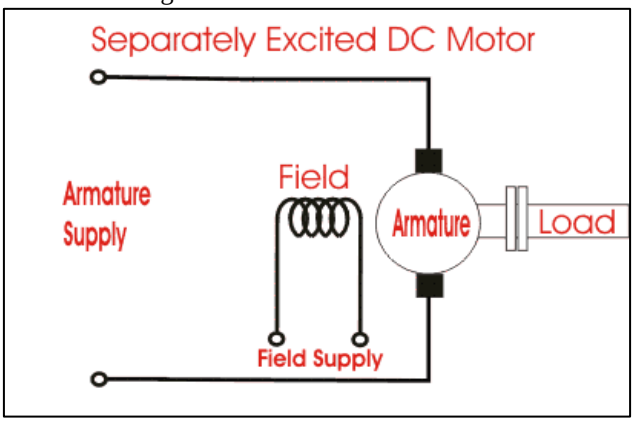

Fig. 3: circuit diagram

C. *Principle of Operation*

In any electric motor, operation is based on simple electromagnetism. A current carrying conductor generates a magnetic field which when placed in an external magnetic field; it will experience a force proportional to the current in the conductor and to the strength of the external magnetic field. The internal configuration of a DC motor is designed to harness the magnetic interaction between a current-carrying conductor and an external magnetic field to generate rotational motion.

The geometry of the brushes, commutator contacts, and rotor windings are such that when power is applied, the polarities of the energized winding and the stator magnet(s) are misaligned, and the rotor will rotate until it is almost aligned with the stator's field magnets. As the rotor reaches alignment, the brushes move to the next commutator contacts, and energize the next winding. Current direction changes as the conductor passes through the neutral zone. The direction of magnetic field also changes as the conductor passes through the neutral zone.

III. METHODOLOGY

A. *Over View*

The various techniques of speed control in DC shunt motors are as following-

a) Flux Control Method
b) Armature Control Method
c) Voltage Control Method
d) Multiple Voltage Control
e) Ward Leonard System
f) Flux Control Method

Speed is inversely proportional to flux. So. In this way if the flux increases then the speed is decreases and flux is decreases then the speed is increases. In this method a variable resistance (known as shunt field rheostat) is placed in series with shunt field winding.

1) Flux α 1/speed

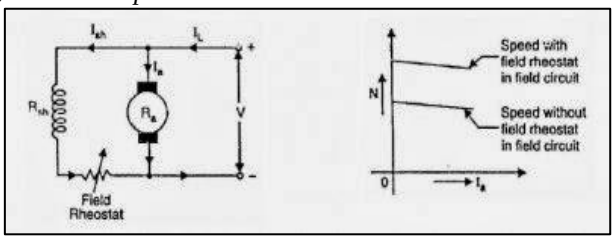

Fig. 4: Flux Control Method

2) Armature Voltage Control Method

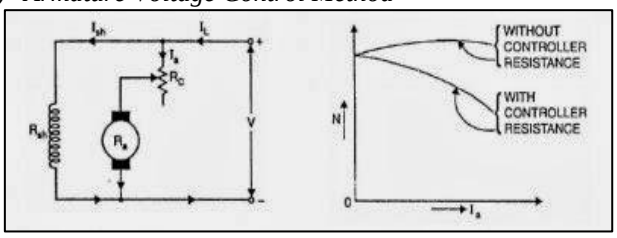

Fig. 5: Armature voltage control method

There are some disadvantages for flux control method and armature control method such as poor speed regulation and poor efficiency. Voltage control method overcome these problems.

This method is used for the separately exited DC motor but not suitable for the shunt motor, because the flux will be change due to change in the supply voltage.

B. *Neuro Fuzzy System*

Highly specialized cells known as neurons or nerve cells are a key part of the neural system. Each cell has the capability to send signals along its length to communicate with other cells. There are several different types of neurons found in various parts of the body which are capable of sending different kinds of signals. Depending on the activity being controlled, signals are sent from various regions of the brain along a chain of neurons to accomplish the desired goal. Signals can also be sent back to the brain, providing feedback which allows the brain to respond to changing situations. [6]

Movements, both voluntary and involuntary, are controlled with neurons. Neural control of movement regulates everything from the pumping of the heart to raising a hand in a classroom. When people develop disorders which interfere with this, they may lose control over their movements, experience involuntary jerks and twitches, or even have difficulty with tasks which are supposed to be automatic, such as subtle adjustments to the muscles which allow people to stand comfortably.[7]

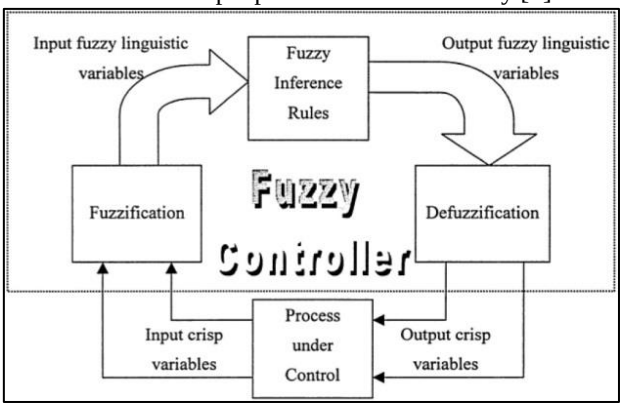

Fig. 6: Fuzzy control modal

1) Introduction to Neuro Fuzzy Systems

During the last few years there has been large and energetic upswing in research efforts aimed at synthesizing fuzzy logics with neural networks. Neural networks possess advantages in areas of learning, classification, and optimization, whereas fuzzy logic has advantages in areas such as reasoning on a high (semantics or linguistic) level. The two techniques nicely complement each other.[3]

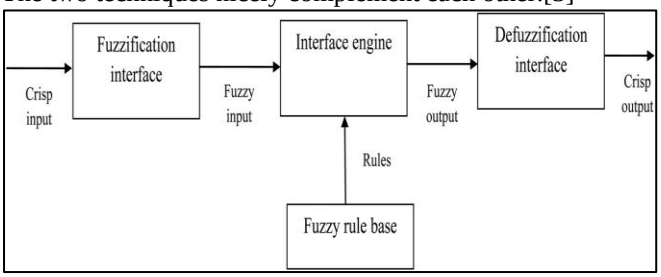

Fig. 7: Neuro fuzzy systems

Neural networks and fuzzy systems individually having three main steps, where they are used in the real world positions. Researchers often utilize these two techniques in series, using one as pre-processor or post processor for the other.[9] Examples include the use of fuzzy inputs and outputs for neural networks, the use of neural networks to quantify the shape of fuzzy membership function and so on.

The neuro fuzzy system exist the following three different layers;-

1) Fuzzification layer
2) Fuzzy rule layer
3) Defuzzification layer

2) Fuzzification

Fuzzification maps from the crisp input space to fuzzy sets in certain, input universe of discourse. So for a specific input value x, it is mapped to the degree of membership $\mu_A(x)$. The fuzzification involves the following functions. Measures the value of input variables.

1) Performs a scale mapping that transfers the range of values of input variables into corresponding universe of discourse.
2) Performs the function of fuzzification that converts input data into suitable linguistic variables, which may be viewed as labels of fuzzy sets.

There are generally three types of fuzzifiers, which are used for the fuzzification process; they are

1) Singleton, fuzzifier.
2) Gaussian, fuzzifier.
3) Trapezoidal or triangular fuzzifier.[5]

For simplicity it is assumed that the membership functions are symmetrical and each one overlaps the adjacent functions by 50% i.e., triangle shaped function, the other type of functions used are trapezoidal-shaped and Bell-shaped.[8] Figure 3.2 shows the seven linguistic variable and the triangular membership function with 50% overlap and the universe of discourse from – a to a.

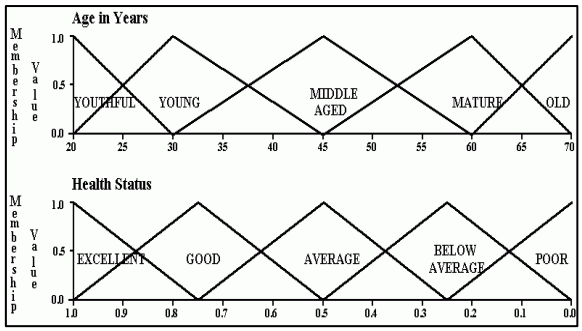

Fig. 8: membership functions

3) Defuzzification

Defuzzification coverts the linguistic variables to determine numerical values. Centroid method of defuzzification is used in this study.A scale mapping, which converts the range of values of input variables into corresponding universe of discourse. Defuzzification, which yields a non-fuzzy control action from an inferred fuzzy control action.

We defuzzify the output distribution B to produce a single numerical output, a single value in the output universe of discourse $Y = \{y_1, y_2 \ldots y_p\}$.[10] The information in the output waveform B resides largely in the relative values of membership degrees. The simplest deuzzificatioin scheme chooses that, element Y_{max}. That has maximal membership put in the output fuzzy ser B. $M_B(y_{max}) = \max m_B(y_j)$; $1 \leq j \leq k$

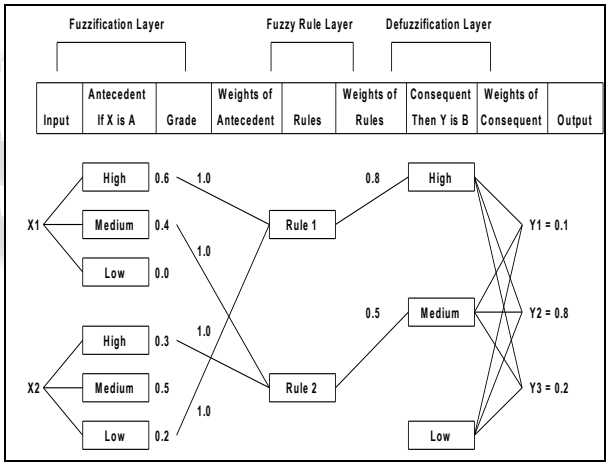

Fig. 9: Neuro Fuzzy system structure

IV. CONCLUSION

FUZZY LOGIC is a problem-solving control system methodology that lends itself to implementation in systems ranging from simple, small, embedded micro-controllers to large, networked, multi-channel PC or workstation-based data acquisition and control systems.

It can be implemented in hardware, software, or a combination of both. FL provides a simple way to arrive at a definite conclusion based upon vague, ambiguous, imprecise, noisy, or missing input information. FL's approach to control problems mimics how a person would make decisions, only much faster. A fuzzy set can be defined mathematically by assigning to each possible individual in the universe of discourse a value representing its grade to membership in fuzzy set. The grade of membership corresponds to the degree to which the individual is similar or compatible with concept represented by fuzzy set.

REFERENCES

[1] K. Mudi and Nikhil R. Pal, IEEE Transaction on Fuzzy systems, Vol-7, no-1, Feb 1999 "A robust self tuning scheme for PI and PD type Fuzzy controller".
[2] Jihong Lee, IEEE Transaction on Fuzzy systems, Vol-1, no-4, Nov 1993 "On methods for improving performance of PI-type fuzzy logic controllers".
[3] Yodyium Tipsuwan and Mo-Yuen Chow, IEEE Transaction on Fuzzy systems, 1999, "Fuzzy logic microcontroller implementation for DC motor speed control".
[4] Manafeddin Namazov, "DC motor position control using fuzzy proportional-derivative controllers with different Defuzzification methods" An Official Journal of Turkish Fuzzy Systems Association Vol.1, No.1, pp. 36-54, 2010.
[5] Atul Kumar Dewangan, Sashai Shukla, Vinod Yadu "Speed Control of a Separately Excited DC Motor Using Fuzzy Logic Control Based on Matlab Simulation Program*"* International Journal of Scientific & Technology Research Volume 1, Issue 2,ISSN 2277-8616 pp. 52 – 54 ,March 2012
[6] Zadeh L. A., "Outline of a New Approach to the Analysis of Complex Systems and Decision Processes", IEEE Transactions Systems, Man and Cybernetics, SMC-3, 1973, pp. 28-44.
[7] Sulochana Wadhwani, Veena Verma, Rekha Kushwah, "Design and tuning of PID controller parameters based on fuzzy logic and genetic algorithm", Int. Conf. On soft computing, artificial intelligence, pattern recognition, biomedical engineering and associated technologies (SAP- BEATS), Feb 23-24 ,2013", department of electrical engineering, MBM eng. College Jai Narain Vyas university, jodhpur.
[8] Nader Jamali Sufi Amlashi "Design and Implementation of Fuzzy Position Control System for Tracking Applications and Performance Comparison with Conventional PID" IAES International Journal of Artificial Intelligence (IJ-AI) Vol. 1, No. 1, March 2012, pp. 31 – 44 ISSN: 2252-8938.
[9] Atul Kumar Dewangan, Sashai Shukla, Vinod Yadu "Speed Control of a Separately Excited DC Motor Using Fuzzy Logic Control Based on Matlab Simulation Program*"* International Journal of Scientific & Technology Research Volume 1, Issue 2,ISSN 2277-8616 pp. 52 – 54 ,March 2012
[10] Zadeh L. A., "Outline of a New Approach to the Analysis of Complex Systems and Decision Processes", IEEE Transactions Systems, Man and Cybernetics, SMC-3, 1973, pp. 28-44.
[11] [10] Sulochana Wadhwani, Veena Verma, Rekha Kushwah, "Design and tuning of PID controller parameters based on fuzzy logic and genetic algorithm", Int. Conf. On soft computing, artificial intelligence, pattern recognition, biomedical engineering and associated technologies (SAP- BEATS), Feb 23-24 ,2013", department of electrical engineering, MBM eng. College Jai Narain Vyas university, jodhpur.
[12] Nader Jamali Sufi Amlashi "Design and Implementation of Fuzzy Position Control System for Tracking Applications and Performance Comparison with Conventional PID" IAES International Journal of Artificial Intelligence (IJ-AI) Vol. 1, No. 1, March 2012, pp. 31 – 44 ISSN: 2252-8938.

