# Design and implementation of Permanent Magnet Synchronous Motor using Neuro-fuzzy Approach

Akansha Kaushal[1], Rameshwar Singh[2]
[1]M.tech Scholar (N.I.T.M Gwalior), [2]Head (N.I.T.M Gwalior)

***Abstract – This paper deals with the detailed modelling of a permanent magnet synchronous motor drive system in Simulink. Decoding of hall signals is used for sensing the position of drive. The simulation includes all realistic components of the system. This enables the calculation of currents and voltages in different parts of the inverter and motor under transient and steady conditions.This paper reports the vector control of PMSM with neuro-fuzzy speed controller.***

***Keywords: PMSM, neuro-fuzzy.***

## I. INTRODUCTION

In the vector-controlled permanent magnet synchronous motor (PMSM) drive, the outer speed loop provides the reference value of the current for the inner current loop and any disturbance in the speed controller output would cause erroneous currents, thus degrading the system performance. Hence, proper operation of the speed controller is of great importance for the appropriate drive performance. The use of proportional plus integral (PI) controller suffers from performance degradation under system disturbances due to the fixed proportional gain and integral time constant, This problem can be overcome with neuro-fuzzy controller. [1]

A permanent magnet synchronous motor (PMSM) is a motor that uses permanent magnets to produce the air gap magnetic field rather than using electromagnets [4].

## II. SYSTEM MODEL

This paper analyzes the mathematical model of PMSM based on the use of simulation with Matlab modeling capabilities. In the Matlab / Simulink to create a simulation model of PMSM control system can be provide effective means and tools for analysis and design [2].

### a) Basic Model

The permanent magnet synchronous motor mainly from stator and rotor two part constitute. Three-phase stator windings produce a rotating magnetic field through the three-phase AC. Rotor is usually equipped with high-performance permanent magnet in surface or inside of ferromagnetic materials

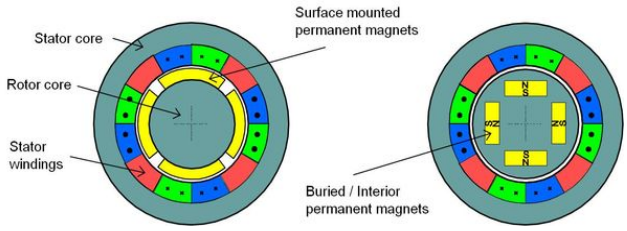


Fig. 2.1 Schematic diagram of PMSM

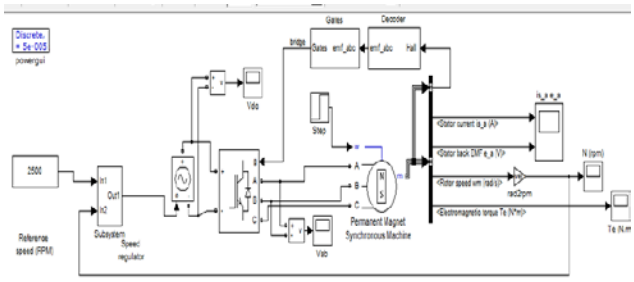

Fig. 2.2 simulink diagram of PMSM implemented with neuro-fuzzy.

The above simulink model is designed with an inverter ,permanent magnet motor,supply and neuro-fuzzy controller. The PMSM is fed fed by step input and three phase supply and then back emf is fed to gate so that it produce pulses and gives to inverter input.

## III. PREVIOUS WORK

Most of the work has been done on PMSM motor but this paper reproduces more efficient and promising result than previous work. In this paper the result is being optimized with the help of neuro-fuzzy controller using anfis fuzzy toolbox. The previous work was on field oriented control method[4] Most of previous study for sensorless drives are focused on the voltage source inverter (VSI) fed drives, and the study for current source inverter (CSI) fed driveis very limited. The CSI fed motor drives are widely used in high power applications [5]

## IV. PROPOSED METHODOLOGY

The performance of the fuzzy logic controller (FLC) is better under transient conditions, while that of neural is

superior near the steady-state condition and testing the data. The combined advantages of these two controllers can be obtained with hybrid fuzzy-Neuro speed controller. The PMSM is self tuned with neuro-fuzzy controller to obtain the better responses.

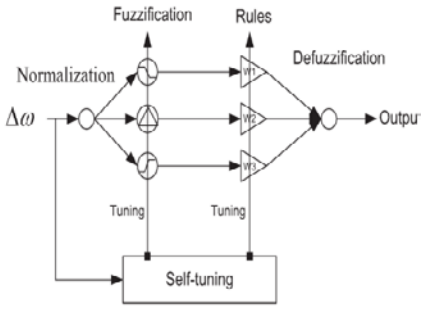


Fig.4.1 structure of self-tuning of Neuro-fuzzy[3]

In anfis fuzzy toolbox a constant output is driven and there is no need of defuzzification. In this paper nine output functions are taken.

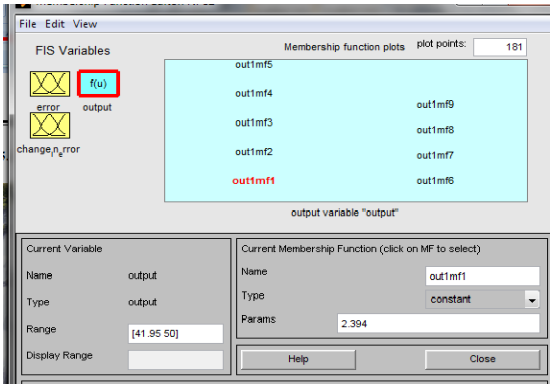


Fig. 4.2 output membership function of output.

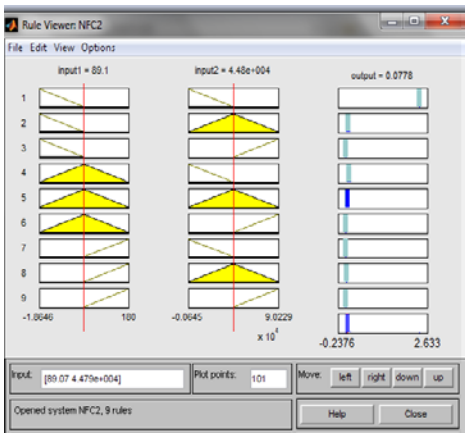


Fig.4.3 rule base viewer of input and output.

The rulebase shows that output depends on input. As we change the input the output changes accordingly.

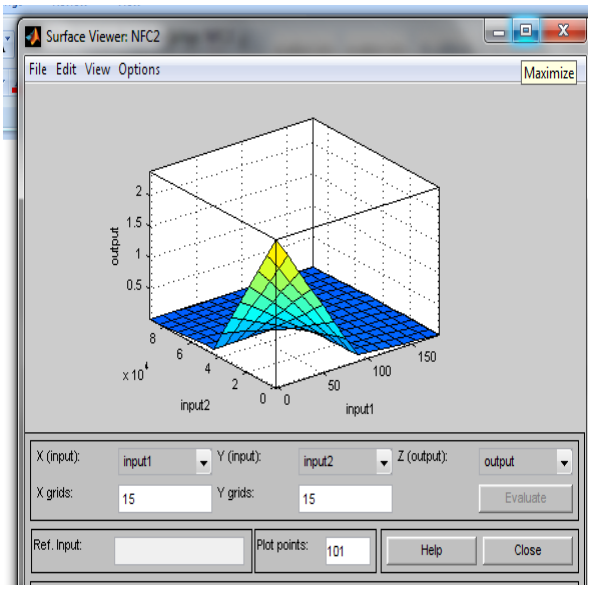


Fig. 4.4 surface viewer of output function.

This is the surface view of constant output membership functions,that depends on input.

## V. SIMULATION/EXPERIMENTAL RESULTS

On basis of simulation model and motor specifications these are the outcomes of result.

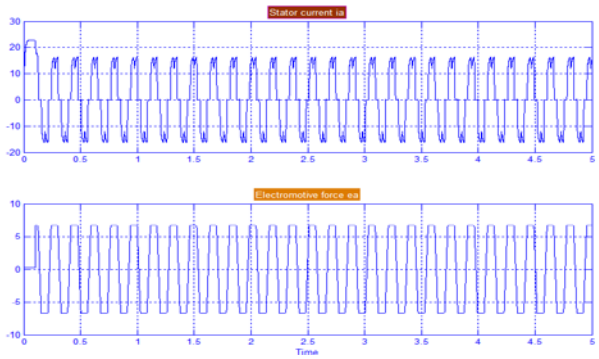


Fig.5.1simulation result of stator current and back emf

From above figure it is seen that the back emf is continuous and with respect to that stator current is also in continuous form and reaches upto 20A initially and achieves a constant path.

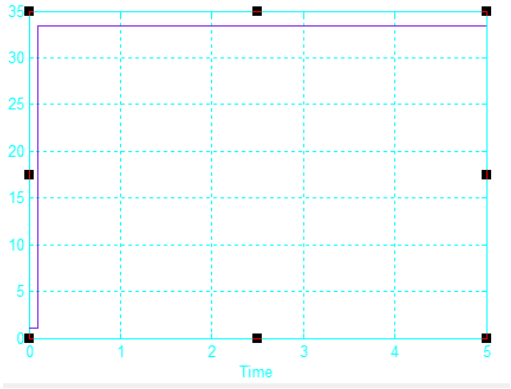


Fig.5.2 Rotor speed of PMSM

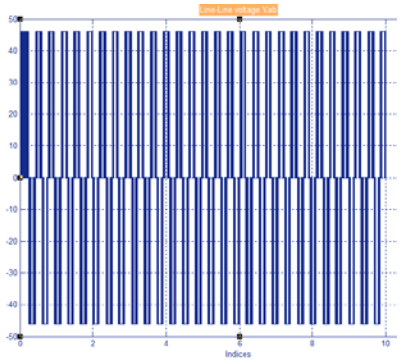

Fig.5.3 line to line voltage.

This result shows a continuous waveform of line to line voltage.

TABLE 1. PARAMETERS OF PMSM MOTOR

| S.no | Motor Parameters | Values |
|---|---|---|
| **1.** | Stator resistance | 1.6Ω |
| **2.** | phase inductance | 8mH |
| **3.** | Flux Linkage | 0.1852 Vs |
| **4.** | Torque constant | 0.748 Nm |

## VI. CONCLUSION

This paper shows that on combining two controllers the response of PMSM are far better than using single controllers i.e PI controller, PID controller and fuzzy controller. The efficiency has improved by using hybrid technique and maximum value has achieved in short time.

## VII. FUTURE SCOPES

The implementation of additional control techniques like genetic algorithm, optimum torque per ampere control and sensorless control can be taken up for detail simulation and performance calculation of PMSM drive systems.

## VIII. REFERENCES

[1] Amit Vilas Sant , K. R. Rajagopal , and Nimit K. Sheth,”. Permanent Magnet Synchronous Motor Drive Using Hybrid PI Speed Controller With Inherent and Noninherent Switching Functions”in IEEE transactions on MAGNETICS, VOL. 47, NO. 10, OCTOBER 2011

[2] Zhonghui Zhang, Jiao Shu” Matlab-based Permanent Magnet Synchronous Motor Vector Control Simulation” 978-1-4244-5539-3/10 in 2010 IEEE

[3] M.Nasir Uddin, Zhi Rui Huang”Development and Implementation of a Simplified Self-Tuned Neuro–Fuzzy-Based IM Drive” IEEE transactions on industry applications, vol. 50, no. 1, january/february 2014

[4] Enrique L Carrillo “Modeling and Simulation of Permanent Magnet Synchronous Motor Drive system” master’s thesis in electrical engineering from university of Puerto Rico mayagues campus in 2006.

[5] Zheng Wang, Yang Zheng, Zhixiang Zou, and Ming Cheng” Position Sensorless Control of Interleaved CSI fed PMSM Drive With Extended Kalman Filter” IEEE transactions on magnetics, vol. 48, no. 11, november 2012.