IFERP
connecting engineers... developing research

ISSN (Online) 2395-2717

International Journal of Engineering Research in Electrical and Electronic Engineering (IJEREEE)
Vol 2, Issue 11, November 2016

ANN Control And Comparitive Methods for Analogue Switched Reluctance Motor Drives

[1]Malini K V, [2]K.Gopinath, [3]M. Savitha, [4]Yeshwanth. S, [5]Sai Prasad K V
[1]Asst. Prof & HOD [2][3]Asst. Prof [4]4th Year UG scholar [5]3rd Year UG scholar
[1][2][3][4][5]Dept. of EEE, Sri Sairam College of Engineering, Bengaluru

Abstract: **-- The Switched reluctance motor is a well known motor for its ruggedness, simple structure, adoptability and inexpensive manufacturing. This paper presents a suitable way of the drive using ANN method of switching. Its linear model switching and characteristics makes the drive suitable for different methods of drive control. Its dynamics, parameters and control characteristics are discussed in detail. The artificial neural network gives the possibility of controlling the drive for various conditions. This paper discussed the methods of control of SRM in various ways and compares the methods. Artificial Neural Networks are computational models used to obtain complex nonlinear relationships between input and output variables. It is one of the powerful modeling techniques, based on a statistical approach, presently adopted in the field of engineering, The key methods of fuzzy logic and ANN mapping by adjusting the controller gain.The scaling factor fine tuned to give tuning mechanism. The reduction in the number of fuzzy sets of controllers improves the characteristics and thereby reduces the number of sets.**

Index Terms: **-- Artificial Neural Network, Switched reluctance motor. Comparitives, Fuzzy Logic controller, Variable speed , drives & control**

I. INTRODUCTION

The advancement of power electronics and microcontroller options is giving a way to research new techniques in the area of variable speed applications like motor pumps, automatic actuators, aerospace applications, household appliances, and so on. The emphasis of switched reluctance motors topologies and ratings, design of motor, ANN control, the comparison of different techniques. Recently, the artificial intelligence methods such as fuzzy logic ,AI systems and expert systems are compared for drives operation and controlling. ANN is an excellent tool for generating behaviour characteristics, and a computing tool. The servomotor drives, the propulsion of electric vehicle, are enhanced their efficiency and working range with the SRM drives and control. SRMs inherently possess certain characteristics like maintenance free, high torque ration, working in the industrious conditions.. The requirements of motor drive is the apmodel is assumed preciable inclusion of steady state and dynamic responses, load ripple being minimum, less oscillation at high speed. The switch reluctance motor finds it hard to control the speed toque characteristics owing to its construction, rotor position, flux linkages and so on. The new innovative methodologies proposed to improve these characteristics are making the best adaptation of P controller, PI controller, derivative controller. Based on the designs developed the system variations are suitable compensated. The Fuzzy logic controller architecture approximates the expert systems in keeping the innovative method of developing the controller, utilizing the self tuning of controller, redefinition of membership functions and shifting of functions to match the requirements. Here the equivalent circuit of SRM is developed and approximated. Here the equivalent SRM model is developed for the control and compared. By studying the dynamics of the linear model of the motor and the using the model the parameters are obtained.

In this paper the equivalent model of the motor is developed and controlling methods are compared. The linear motor is assumed and in this model the mutual inductance between the phases is neglected. The resistance of the circuit is not neglected The merits and demerits of the motor is compared with the A C motor. The production of electromagnetic torque is proposed and the equations are formed. The SRM model the strategy of energizing it is proposed alongwith the comparative methods of controlling. The SRM can run directly from d c bus but should be electronically commutated.

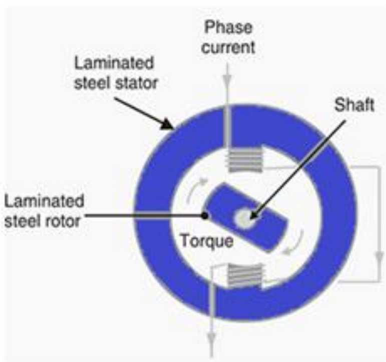
II.MOTOR CHARACTERISTICS

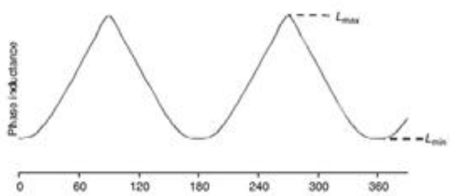
In the SRM, the winding are placed in the stator and the rotor is made of laminated steel. Both the rotor and stator are having the salient poles. This motor specifically requires a power converter and a control.

ISSN (Online) 2395-2717

International Journal of Engineering Research in Electrical and Electronic Engineering (IJEREEE)
Vol 2, Issue 11, November 2016

The rotor is made of ferromagnetic material. Fig 1 shows a simple reluctance motor.





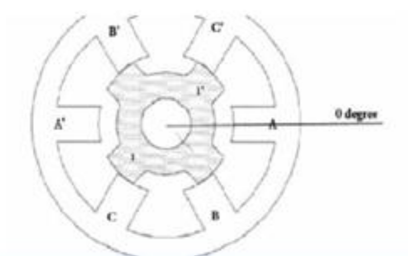


Fig 1.Simple reluctance motor. Fig2. Variation of Inductance with rotor angle Fig.3 Crossectional view of the 3ph SRM

If current is applied to the winding the rotor will rotate until it reaches a maximum position. Where it is aligned with the depends on coils and the inductance of the coils is minimum. The variation of inductance with rotor angle is as shown in the fig.After a slight loading of the motor magnetically, the laminated steel will also behave in accordance to it. That is for a given no.of turns the flux produced varies as the phase current. Thus the torque produced is a function of torque angle.

$$T= [i^2 (dL / d\theta)] / 2$$

The torque produced depends on the time of applying current that too when the inductance is rising or falling with respect to the rotor angle but is independent from the direction of current.The three phase SRM is considered to be with 6/4 that with the 6 stator poles and 4 rotor poles. Each stator pole has a concentrated coil wound on it. One stator phase is made of two stator poles. Very High speeds can be achieved as there are no electromagnets are placed on the rotor. The main drawback of SRM is the lack of control as they have more torque ripple. The basic operating principle is simple and easy to operate. The current passing through the stator winding makes the rotor to align the excited pole. The number of phases can be varied with the requirement of speed. Here the case study is taken for 3phase motor. Minimum number of phases required is 2.however, increasing the number of phases increases the torque ripple. It is very important to keep the number of rotor poles and stator poles different to ensure the starting.

The operating point may be located on the torque-speed characteristics. The Base speed is determined by the current region. At higher speeds the the shaft out power falls with the increase in the back e.m.f. The current region is characterized by the product of current keeping the square of the speed constant. Hence compared to AC motors very high speeds can be achieved.

III. ELECTROMAGENTIC EQUATIONS

Accurate analysis of the SRM motor is required to analyse motor behaviour. The electromagenetic equations can be formed by faradays law.

$$V=iR+\frac{d\psi}{dt} \quad \text{-----(1)}$$

Where v is the terminal voltage, I is the terminal current, R is the resistance per phase, flux linked varies as a function of rotor position θ and the phase current.

Equation 1 can be expanded

$$V=iR+\frac{\partial\psi}{\partial I}\frac{d\psi}{dI}+\frac{\partial\psi}{\partial\theta}\frac{d\theta}{dt} \qquad (2)$$

IFERP connecting engineers... developing research

ISSN (Online) 2395-2717

International Journal of Engineering Research in Electrical and Electronic Engineering (IJEREEE)
Vol 2, Issue 11, November 2016

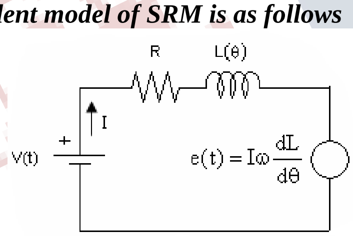
Where $\frac{\partial \psi}{\partial I}$ is defined as L(θ,I), the instantaneous inductance, and term $\frac{\partial \psi}{\partial \theta} - \frac{d\theta}{dt}$ is defined as instantaneous n one back e.m.f. The torque production is described by complex function and is the derivative of θ and currents in the n phases I-$(I_1, I_2, \ldots I_n)^t$. This function is the co energy of $\overline{W}$ (I,θ) .In the similar way , the function energy(ψ,θ), where variables of "ψ" are ψ –$(\psi_1, \psi_2, \psi_3 \ldots \psi_n)^t$. Whatever be the position of rotor the function of energy is described by following equation: $\overline{W}(I,\theta) + \overline{W}(\psi, \theta) \geq \psi^t I$ ----(3)

The partial derivative of the function of energy with relevance to rotor position is given by

Machine torque T= $\Gamma(\psi_1, \psi_2, \psi_3 \ldots \psi_n, \theta) - \frac{\partial W}{\partial \theta}(\psi_1, \psi_2, \psi_3 \ldots \psi_n, \theta)$ ------(4)

When one energizes one phase the rotor runs in the direction of increase of inductance.Because of this the direction of torque assumes the direction of the nearest aligened position of rotor pole.

The equivalent model of SRM is as follows



To derive a model all functions of rotor position are converted to parameters of a function of time (from θdomain to t domain) from this

$$t = \frac{\theta}{w}\left(\frac{rad}{rad/\sec}\right) \text{ ----(5)}$$

This defines the all rotor position. Here switching angle it is converted into time domain. After converting the domain θ→t the equivalent diagram is drawn as shown in the fig.5. Among all the techniques of controls the self tunig control approach is most used and in common Based on this approach a new self tuning PI controller model is developed and reviewed. The algorithm selected is genetic and is used to minimize the overshoot time, the rising and settling time. In addition a function which is the integral function is added to the controller in order to avoid the oversize . The fuzzy logic modeling,estimation the developed controller gives the high system reliability, against any signal noise owing to feedback loop and error. Depending on the motor characteristics the controller can be made predictive. Keeping the requirement of minimum torque-ripple in design, the controller is made to adapt to motor characteristics, which covers avoidance of negative torque production. This study aims at reducing the acoustic noise by using the algorithm. Based on the rotor aligning and sliding position this fuzzy controller is proposed. Instead of controller fixing an operative point , the adaptable Fuzzy logic controller is designed . In this method no proportional or integral definite gains are fixed. Instead the controller deduce the signal from the knowledge base. This is computed with the fuzzy interference. This is called PI like-fuzzy proposed controllers. Here the structure is almost similar to the PI controller. A self tuning mechanism introduces a improvement in the system gain by altering the scaling gains.If the fuzzy controller is used in the outer loop it senses the speed error and compares ,changes the error with respect to input signal, and generates a equivalent term. This will produce a amooth torque and improves the motor characteristics.

Here, a modified PIlike-fuzzy proposed controllers are discussed to operate as SRM controllers. The scaling gain operation, self tuning mechanism is introduced for the experimental results.

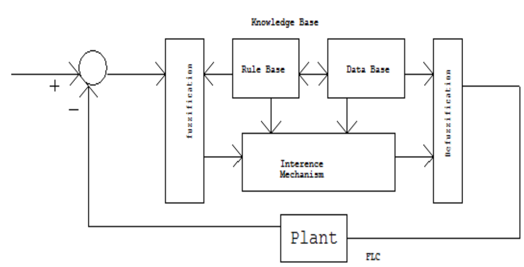


Fig 6: Proposed model

Fig 6. Shows a basic mechanism of fuzzy Proposed model which includes a knowledge base, interference mechanism, the fuzzification structure , the interference calculation. Here, the fuzzy controller design considers the fundamental structure., self tuning

ISSN (Online) 2395-2717

International Journal of Engineering Research in Electrical and Electronic Engineering (IJEREEE)
Vol 2, Issue 11, November 2016

fuzzy proposed PI like controller is discussed. The inputs are speed error, current command and the rotor position . The speed error signals are converted into four quadrant current signals. The current is sensed by the hall effect sensor, and the commutation signal is converted by the controller. The fig.6 shows the self tuning mechanism fuzzy PI like controller is discussed. The artificial intelligence design interface is looked upon as the closed loop system in real time. It takes the part of output y(t), compares it with the sedired output r(t) and then decides for the further action. The obtainable output and the driving input are considered as “crisp” . Hence the defuzzification controller returns the conclusions as compared to crisp inputs provided by the fuzzifier. The main difference observed between the self tuning fuzzy controller and the PI controller is that the additional control rule base provided to improve the gains.To overcome the steady state error, the normal fuzzy controllers makes use of UOD tuning rule.

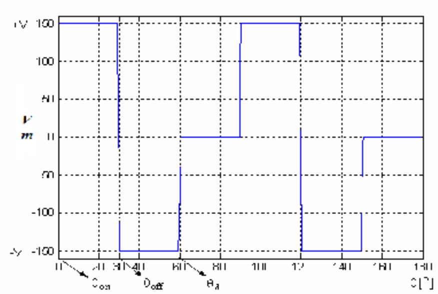


Fig 7: SRM voltage behaioural characteristics.

V: CURRENT CONTROLLER

Current is regulated by the fixed frequency PWM signals with varying duty cycles. This is achieved by compare units and logic circuits. The compare units are programmed for PWM mode. The percentage duty cycle is performed by the current loop algorithm, which is designed using linear analysis. Approximation of current loop is the base of linear analysis. Loop gain is calculated using the loop constant. The position reference starts with the 4 possible combinations of the optocoupler per electrical cycle. The transitions of the outputs define specific angles. The opto couplers and disk provide the position measurements. The large angle change means the current controller requires more time to make it to reach higher value. Here there is a fear of loosing efficiency with the increase in power consumption. Here when compared with PI controller the rising time is almost similar tto the proposed one. However, the rule reduction shows the controller outperforms the its counterpart performing on rulebase. When the load burden is increased more than double the variation shown is very little.

V. CONCLUSION

In this paper, the linear model is assumed and the parameters are calculated for an equivalent circuit model. The fuzzy controller is proposed in the place of conventional controller. The fuzzy based PI like controller is proposed by keeping the gain alteration. The self tuning mechanism is discussed on the base of rule base . The fuzzysets for rulebase is reduced so as to improve efficiency interms of logic comparisons. The rule bases are built on the switched reluctance modes of tor behaviours, experimental analysis, output-gain characteristics and membership functions, tuning mechanisms or strategy. The comparison is made for the slf controller on rule base mechanism and rule definition mechanism. In both the cases the sfl mechanism is found better than its counterpart.

REFERENCES

[1] T. J. E Miller, Electronic Control of switched Reluctance motor London,U.K. Oxford Univ. Press, 2001

[2] R. Krishnan, Switched Relucttance Motor Drives: Modeling, Simulation, Analysis, Design and Application London,U.K. CRC, 2001

[3] J.G. Amoros and p. Andrada, “ Sensitivity analysis of geometrical parameters on a double sided linear switched reluctance motor” ,IEEE Trans. Ind. Electron., vol. 57, no.1, pp. 311-319, jan. 2010

[4] T. Orlowska-Kowalska, M.Kaminski, and k. Szabat, “ Implementation of a sliding –mode controller with an integral function and fuzzy gain value”.

[5] P.N. materu, and R.Krishnan, “Steady state analysis of the variable speed switched reluctance Drive” IEEE transactions on Industrial Elec. Vol 36, no 4, November 1989.

[6] F. Soares and P.J. Coasta Branco, “ Simulation of a 6/4 switched reluctance motor based on Matlab simulink Environment” 2005.

