Comparative Analysis of PI Controller and Fuzzy Logic Controller for Speed Control of Three Phase Induction Motor Drive

Manjunatha M N,
M.Tech, Dept. of Electrical and Electronics KVGCE Sullia, Karanataka, India

---

Abstract - Three-stage induction magnetic motors are utilized as a part of an extensive employed in numerous varieties of mechanical applications. The present day innovation utilizes the speed of stimulation engine and can be effectively controlled by drives. These drives utilize fast power transistors with different switching systems, for the most part PWM plans. For rapid variable rate drives, exact arrangements have been accommodated speed control of three stage induction magnetic motors. The Fuzzy rationale controller gives a compelling answer for accomplishing better execution contrasted with PI controller. The proposed work focused on the particular speed manage connected with three stage induction magnetic motor get dependent relative on fuzzy judgments controller weighed against PI controller. The actual planned work incorporates a voltage resource PWM inverter nourished indirect vector manage method connected with induction magnetic motor. traditional indirect vector manage method connected with induction magnetic motor features presents ordinary PI controller in external speed loop as a result of its effortlessness and steadiness, it is demonstrated that the low exactness of the speed controller corrupts the execution of the entire framework. To beat this issue, alternative connected with PI controller by a very good Controller dependant on fuzzy arranged principle and hypothesis can be planned and proposed. The actual overall performance in the intelligent controller can be simulated as a result of electronic simulation applying MATLAB-SIMULINK within different operating condition. The simulation results reveal that the execution of the proposed controller is superior to anything that of the custom PI controller.

KeyWords: **Fuzzy rationale, PWM inverter, speed loop, hypothesis**

1.1 General Introduction

Today's modern society is totally automated with less human interventions. All predictable and routines jobs are assigned to a machine. The automated machine alone does if the parameters are defined. The control algorithms and estimation of induction motor drives had grown significantly over the past few years and the innovation has furthermost propelled lately. Employing induction magnetic motor was improved enormously because of some of their advantages such as robust construction, reliable and it is free from customary maintenance. The variable speed drives for cage type induction magnetic motor requires fast torque response along with wide operating speed range irrespective of the variations in load, thus giving more advanced methods of control so as to meet the real demand. The exacting vector manages in the induction engine electric disks is all around acknowledged procedure whenever excessive degrees of effectiveness in the system reply are required. While using technique in the vector manage procedure, a induction engine has become effortlessly handled such as a on their own thrilled DC engine with regard to high performance programs and will be offering an increased a higher level active effectiveness. In addition the actual active effectiveness is actually required with regard to outstanding effectiveness associated with electric disks. These AC drives prerequisites can be satisfied by the vector control framework.

PI controller is a very comprehensive feedback technology that offers a very efficient solution to numerous control problems in the real world. An enhancing the PI controller becomes popular in industrial applications due to their simplicity, robust and reliability of the systems. In order to make sure a satisfactory closed loop performance, PI controllers are tuned properly. The vector control scheme make use of controllers like PI controller or any other controllers in the outer speed loop hence variation in the load condition or environmental factors could produces the overshoot and oscillation of motor speed and torques were reduced.

2. Proposed System:

2.1Block Diagram of the Proposed System:

The Block Diagram demonstrates the proposed arrangement of speed control of three stage induction magnetic motor drive utilizing Indirect Vector manage Tactic.

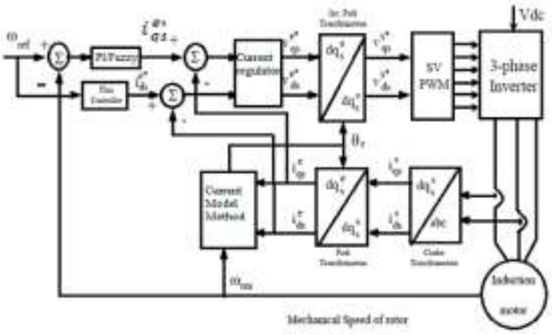

FIG 2.1: The Block Diagram demonstrates the proposed arrangement of speed control of three stage induction magnetic motor

The proposed work centers the speed manage of three stage induction magnetic motor drive taking into account fuzzy rationale controller contrasted and PI controller. This incorporates a voltage source PWM inverter-encouraged indirect vector manage arrangement of induction magnetic motor.

The induction magnetic motor is bolstered by a variable frequency, variable voltage PWM inverter, which works in current control mode. The magnetic motor speed ω_{rm} is contrasted and the reference speed ω_{ref} and the error is created which is bolstered to the speed controller, which is a PI controller or fuzzy rationale controller. The yield of speed manager is the stator quadrature-axis in excitation outline i_{qs}^{e*} is ascertained from electro-magnetic torque reference T_e^*.
Seeing that found with fig5.1, the particular feedback towards the Clarke transformation prohibit will be feasted through two-phase present. These types of projection results are generally indicated as $i_{ds}^{s}$and i_{qs}^{s} and the inputs to Park's transformation are given by two present parts, which gives the current in the qds^e which is in excitation reference outline. The i_{ds}^{e} and i_{qs}^{e} current parts, which are yields of the Park transformation block are contrasted to their reference values (i_{ds}^{e*}) the flux reference and (i_{qs}^{e*}) the torque reference. The yield of speed manager of controller is the torque command i_{qs}^{e*}. The flux command i_{ds}^{e*} is the yield of the flux controller which shows the right rotor flux command for each speed reference
The current managers of controller yield the voltages in dq axis in the casing of reference excitation v_{ds}^{e*} andv_{qs}^{e*} are connected to the inverse Park transformation. The calculation of verdict the rotor flux position is called current model technique. The Current Model takes i_{ds}^{e*}andi_{qs}^{e*} as an input. In addition the rotor mechanical speed and gives the rotor flux position as a yield and it is encouraged to Inverse Park's transformation as an input. The yields of Inverse Park's change are the projections of v_{ds}^{s}andv_{qs}^{s}, which are the segments of the stator voltage vector dqs^s in the orthogonal reference outline. They frame the inputs of the SVPWM block. The yields of these blocks are the signs that drive the inverter. The Park and the inverse Park changes both require the exact rotor flux position, which is given by the current model block. This block needs the rotor resistance or rotor time consistent as a parameter. SVPWM is utilized to copy v_{ds}^{s} and v_{qs}^{s} so as to execute current regulation.

3. RESULTS AND DISCUSSIONS
3.1 Results
The proposed model is simulated in MATLAB/SIMULINK package of version R2013a**.** The simulation result of speed control of three stage induction magnetic motor using PI-controller and fuzzy rationale controller based on indirect vector control approach is performed. The parameters like reference speed, theta, rotor speed and electromagnetic torque are used for performance evaluation.

3.2 Simulation Results
3.2.1 Performance of Speed Control of Three Phase IM Using PI Controller
Reference speed is kept for different values of speeds in rad/sec. Though the system undergoes any dynamic changes controller should adopt the changes hence reference speed generates a signal changing at specified times. The different values of reference speed changes by time in sec.

The following are the table which represents the time and reference speed used in MATLAB/SIMULINK of source block parameters

Times(S)	[0 1 5 3]
Amplitude(Reference Speed In rad In Sec)	[80,130,50]

TABLE 1: Source Block Parameters in MAT LAB

The waveform of reference speed, rotor speed, electromagnetic torque and theta using PI controller

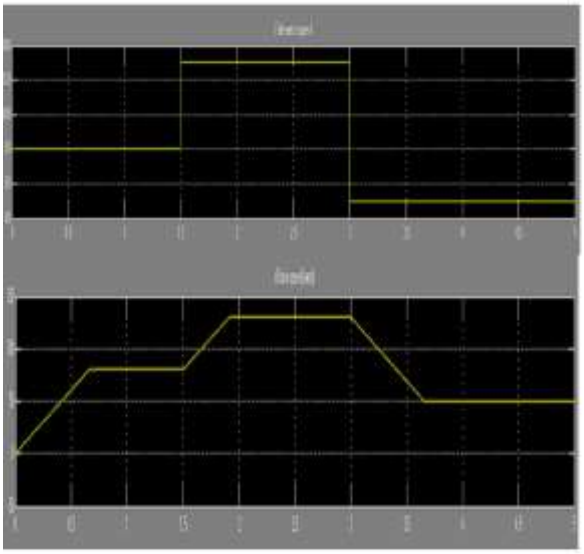

Fig.7.2: Waveform of Reference Speed and Rotor Speed using PI controller

The above graph shows the performance of the speed control of three stage IM using PI controller where reference speed is set to different values and rotor speed is evaluated for each different speed and it is a.

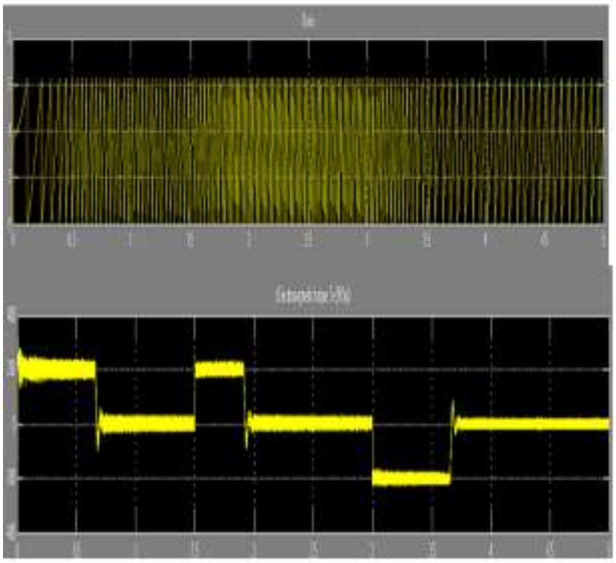

Fig .7.3: Waveform of Theta and Electromagnetic Torque using PI controller

Fig 7.2 waveform describes that the initial speed is kept at 80rad/sec which is at initial time in sec, so that the rotor speed increases from initial time to nearly 80rad/sec and reaches the steady state value, which takes a settling time of 0.7sec.After that reference speed changes to 130rad/sec at time 1.5sec and again rotor speed increases and reaches to steady state .As the rotor speed increases the torques will be positive high and if speed settled, the torque is around zero.The waveform of voltage and current by PI controller

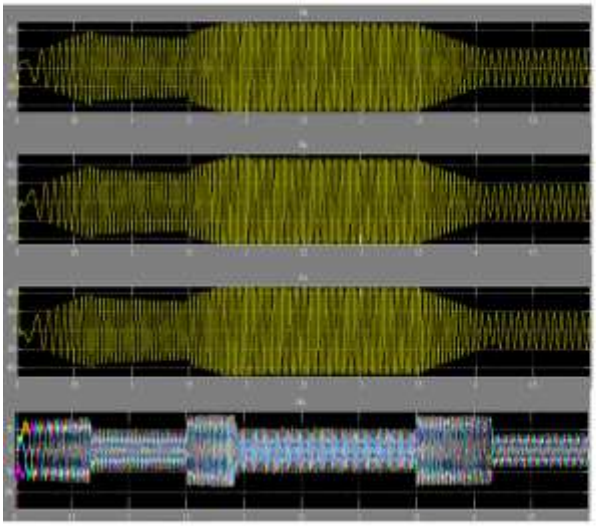

Fig.7.4: Waveform of Voltage and Currentby PI Controller

By evaluating the performance of speed control of IM, the voltage varying from +400V to -400Vand the current in three phase is varying in the range of +50A to-50A.

3.2.2 Performance of Speed Control of Three Phase IM Using Fuzzy rationales Controller

The waveform of reference speed, rotor speed, electromagnetic torque and theta using Fuzzy logic controller

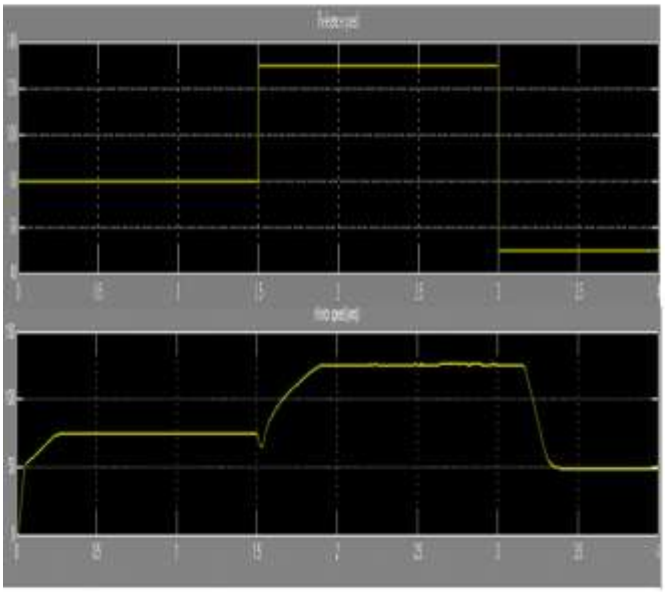

Fig.7.5: Waveform of Reference Speed and Rotor Speed using Fuzzy Logic Controller

The above graph shows the performance of the speed control of three stages IM using Fuzzy rationales controller where reference speed is set to different values and rotor speed is evaluated for each different speed and it is a graph of sperad/sec verses time in sec.

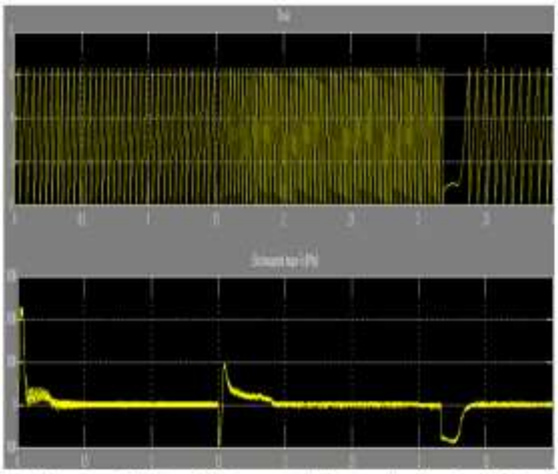

Fig.7.6:Waveform of Theta and Electromagnetic Torque using Fuzzy logic Controller

Fig 7.5 waveform describes that the initial speed is kept at 80rad/sec which is at initial time in sec, so that the rotor speed increases from initial time to nearly 80rad/sec and reaches the steady state value, which takes a settling time of 0.3 sec. This shows that the fuzzy rationales controller of speed control of induction magnetic motor takes lesser settling time compared with PI controller. After reaching to 80rad/sec, the reference speed changes to 130rad/sec at time 1.5sec and again rotor speed increases and reaches to steady state. As the rotor speed increases the torques will be positive high and if speed settled, the torque is around zero.
The waveform of voltage and current by Fuzzy logic controller

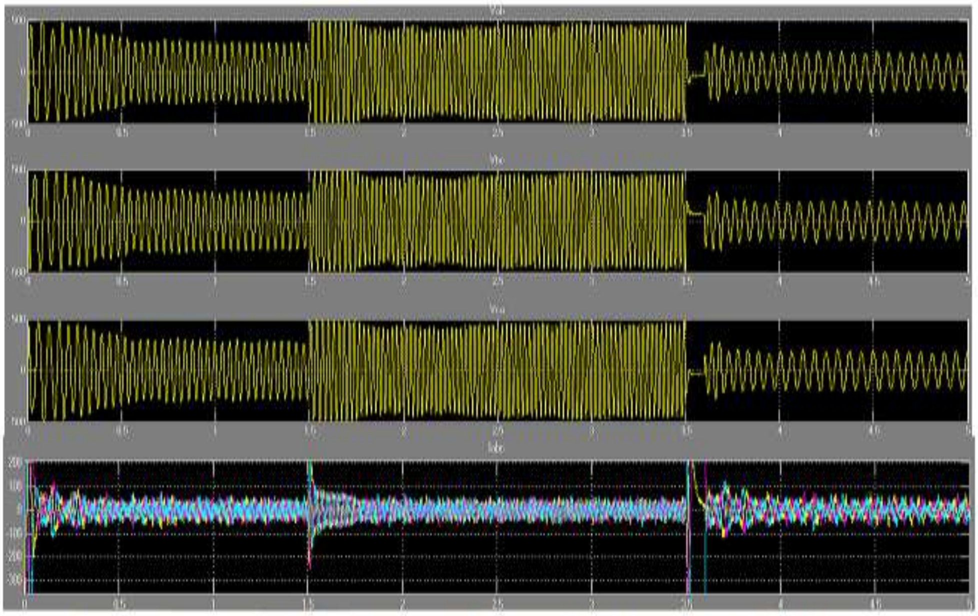

Fig.7.7:Waveform of Voltage and Current by Fuzzy Logic Controller

3.2.3 Comparative Result of Speed Control of Three Phase IM Using both PI Controller and Fuzzy rationales Controller
The following table represents the comparison between PI & fuzzy logic controller with set time, reference speed & steady state response time or settling time as well.

Controllers	Pi controller			Fuzzy logic controller		
Set time(sec)	0	1.5	3.0	0	1.5	3.0
Reference Speed(rad/sec)	80	130	50	80	130	50
Settling Time(sec)	0.7	1.9	3.7	0.3	1.7	3.3

Table2: Comparison between PI and FLC

4. CONCLUSION AND FUTURE WORK

4.1 Conclusion:

The proposed work is all about the speed control of three stage induction magnetic motor utilizing PI controller & Fuzzy rationale controller is based on indirect vector control approach. The proposed control frameworks use fuzzy rationale controller to improve the execution of induction magnetic motor drives & likewise serves to accomplish accuracy in control. From the SIMULINK results, it is observed that the Fuzzy rationale controller shows better execution regarding rise time and consistent steady state reaction. The fuzzy rationale controller gives quick reaction to speed command than the PI controller. Thus the fuzzy rationale controller has demonstrated predominant element execution and superior dynamic performance furthermore power than that of PI controller.

4.2 Future Work

- Hardware implementation can be carried out for the above method with the desired values.
- For tuning the controller, different strategies like genetic algorithms can be used and can easily be adopt a neuro-fuzzy logic controller instead of just fuzzy controller so as to achieve desirable result.

REFERENCE

[1] Rakesh Singh Lodhi and Payal Thakur. Performance & Comparison Analysis of Indirect Vector Control of Three Phase Induction Motor International Journal of Emerging Technology and Advanced Engineering Volume 3, Issue 10, October 2013)
[2] Ashutosh Mishra, Prashant Choudhary. Speed Control Of An Induction Motor By Using Indirect Vector Control.International Journal of Emerging Technology and Advanced Engineering, Volume 2, Issue 12, December 2012)
[3] P.Tripura and Y.Srinivasa Kishore Babu, " Fuzzy Logic Speed Control of 3 phase Induction Motor Drive ",World Academy 0f Science, Engineering and, Vol.: 5 2011-12-20 .
[4] Arun Kumar R. Indirect Field Oriented Control of Induction Motor Using Fuzzy Logic, PG Scholar, PED, SELECT, VIT University, Chennai.
[5] S. RAFA L. BARAZANE A. LARABI .Intelligent Control of Induction motor using interval type-2 fuzzy logic, Journal of Electrical Engineering.
[6] Afonso, JoãoL. Fonseca, Jaime C Martins, Júlio S. Couto, Carlos .Fuzzy logic techniques applied to the control of a threephase induction motor.