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An Improved Hybrid Fuzzy-PID Tunning With Particle Sawrm Optimization For Enhancing Induction Motor Performance

Parmjit Singh | Prince Jindal | Simerpreet Singh

Department of Electrical Engineering Bhai Gurdas Institute of Engineering and Technology, Punjab, India.

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ABSTRACT

The fuzzy logic controllers are estimated as an appropriate controller because it is minimally complex method and did not involve any of the mathematical models. The major concern of this study is to control the fluctuations in speed of the induction motor through improving the conventional mechanism by utilizing the ANFIS paradigm as controller. Therefore a new mechanism is to be projected that will execute ANFIS. Because of the merits like Adaptive learning, Self-Organization, Real Time Operation, Fault Tolerance through Redundant Information Coding etc. The ANFIS algorithm is utilized as a speed control in the proposed work. It is expected that the hybridization of ANFIS and PID controller can be useful in order to achieve the stability. An optimization technique is also utilized in this study. The values of PID controller can be adjusted by an optimization technique that can be a PSO (Partial Swarm optimization) technique which is required to optimize the values of PID controller in order to choose the best values of P, I and D. In this way, the best output results of the proposed work can be attained.

Keywords:- *Induction Motor, PID Controller, Fuzzy Logics Based PID Controller.*

I. Introduction

Nowadays different control method based calculations have been executed for control framework engineering and position control [1]. In digital servomotor, the position control should be possible by utilizing the diverse sort of programmed process. On the other hand, the nonlinearities like load impact which have a negative impact to the execution of the framework, did not occur in framework [2].

Electrical motors are used for generalized applications whereas other electrical motors have been developed for application specific tasks. Electric motors can also employ for fulfilling the dynamic need of the systems without increasing the temperature of electric motor [3]. Hence it is an important to determine the load characteristics while electing the electric motor. Other factors such as mission goals, availability of power and cost can also be considered while selecting the electric motor for system [4]. But when implemented practically, it becomes difficult to fetch the full information regarding the uncertainties. Lot of research had been conducted till now in order to perform position control in servo motors [5]. And fuzzy logics are one of the prominent mechanisms that is preferred over PID controllers specifically in servo motors for handling the uncertainties [6].

The induction motor discovers its place among over 85% of mechanical motors and additionally in its single-phase formation in different local uses. Clearly a constant-speed motor with shunt feature, speed drops just by a small number of percent from no-load to full load. Thus previously, induction motors have been utilized fundamentally in consistent speed applications [7].

II. PID CONTROLLERS

The other name of PID controllers is Proportional-Integral-Derivative controllers. In order to attain an outcome there are majorly three control parameters which required to be regulating [8]. The attained outcome is the arrangement of Proportional, Integral and Derivative parameters. The major domains of utilizing this controller are the education and industry [9].

A block Diagram for PID controller is shown in Figure 1.

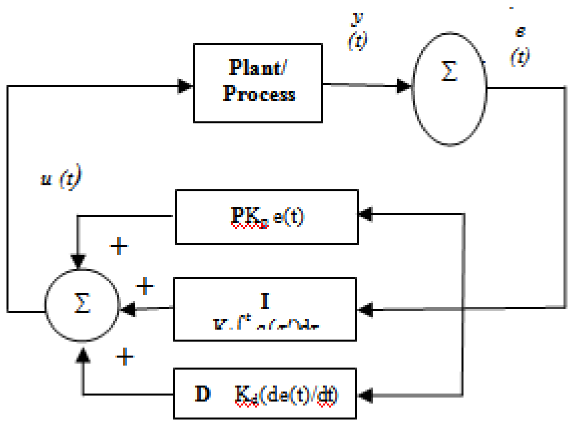

Fig 1: Conventional PID Controller design

In nearly all areas the PID controllers are utilized however these couple of fields is basic building as nearly all the controllers are utilized in these domains. In order to offer the installation of the controllers the PID controllers should be tuned. Therefore over the dynamic behavior of the mechanism the tuning is performed [10].

III. PROBLEM FORMULATION

The traditional control like the proportional-integral (PI), and proportional-integral-derivative (PID) controllers have been utilized together among vector control mechanisms over the years in order to control the speed of the induction motors in a better way. Where in conventional research the hybrid control mechanism is utilized for the speed control of a three-phase squirrel cage induction motor (SCIM). In the projected mechanism integrated fuzzy logic among traditional controllers and the vector control mechanism is also utilized. In order to enhance the speed response of the three-phase induction motor the merits of fuzzy logic controller and traditional PID controllers are merged in this work. The parameters like K_p, K_i and K_d are utilized by the PID controller. Based on the Hit and trail mechanism these parameters selection is accomplished as well as at the time these parameters meet some fluctuations in their values, in that case the entire controller gets affected. The implementation of fuzzy inference method based controller was the other loophole. As the fuzzy can produce the output only on the basis of the generated rules that are derived from the set of input values.

IV. PROPOSED WORK

Through utilizing several sorts of controllers like PI, PID controllers and fuzzy logic controllers several authors conduct several analyses to control the speed of the induction motor as defined in above section. The fuzzy logic controllers are estimated as an appropriate controller because it is minimally complex method and did not involve any of the mathematical models. The major concern of this study is to control the fluctuations in speed of the induction motor through improving the conventional mechanism by utilizing the ANFIS paradigm as controller. Therefore a new mechanism is to be projected that will execute ANFIS. The hybridization of ANFIS and PID controller is prepared in order to achieve the useful and reliable result. The major concern of utilizing ANFIS is illustrated below as:

- Adaptive learning: On the basis of information that is specified for training or starting experience a capacity to learn how to perform tasks.
- ·Self-Organization: An ANN can generate its own organization or presentation of the data it attains throughout learning time.
- Real Time Operation: May be the ANN calculations are carried out in parallel, as well as specific hardware appliances are being deliberated also manufactured that take merit of this ability.
- Fault Tolerance via Redundant Information Coding: Partial destruction of a system direct to the corresponding degradation of presentation.

Though, various system abilities may be preserved even among huge system damage.

Along with this an optimization technique is utilized in this work, as the PID controller involves calculation of three different (separate) parameters, Proportional (P), Derivative (D) and the Integral (I) values. If these values of PID are auto adjusted then it is not sure that the auto adjusted values are best for the proposed work. Therefore these values are adjusted by an optimization technique that is a PSO technique is required to optimize the values of PID controller in order to choose the best values of P, I and D.

V. RESULTS ANALYSIS

This section illustrates the outcomes which are attained after implementing the proposed work in MATLAB through utilizing the ANFIS algorithm as a controller to control the fluctuations in speed of the induction motor.

The Simulink model of the proposed work is shown in the figure 2. First of all, to the speed controller a reference speed as well as a constant is specified which is utilized to control the reference speed. The PID controller is utilized as the speed controller in this work. Then in order to modulate the speed a space vector modulator is utilized. The resultant outcome of the space vector machine is specified to the gate whose results are further provided to the Asynchronous Machine SI units. Afterward to the Subsystem the outcome of the Asynchronous machine is provided. Then the Rotor speed and the Torque which is obtained from the Subsystem are offered to the Scope 1.

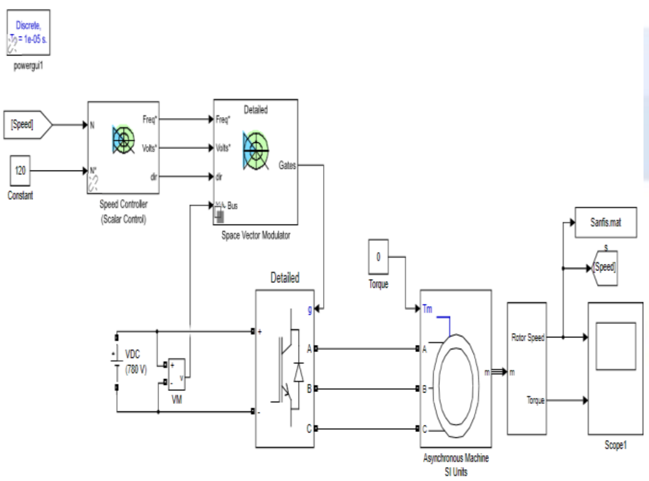

Fig 2: Simulink model of the proposed work

The Figure 3 depicts the membership function of error. The range of error is shown on the x-axis and varies from 1 to 7 whereas the degree of membership is shown on the y-axis that ranges from 0 to 1.

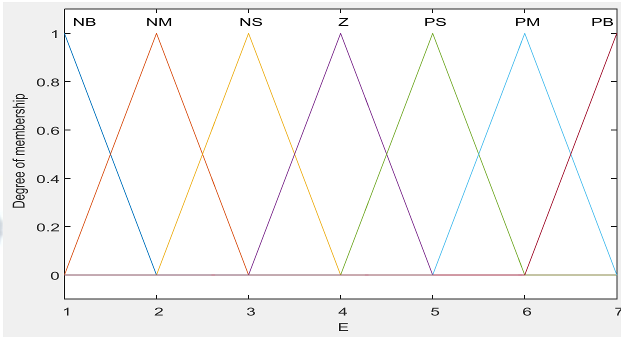

Fig3: Membership Function of Error

Figure 4 depicts the Membership function of Change in Error. The range of x-axis varies from 1 to 7 and the range of y-axis varies from 0 to 1. Here in this graph the degree of membership and the Change in error is shown on the y-axis and the x-axis.

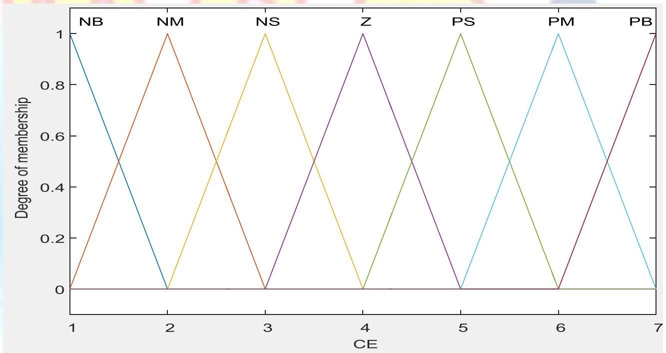

Fig4: Change in Error membership function

The Figure 5 represents the basic model of the ANFIS method. It is shown in this figure that a couple of inputs are fed to the single ANFIS system that are further processed and utilized to generate the resultant function. There are 49 rules to process these signals whereas these rules are generated based on the input signals.

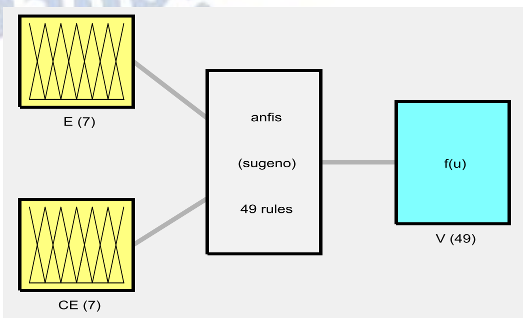

Fig 5: ANFIS system with 2 inputs and 1 output, 49 rules

The Table1 depicts the data set for ANFIS Controller. The Column and Row with the Bold letters of the table depicts the values of the E and CE as well as the other columns and rows shows the output values.

Table 1 Dataset for ANFIS Controller

E / CE	NB	NM	NS	Z	PS	PM	PB
NB	NVB	NVB	NVB	NB	NM	NS	Z
NM	NVB	NVB	NB	NM	NS	Z	PS
NS	NVB	NB	NM	NS	Z	PS	PM
Z	NB	NM	NS	Z	PS	PM	PB
PS	NM	NS	Z	PS	PM	PB	PVB
PM	NS	Z	PS	PM	PB	PVB	PVB
PB	Z	PS	PM	PB	PVB	PVB	PVB

The graph of Figure 6 shows the Rotor speed Output of the proposed mechanism. In this graph it is depicted that the variations in the rotor speed are less. Here the Rise time of the proposed work is 0.099874 and the settling time is 0.11782. The overshoot of the proposed work is zero.

Fig 6: Output of Proposed model (ANFIS)

Fig 7: Output of Proposed model (PID-ANFIS-PSO)

The graph of Figure 7 shows the Rotor speed Output of PID-ANFIS-PSO. The fluctuation in the rotor speed is less as shown in this graph. The overshoot of this technique is 0, rise time is 0.0732 and the settling time of the proposed work is 0.09792.

The graph of Figure 8 shows the comparison of PID-Fuzzy with PID-ANFIS. In this graph it is shown that the rise time of the PID-ANFIS is less than the PID-Fuzzy, the settling time of the proposed work is also less comparative to the traditional mechanism and the overshoot time is 0 of the proposed work whereas the overshoot time of the conventional method is 0.7. Therefore the proposed work is better in every case comparative to the conventional mechanism.

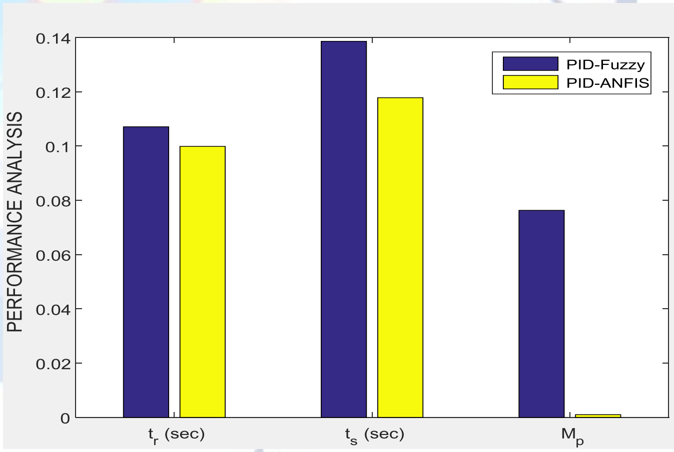

Fig 8: Comparison of PID-Fuzzy with PID-ANFIS

The comparison of PI-Fuzzy and the PID-ANFIS is shown in Figure 9. In this graph the rise time, settling time and the peak overshoot is given on the x-axis whereas the values of these parameters are shown on the y-axis that ranges from 0 to 0.15. The rise time, settling time and overshoot of the traditional method is 0.3, 0.11 and 0.13 whereas the values of rise time, settling time and overshoot of the proposed method are 0.1, 0.5 and 0. The values of PID-ANFIS are less comparative to the PI-Fuzzy mechanism.

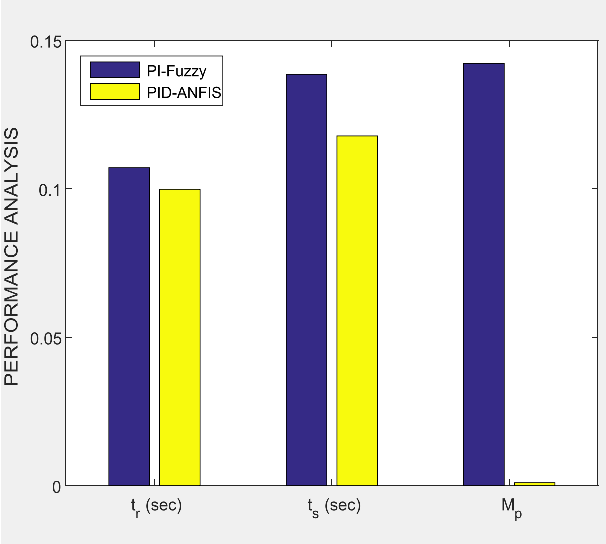

Fig 9: Comparison of PI-Fuzzy with PID-ANFIS

The graph of Figure 10 depicts the comparative analyses of PD-Fuzzy and PID-ANFIS. The rise time of the PID-ANFIS system is much lesser than the PD-Fuzzy system whereas the settling time of the proposed method is also less than traditional mechanism. The overshoot of the proposed work is equal to the overshoot of the traditional mechanism that is 0.

The graph of Figure 11 shows the Comparative Analyses of PID-ANFIS and PID-ANFIS-PSO. It is depicted in this graph that the values of rise time, settling time, and peak overshoot of PID-ANFIS-PSO is better compared to the PID-ANFIS mechanism that are 0.0732, 0.09792 and 0.

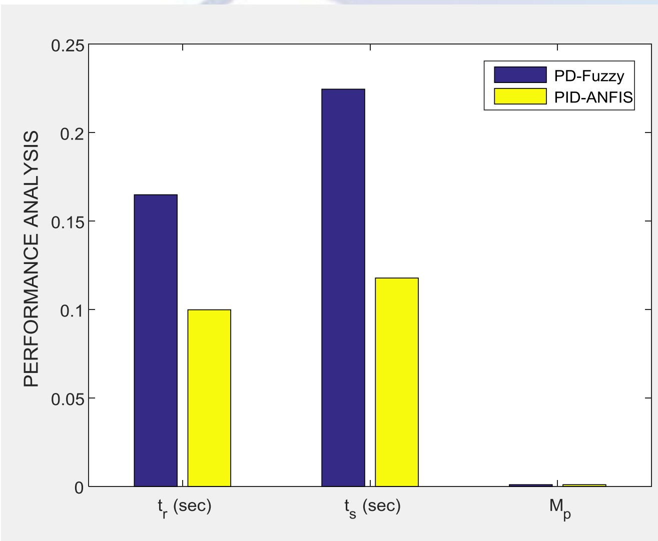

Fig 10: Comparative Analyses of PD-Fuzzy and PID-ANFIS.

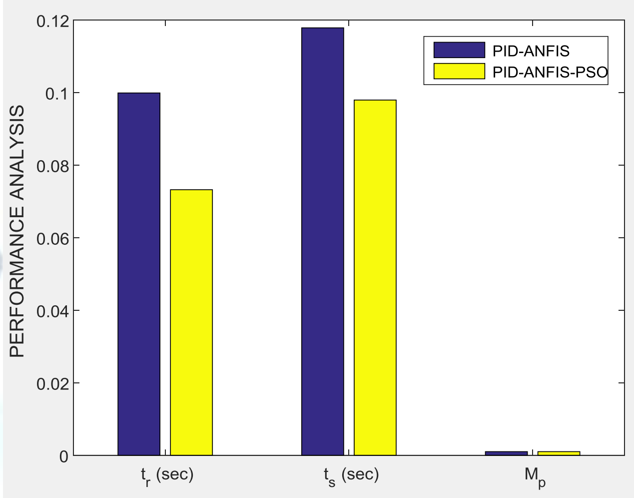

Fig 11: Comparative Analyses of PID-ANFIS and PID-ANFIS-PSO.

The Table 2 shows the values of several performance parameters such as rise time, settling and peak overshoot that are represented as t_r, t_s and M_p.

Table 2 Performance Analysis of Different Speed Controllers for SCIM

Controller	**t_r (sec)**	**t_s (sec)**	**M_p**
PI	0.5439	1.9326	61.202
PD-Fuzzy	0.1649	0.2246	0
PI-Fuzzy	0.1071	0.1386	0.1423
PID-Fuzzy	0.1071	0.1386	0.0763
PID-ANFIS	0.099874	0.11782	0
PID-ANFIS-PSO	0.0732	0.09792	0

VI. CONCLUSION

Electrical motors are used for generalized applications whereas other electrical motors have been developed for application specific tasks. Electric motors can also employ for fulfilling the dynamic need of the systems without increasing the temperature of electric motor. Hence it is an important to determine the load characteristics while electing the electric motor.

Other factors such as mission goals, availability of power and cost can also be considered while selecting the electric motor for system. But when implemented practically, it becomes difficult to fetch the full information regarding the uncertainties. Lot of research had been conducted till now in order to perform position control in servo motors. And fuzzy logics are one of the prominent mechanisms that are preferred over PID controllers specifically in motors for handling the uncertainties.

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The fuzzy logic controllers are estimated as an appropriate controller because it is minimally complex method and did not involve any of the mathematical models. The major concern of this study is to control the fluctuations in speed of the induction motor through improving the conventional mechanism by utilizing the ANFIS paradigm as controller to select the K_p, K_i and K_d parameters for PID controller with the help of an optimization technique that is Particle Swarm Optimization (PSO) technique. The proposed method offers significant results as the optimization along with the PID controllers can be utilized to control the speed of the induction motor at another level in future.

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