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Comparison And Control Of An Induction Motor Drive By Using Pi And ANFIS Controller

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ABSTRACT

A new speed control approach based on the Artificial Neuro-Fuzzy Inference System (ANFIS) to a closed-loop, variable speed induction motor (IM) drive is proposed in this paper. It is needless to mention that controlling speed of electrical drives is very important in rapidly growing industrial era. Generally electrical drives play an important role in rapidly growing industrial era, so the controlling of electrical drives is also important. Variable speed drives are essential in the major part of power system, microelectronic, power plant and so on. The controllability of torque control of an induction motor without any peak overshoot, and less ripples with good transient and steady state responses forms the main criteria in the designing of a controller. Though, PI controller is able to achieve these requirements but with certain drawbacks. Such as T the gains cannot be increased beyond certain limit so as to have an improved response. Moreover, it introduces non linearity into the system making it more complex for analysis. Also it deteriorates the controller performance. These drawbacks can be mitigated by artificial intelligent techniques. This has been verified through the simulation results of the model built completely in a MATLAB/SIMULINK environment.

I. INTRODUCTION

Induction motors play a vital role in the industrial sector especially in the field of electric drives & control. Speed imbalances shows that, it is virtually impossible to achieve the desired task for a specific application. AC motors, particularly the squirrel-cage induction motors (SCIM), make an inherent advantage like simplicity, reliability, low cost and virtually maintenance free electrical drives. Again for high dynamic performance industrial applications, their control remains a challenging problem because they exhibit significant nonlinearities and many of the parameters, mainly the rotor resistance, vary with the operating conditions. The Field Orientation Control (FOC) of an induction machine achieves decoupled torque and flux dynamics leading to independent control of the torque and flux as for a separately excited DC motor. The FOC methods are attractive, but suffer from one major disadvantage, viz., they are sensitive to motor parametric variations such as the rotor time constant and an incorrect flux measurement or its estimation at low speeds. Advanced variable speed drive applications require steepless control and suitable dynamic response and accuracy. These considerations made (what?) to a large extent in the past due to thyristor controlled dc machines. However, the dc machine remains relatively expensive in the types of rotating machines. For the higher power drives in industries, the lighter, less expensive, reliable, simple, more robust and commutator less induction motors [1] are desirable and these motors are being applied today to a wider range of applications requiring variable speed. Unfortunately, accurate speed control of such machines by a simple and economical means remains a difficult task. The development of thyristor family devices such as silicon controlled rectifier, triac, and related members of the thyristor family, it has become most feasible made it possible to design variable speed induction motor drives for a wide variety of applications. An Induction motors are widely used in various industries as prime work to produce rotational motions and forces. In General, variable speed drive induction motors require both wide operating range of speed and fast torque response, regardless of load variations. The classical control is always used in majority of the electrical motor drives in [2]. Conventional control makes use of the mathematical model for controlling the system. But behavior of system is not satisfactory & deviates from the desired performance, when there are system parametric variations or environmental disturbance i.e. noise. In

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addition, usual computation of system mathematical model is inaccurate due to varying non-linearity, difficult or impossible. Hence, system identification techniques need to be used for finding exact mathematical model of the system. For exact mathematic model of the system, then one has to do some identification techniques such as the system identification & obtain the plant model. Moreover, the design and tuning of conventional controller increases the implementation cost and adds additional complexity in the control system. & thus, may reduce the reliability of the control system. Hence, the fuzzy based techniques are used to overcome this kind of problems. (How Fuzzy Logic helpful in short?) The efficient torque control of induction motor drives in combination with resonant DC-link input filters (Is it reqd in Fuzzy Logic?) can lead to a type of stability problem that is known as negative impedance instability.(These two sentences are contradictory for completing this para) Generally, motor control drives rely on the use of PI controllers. These controllers, however, are sensitive to system non-linearities, variations in parameters and any unwanted disturbances. (Use it in continuation of PI controllers above, do not bring here again) These disadvantages can be overcome by the use of AI based intelligent controllers. The use of an ANFIS based speed controller for a direct torque controlled induction motor drive is presented in this paper. (But still your introduction does not indicate some obvious advantatages of ANFIS to indicate why only that is chosen?)

II. LITERATURE REVIEW

R. P. Basu, have proposed this paper describes a closed-loop control system for an ordinary wound-rotor induction motor, which makes use of thyristors on the secondary side as phase-controlled ac switches operating at slip-frequency. It is shown that such phase-controlled thyristors allow the torque of the machine to be varied from zero to values bounded by the normal torque/speed characteristic of the basic motor, and when overall speed control is applied the motor can be given shunt-type torque/speed characteristics.

Henrik Mosskull, Johann Gali´c, and Bo Wahlberg, are proposed Efficient torque control of induction motor drives in combination with resonant dc-link input filters can lead to a type of stability problem that is known as negative impedance instability. An often-proposed solution to this problem is the nonlinear system stabilizing controller (NSSC). Stability is usually analyzed under the simplifying assumption of perfect torque control. This indicates that the NSSC stabilizes the drive at any operating point. In this paper, however, we show power laboratory experiments where the NSSC stabilization fails. An improved framework for stability analysis and synthesis of stabilization, based on a linear feedback model of the drive, is therefore proposed. With this approach, effects of time delays can easily be included, and stability margins can be directly established from measurements. To solve the indicated problems with NSSC, a stabilization controller that considers the practical limitations of torque control is derived. In the design of the stabilization controller, the tradeoff between damping and acceptable torque control is also explicitly taken into account. The proposed stabilization scheme is implemented and evaluated on a hardware-in-the-loop simulator as well as in a power laboratory. The results show that the proposed method outperforms the NSSC method.

J.S.R. JangANFIS have proposed the architecture and learning procedure underlying ANFIS (adaptive-network-based fuzzy inference system) is presented, which is a fuzzy inference system implemented in the framework of adaptive networks. By using a hybrid learning procedure, the proposed ANFIS can construct an input-output mapping based on both human knowledge (in the form of fuzzy if-then rules) and stipulated input-output data pairs. In the simulation, the ANFIS architecture is employed to model nonlinear functions, identify nonlinear components on-line in a control system, and predict a chaotic time series, all yielding remarkable results. Comparisons with artificial neural networks and earlier work on fuzzy modeling are listed and discussed.

B. Dandil, have proposed in this paper, a fuzzy neural network (FNN) controller which emulates the conventional IP controller is proposed for a vector controlled induction motor drive. A Sugeno type FNN is adopted for the proposed control system and the fuzzy neural network is so designed that the FNN controller behaves an robust-nonlinear IP controller. The proposed FNN-IP controller is used for the position control of induction motor drive and the performance and the robustness of the control system is tested for nonlinear motor loads and parameter variations. The FNN-IP controller is trained off-line using experimental data's and then the trained controller is used for experimental studies. DS1104 digital signal processor control card is used to implement the control algorithm. Experimental results showing the effectiveness of the proposed control system are presented for parameter and load variations of the motor

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III. ANFIS CONTROLLLER

Design of ANFIS-torque controller

The information representation of fuzzy logic consolidating with learning power of artificial neural network system gives Adaptive Neuro-Fuzzy Inference System (ANFIS). Subsequent to ANFIS plan starts with a pre structured framework, level of flexibility for learning is inhibited that is the input and output membership function comprises of more information that a neural system needs to get from test pair of information. Data concerning a system under arrangement can be used right from starting. Some part of the system can be banished from training; therefore process is more effective. The intermediate results can be examined effortlessly as the guidelines are in linguistic form structure. ANFIS implements a first order fuzzy system as a result of its computational efficiency and versatile procedures [3], [4-10]. To start ANFIS adjusting, a training data pair first that contains required input–output information set of the target system to be outlined is required. The objective is picked taking into account the best response of the system.

The schematic diagram of proposed ANFIS-based drive is demonstrated in Fig. 1. The ANFIS controller structural design integrates fuzzy logic and learning algorithm with a five level artificial neural network arrangement [5] as portrayed in Fig. 4(a). The parameter of the fourth layer is modified by tuning to control any deviation of control effort. The two inputs of the ANFIS controller are given by

error, $e(t)=T_e^*-T_e$

change in error, $\Delta e(t)=e(t)_k-e(t)_{k-1}T\times 100$

where T_e^* is the reference torque, T is the sampling time and k is the sampling instant.

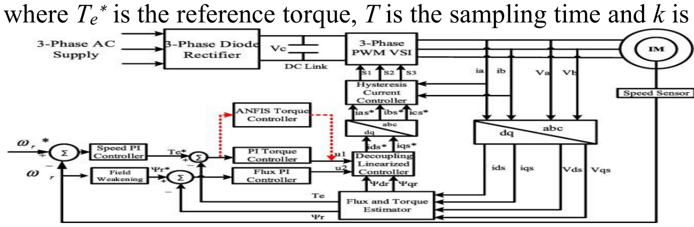

Fig.1.Schematic diagram of an ANFIS-based controller.

IV. SIMULATION RESULTS

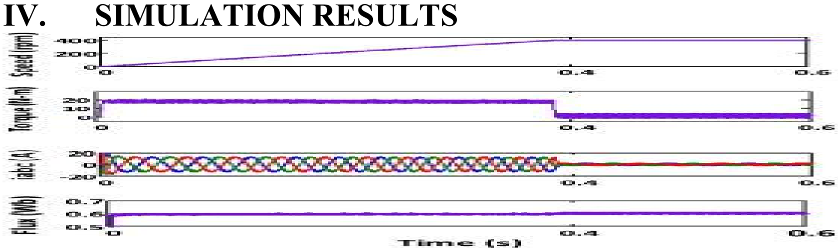

Fig.2a . Dynamic performanceof an Induction motor using PI controller.

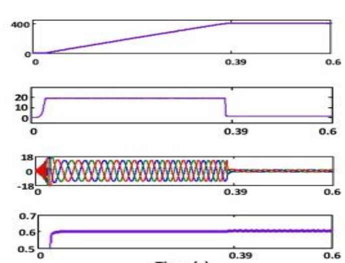

Fig.2b . Dynamic performanceof an Induction motor using ANFIS controller.

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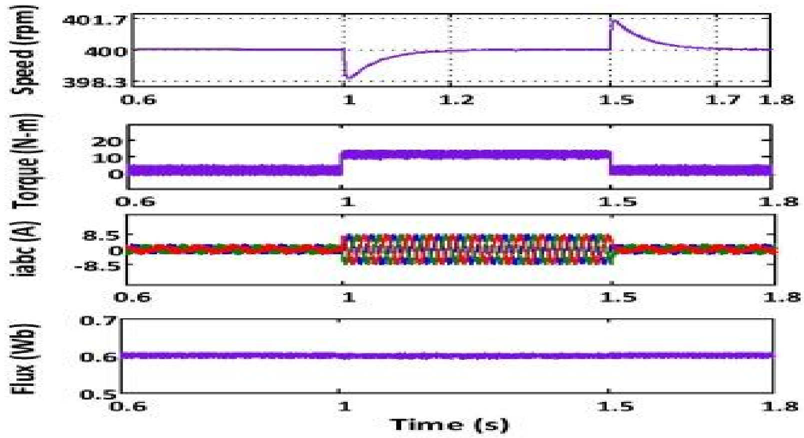

Fig.3a . Dynamic performanceof an Induction motor using PI controller.

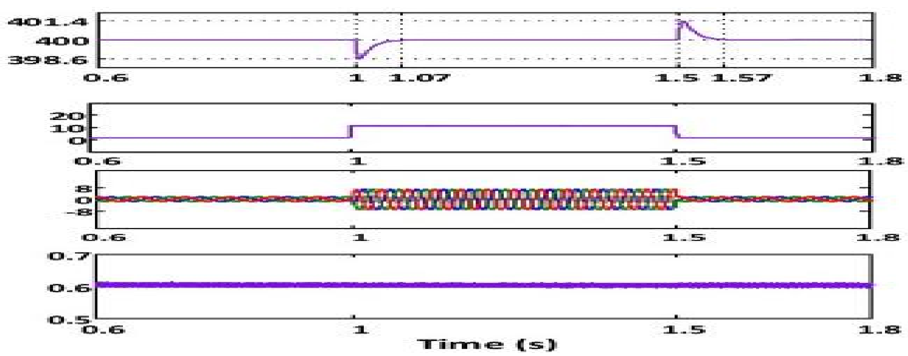

Fig.3b . Dynamic performanceof an Induction motor using ANFIS controller.

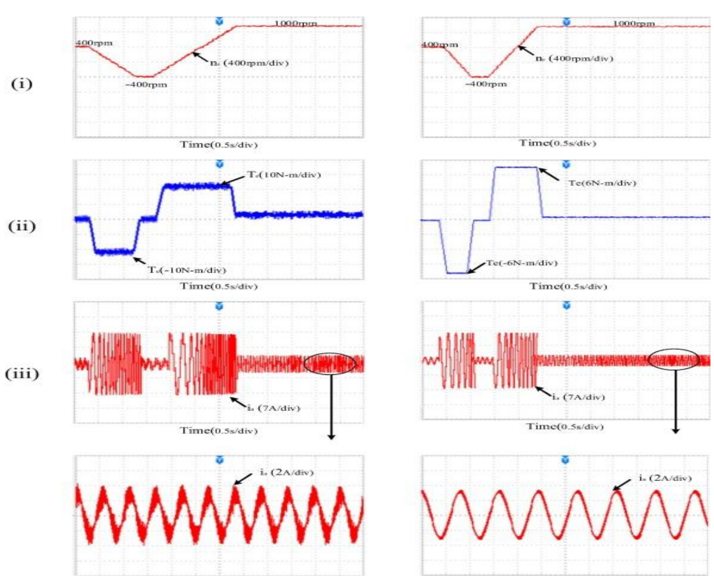

Fig.4. The experimental performance characteristics of induction motor drive under speed reversal for (a) PI-torque controller (i) Speed (n_r), (ii) torque (Te), (iii) stator current (i_a), and (iv), (b) ANFIS-torque controller (i) Speed (n_r), (ii) torque (Te), (iii) stator current (i_a).

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V. CONCLUSION

The new design approach which incorporates ANFIS controller with decoupled feedback linearization based induction motor drive is articulated in this paper. The overall drive system was designed and modeled in MATLAB software. Also, the adaptability and robustness of ANFIS scheme are proved experimentally by changing the gain of the speed-PI controller. Also, the results demonstrate the better response of flux and perfect decoupling when the proposed ANFIS controller is implemented. The comparative performance analysis by simulation as well as experiment has been carried out under different speed conditions.

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