ANN BASED FOUR SWITCH INVERTER FOR INDUCTION MOTOR DRIVE

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Abstract – *In this paper an ANN based four-switch three-phase (FSTP) inverter for induction motor drive is designed. The IM drive system is sustained by a FSTP inverter rather than the conventional six-switch three-phase (SSTP) inverter for low-power applications with ANN enhances dynamic reactions in the proposed system. The proposed FSTP inverter is simulated by MATLAB/Simulink. The proposed system with dynamic speed reaction of the IM drive at low speeds is improved utilizing the ANN which is outlined with low calculation weight to be proper for continuous applications.*

Key Words: *Indirect field-situated control (IFOC), Four-Switch Three-Phase (FSTP)*, Artificial Neural Network (ANN), Induction Motor (IM)

1.INTRODUCTION

The most commonly used electric machines in industrial applications is Three-phase induction motors due to their low cost, simple, and robust construction. Three-phase inverters ie traditional six-switch three-phase (SSTP) inverters have been widely used in different industrial applications such as variable speed ac motor drives. These inverters have some drawbacks in low-power range applications which involve extra cost due to the six switches losses. An adjustable-speed drive used in this application has the potential to increased efficiency to hold a tighter temperature band since airflow will always be circulating. This paper proposes a new adjustable-speed motor drive system containing and an electronic drive and that allows for the motor to be speed and/or torque controlled. Voltage source inverter-fed induction motors are most preferred for variable speed drive applications. For an accurate operation of indirect field-oriented control (IFOC) of IM drives rotor flux is essential. The field-orientation technique needs precise machine parameters to guarantee accurate decoupling of the stator current vector in relation to the rotor flux vector. The dynamic model of the IM is highly required for high-performance IFOC of IM drives based on Flux estimation Techniques. Torque non linearity and saturation of the motor caused by inaccurate machine parameters. It is possible that the machine control performance degrades due to the parameters mismatch and the system becomes detuned.

2. MODEL OF IM AND CONTROL SCHEME

Figure1 shows the control structure of the proposed voltage-source inverter based indirect field-situated control of the Induction motor drive. The Induction motor is represented in a d−q axis and the control structure relies on the indirect field-situated control. The speed error between the reference and actual motor speeds and the derivative of speed error are the inputs to the FLC and reference torque (Te) is output. By inverse Park's transformation, the reference currents in d−q axis are transformed into the reference motor currents in a−b−c axis.

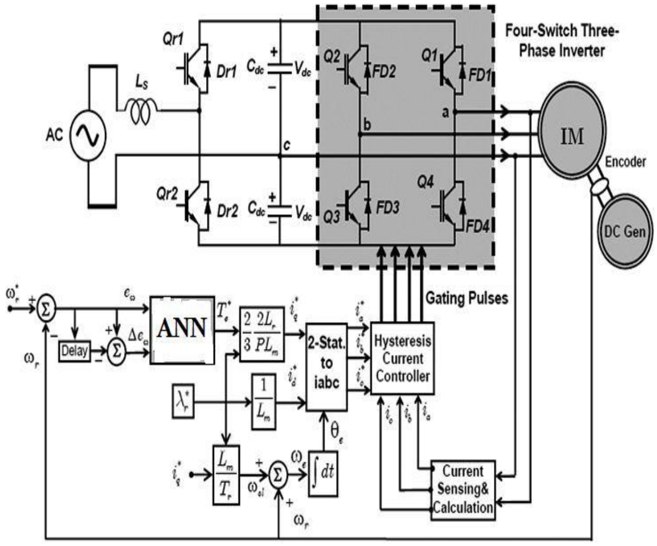

Figure 1 Block diagram IFOC of the IM drive with VSI

Figure1 shows the power circuit of an FSTP-VSI-fed Induction motor and is composed from two sides. The first side consists of a single-phase ac power supply whose frequency is fixed and has a half-wave voltage doubler. By rectifier switches Qr1 and Qr2, the voltage is rectified and the capacitor bank connected in the dc link gets charged. The other side is the FSTP inverter has four switches Q_1, Q_2, Q_3 and Q_4. IM are connected to Phase "a" and phase "b" through two limbs of the inverter, while midpoint of the capacitors bank is connected to the phase "c". In order to get the two line-to-line voltages V_{ac} and V_{cb}, FSTP inverter uses four isolated gate bipolar transistors (IGBTs) and four freewheeling diodes.

The third line to line voltage (V_{ba}) is obtained from a split capacitor bank. The maximum dc-link voltage across each capacitor is equal to V_{dc}. Using an FSTP inverter, the generated three phase output voltages are balanced with adjustable voltage and frequency. The three-phase output voltages of the FSTP inverter are obtained using the dc-link voltages V_{dc} and the binary signals of the two limbs of the FSTP inverter.

3. Artificial Neural Network

An artificial neural network (ANN) is a mathematical model or computational model that is inspired by the structure and/or functional aspects of biological neural networks. It is powerful tools for modeling, especially when the underlying data is unknown by a group of artificial neurons interconnected to a neural network. Correlated patterns between input data sets and corresponding target values can identify and learn by ANNs. ANNs can be used to predict the outcome of new independent input data after training.

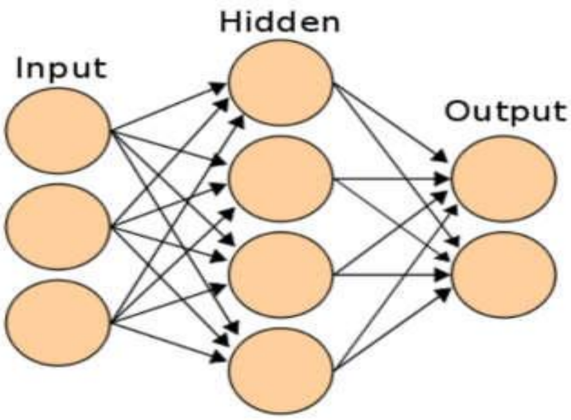

Figure 2: Three layer neural network

Neural network consist of three layers, first layer has input neurons, second layer of hidden neurons, third layer of output neurons as shown in figure 3. In order to produce desired outputs in response to training set of inputs neural networks are trained is called supervised learning. It used in the modeling and controlling of dynamic systems, classifying noisy data and predicting future events. Neural networks are trained by letting the network continually adjusting itself to new input is called unsupervised learning. The ANNs would be a compared with a black box having multiple inputs and multiple outputs which operates using a large number of mostly parallel connected simple arithmetic units. All ANN methods are that they work best if they are dealing with nonlinear Dependence between the inputs and outputs.

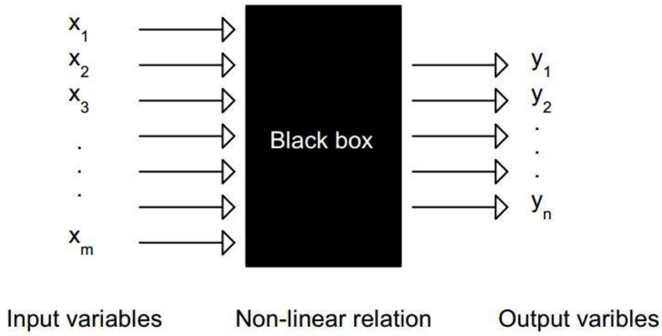

Figure 3 Non-linear relationship neural networks as a black-box

ANN is based on the biological concept of neural network and has different interconnected layers and is designed to process information accurately. In this paper the rest of the block diagram is same as that of the FLC but the only change is ANN subsystem as show in figure 5 and 6. Neural network is trained constantly matching the input and output pattern. Input to the ANN subsystem is same that of the FLC system and output is also the same.

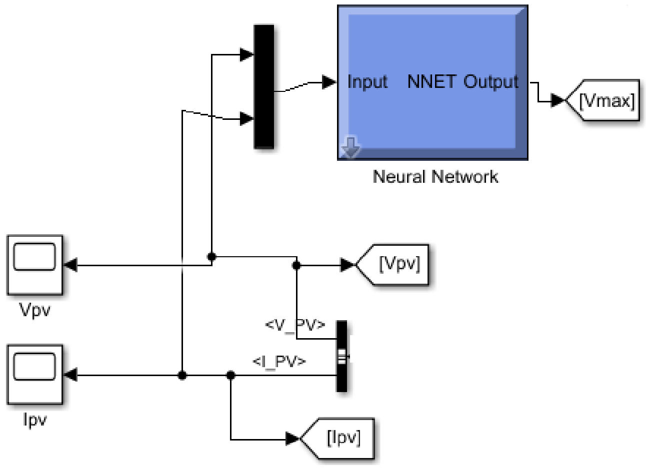

Figure 4 Subsystem of ANN based system

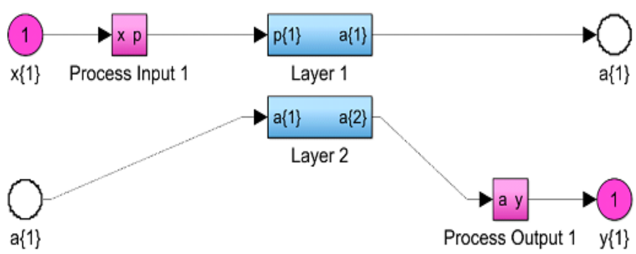

Figure 5 Layers used in subsystem of ANN based system

4. SIMULATION AND RESULTS

To validate the effectiveness of the FL speed controller for the FSTP based-IM drive using ANN, a simulation model is built by MATLAB/Simulink. The dynamic performance of the proposed IM drive system has been examined as shown in figure6.

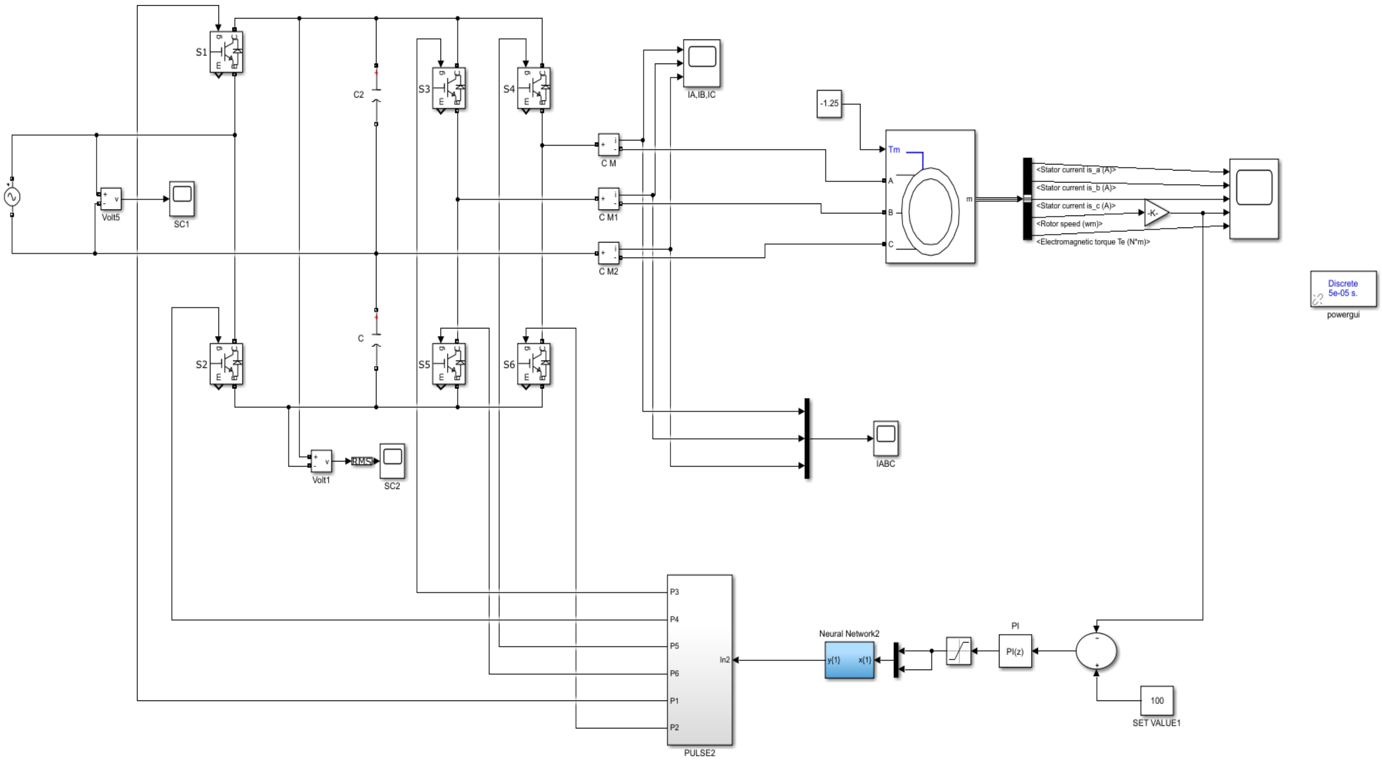

Figure 6 speed controller for the ANN based-IM drive

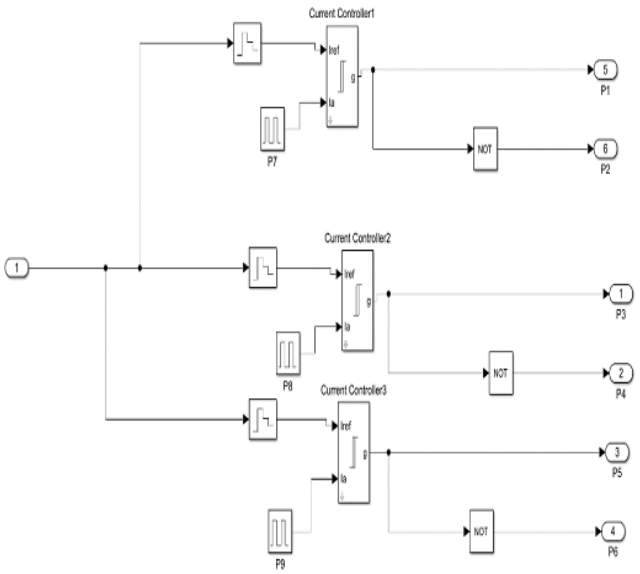

Figure 7 Pulse Generation

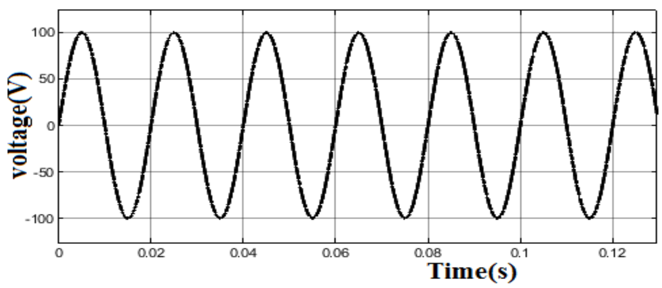

Figure 8 Input voltage

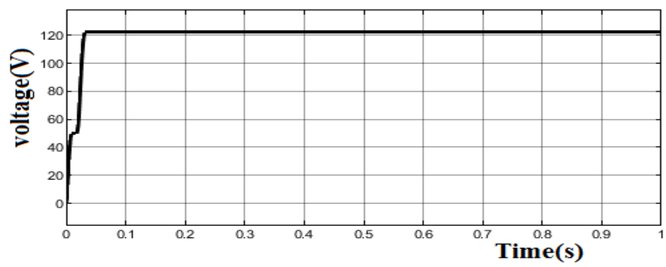

Figure 9 RMS voltage at input

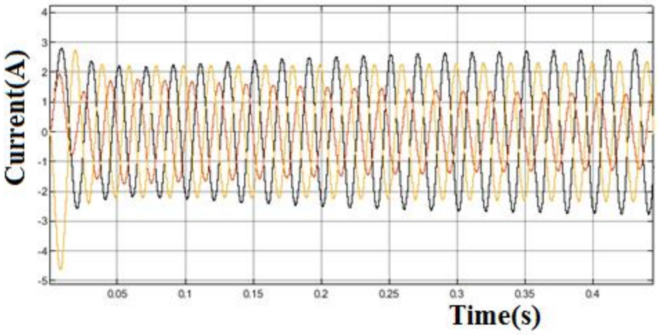

Figure 10 Output current at Inverter

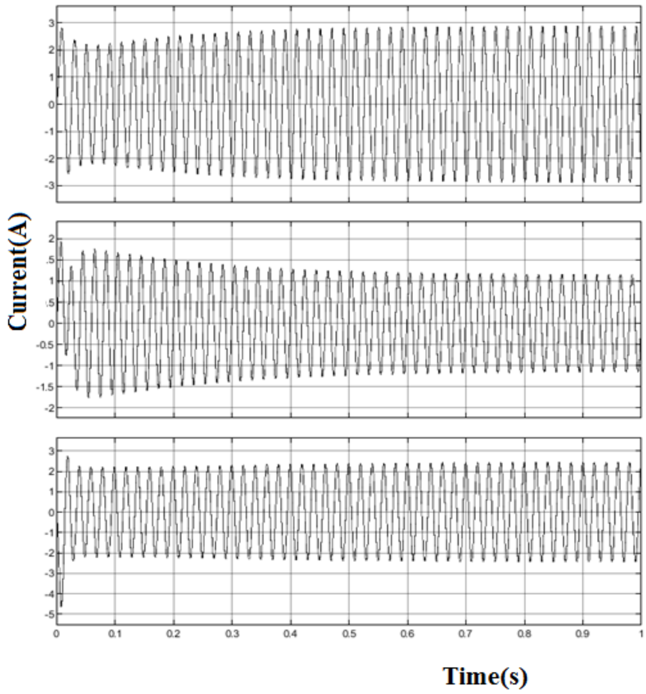

Figure 11 Output current at Inverter(each phase)

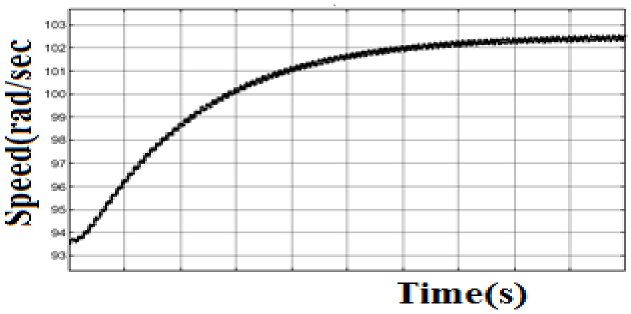

Figure 12 Motor speed

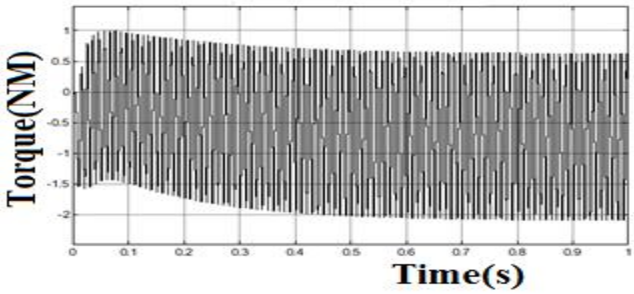

Figure 13 Electromagnetic Torque

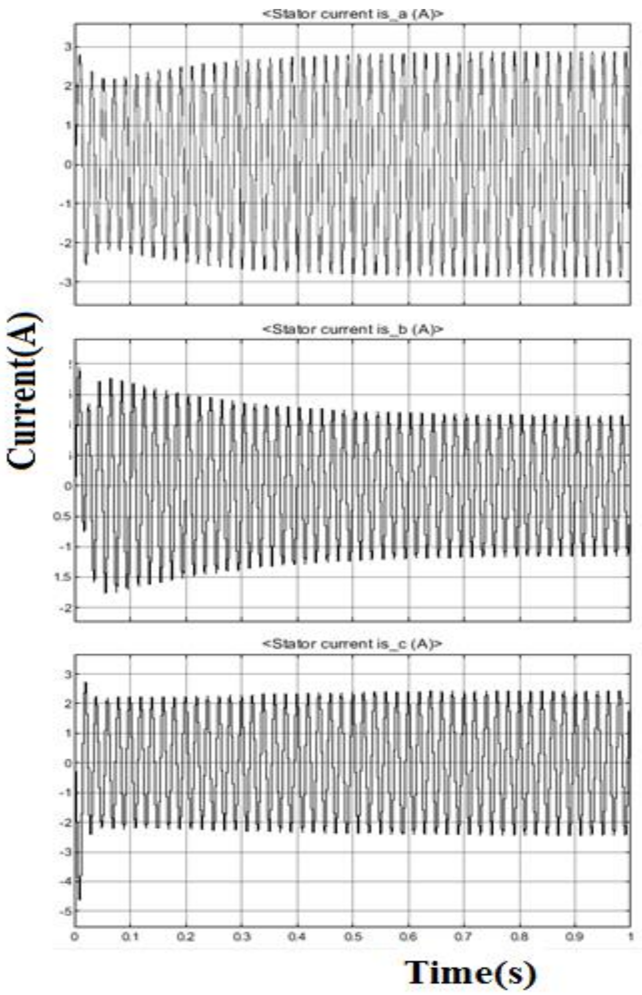

Figure 14 Stator Current at each phase

5. CONCLUSION

In this paper an ANN based four-switch three-phase (FSTP) inverter for induction motor drive was designed and simulated. The dynamic speed reaction of the IM drive at low speeds is improved utilizing the ANN which is outlined with low calculation weight to be proper for continuous applications. The robustness of the controllers has been inspected under parameters variety, particularly motor inactivity, and stator and rotor protections.

REFERENCES

[1] Mohamed S. Zaky,Member,IEEE,and Mohamed K Metwaly, "A Performance Investigation of a Four-Switch Three Phase Inverter – Fed IM Drives at Low Speeds Using Fuzzy Logic and PI Controllers," IEEE Transactions on Power Electronics, vol. 32, no.5, May. 2017.

[2] H. W. van der Broeck and J. D. van Wyk, "A comparative investigation of three-phase induction machine drive with a component minimized voltage fed inverter under different

control options," IEEE Trans. Ind. Appl., vol. IA-20, no. 2, pp. 309–320, Mar./Apr. 1984.

[3] C. B. Jacobina, M. B. R. Correa, E. R. C. da Silva, and A. M. N. Lima, "Induction motor drive system for low power applications," IEEE Trans. Ind. Appl., vol. 35, no. 1, pp. 52–61, Jan./Feb. 1999.

[4] C.-T. Lin, C.-W.Hung, and C.-W. Liu, "Position sensorless control for four-switch threephase brushless DC motor drives," IEEE Trans. Power Electron., vol. 23, no. 1, pp. 438–444, Jan. 2008.

[5] S. B. Ozturk, W. C. Alexander, and H.A. Toliyat, "Direct torque control of four-switch brushless DC motor with non-sinusoidal back EMF," IEEE Trans. Power Electron., vol. 25, no. 2, pp. 263– 271, Feb. 2010.

[6] C. Xia, Z. Li, and T. Shi, "A control strategy for four-switch three-phase brushless DC motor using single current sensor," IEEE Trans. Ind. Electron., vol. 56, no. 6, pp. 2058–2066, Jun. 2009.

[7] M. Masmoudi, B. El Badsi, and A.Masmoudi, "DTC of B4-Inverter Fed BLDC motor drives with reduced torque ripple during sector-to sector commutations," IEEE Trans. Power Electron., vol. 29, no. 9, pp. 4855–4865, Sep. 2014.

[8] K. D. Hoang, Z. Q. Zhu, and M. P. Foster, "Influence and compensation of inverter voltage drop in direct torque-controlled four-switch three-phase PM brushless AC drives," IEEE Trans. Power Electron., vol. 26, no. 8, pp. 2343–2357, Aug. 2011.

[9] B. El Badsi, B. Bouzidi, and A. Masmoudi, "DTC scheme for a four switch inverterfed induction motor emulating the six-switch inverter operation," IEEE Trans. Power Electron., vol. 28, no. 7, pp. 3528–3538, Jul. 2013.

[10] S. Dasgupta, S. N. Mohan, S. K. Sahoo, and S. K. Panda, "Application of four-switchbased three-phase grid-connected inverter to connect renewable energy source to a generalized unbalanced micro grid system," IEEE Trans. Ind. Electron., vol. 60, no. 3, pp. 1204–1215, Mar. 2013.

BIOGRAPHIES

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