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SPEED CONTROL OF INDUCTION MOTOR USING ARTIFICIAL NEURAL NETWORK.

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Abstract
An induction motor (IM) is a type of asynchronous AC motor where power is supplied to the rotating device by means of electromagnetic induction. An electric motor converts electrical power to mechanical power in its rotor. In this paper speed controller for an induction motor has been developed using feed forward artificial neural network.
Keywords: Artificial Neural Network (ANN), Induction Motor, Sampling Frequency

The key goal of this work is the creation of a general purpose motor velocity estimator based on the dynamic equations of the motor induction. This technique is presented to estimate Induction velocity motor ANNs to use. These schemes, in contrast to other speed estimation circuits, are not specific, control techniques like vector control or some form of adaptive control. This scheme could instead be used as a shaft encoder, depending on the control algorithm.

2 Mathematical model for Induction Motor

D-q axis dynamic equations are given for the cage squirrel induction motor [l]

$$V = AI$$

$$V = \begin{bmatrix} V_{sd} & V_{sq} & 0 & 0 \end{bmatrix}^T$$

$$A = \begin{bmatrix} R_s + pL_s & 0 & pL_m & 0 \\ 0 & R_s + pL_s & 0 & pL_m \\ pL_m & \omega_r L_m & R_s + pL_r & \omega_r L_r \\ -\omega_r L_m & pL_m & -\omega_r L_r & R_s + pL_r \end{bmatrix}$$

The above-mentioned equations include the stator quantities, r indicates the quantity of the rotor, q and d correspond respectively to the quadrature and direct axis amounts and L are the inductance magnetising.. That can be seen that in (l), We only have 3 unknown circuit parameters where the stator and stator currents are known. , and . We can thus solve for Only with regard to the stator amounts. The rotor currents are first obtained as stator quantity functions and The rotor currents are not available in an Induction motor squirrel cage from the two first rows of (l). The expressions for and are obtained as

$$i_{rd} = \frac{1}{L_m}\left[\int \left(V_{sd} - R_s i_{sd}\right) dt - L_s i_{sd}\right] \qquad (4)$$

$$i_{rq} = \frac{1}{L_m}\left[\int \left(V_{sq} - R_s i_{sd}\right) dt - L_s i_{sq}\right] \qquad (5)$$

We can substitute (5) and (6) in Two last rows of (1) and obtain two expressions for the rotor speed as

$$\omega_r = \frac{-\left[\sigma^2 \frac{di_{sd}}{dt} - R_r L_s i_{sd} + R_\tau \int v_{xd} dt + L_r v_{xd}\right]}{\sigma^2 i_{sq} + L_r \int v_{xq} dt} \qquad (6)$$

$$\omega_r = \frac{\left[\sigma^2 \frac{di_{sq}}{dt} - R_r L_s i_{sq} + R_r \int v_{xq} dt + L_r v_{xq}\right]}{\sigma^2 i_{sd} + L_r \int v_{xd} dt} \qquad (7)$$

Where, and The pace of the induction motor can be restored (7) or (8). These two equations have unique characteristics for normal motor induction operation, however. The numerator and denominator of any equation can be seen in this. The signals provided by the numerator and denominator equation are from the same process, leading to simultaneous null crosses.. Equation (8) It also makes a related storey, but it is moved by both ways .The numerator and denominator for equation is observed (8) lead those for equation (7) by . This suggests that we can treat them like and components of a vector or space phasor quantity. Thus equations (7) and (8) The component of the direct axis and the component of the square axis which be mixed by treatment of one. This gives the final expression of pace:

$$\omega_r = \frac{\left(\sigma^2 p - R_r L_s - R_s L_r - \frac{R_s R_r}{p}\right)\bar{I}_s + \left(L_r + \frac{R_r}{p}\right)\bar{V}_s}{j\left[\left(\sigma^2 - \frac{R_s L_r}{p}\right)\bar{I}_s + \frac{L_r}{p}\bar{v}_s\right]} \qquad (8)$$

where and Reflect vector current stator and vector voltage stator. These are provided by

$$\bar{I}_s = i_{sd} + ji_{sq} \qquad (9)$$

$$\bar{v}_s = v_{sd} + jv_{sq} \qquad (10)$$

Note that the R.H.S. of equation (9) is complex and the speed would be given as the modulus of the equation. The Induction velocity motor can be achieved in another manner by simultaneously resolving the motor-induction dynamical equations to obtain and But, if there are sinusoidal current and tensions assumed, both the numerator and denominator are set to zero. and But, if there are sinusoidal current and tensions assumed, both the numerator and denominator are set to zero, If there is a presupposition between sinusoidal currents and voltages. For non-sinusoidal currents and voltages, such as inverter operations [ll], non-zero values are obtained. Therefore, the utility of this method is minimal and not very general.

3 Motor Speed Estimation

For an ANN to approximate a function, it is important to have the function squarely integrated into the hypercube n-dimensional unit. Obviously, neither (7) nor (8) satisfies this condition since the two equations are singular. It would therefore be pointless to ask the ANN to consider the Quantities of one of these equations on the right side. This is not an issue there are in (9), But compared to the other two, this mechanism is more complex This paper proposes two types of schemes -one for the singular functions given in (7) and (8), and the other for the function given in (9).The induction motor parameters used in the following methods shall be defined In the appendix. The fundamental problem in the ANN training in induction motor recognition The functional connection between speed and stator parameters is speed The effect is very complicated, with the large number of training vectors required. Thus, it becomes difficult for the commercially available ANN softwares to handle the large data files involved. Also, the training times involved on a PC become quite substantial. . The whole drive mechanism was simulated with the ANN to avoid issues with massive data files and significant training times. The simulation used a multi-layer neural back propagation network and used the sigmoid feature as the non-linear part. An external parameter file will describe the ANN structure The General Lord of the Delta given by,

$$\Delta w_{ji}(n) = \alpha \Delta w_{ji}(n-1) + \eta \delta_j(n) y_i(n) \qquad (11)$$

was used to update the weights, and both the learning rate and the momentum parameter can be defined in the external parameter file. The training vectors were created online so that training data on the disc could not be stored.

4 Estimation of motor speed using ANN

The basic principle of this approach is to divide the key feature into smaller features that have singularities (or poles).

There are no peculiarities and small ANNs need to be trained to distinguish these minor roles.

By eliminating single points or poles of the primary function, the optimal output can be achieved from the outputs of these ANN's. Having regard to their numerators and denominators independently is one of the easiest ways to split the roles. The equations (7) and (8) can be defined as numerators and denominators as respectively

$$N_1 = -\left[\sigma^2 \frac{di_{sd}}{dt} - R_r L_s i_{sd} + R_r \int v_{xd} dt + L_r v_{xd}\right] \qquad (12)$$

$$D_1 = \sigma^2 i_{sq} + L_r \int v_{xq} dt \qquad (13)$$

$$N_2 = \left[\sigma^2 \frac{di_{sq}}{dt} - R_r L_s i_{sq} + R_r \int v_{xq} dt + L_r v_{xq}\right] \qquad (14)$$

$$D_2 = \sigma^2 i_{sd} + L_r \int v_{xd} dt \qquad (15)$$

You may train ANNs in N1 and D1 N2 or The Other Approximates (equation 8). A filter that separates the numerator and denomination into non-null spaces will transfer the results of these ANNs.

4.1 Results and Discussions

If the feature is integratable in the n-dimensional unit hypercube, an ANN will approximate a function. The equation of rotor speed doesn't meet this requirement since it is unique.

Thus, in present work A method for estimating the was proposed speed by ANN using the singular rotor speed equation. The parameters of the Used induction motor in this method are given in Table 1.

Table 1 Induction motor parameters

Parameter	Value
Stator Inductance	0.1004
Rotor Inductance	0.0969
Magnetizing Inductance	000915
Rotor Resistance	1.294 Ω
Sampling Frequency	10 KHz

As we have used ANN to detect the speed of rotor, such that the rotary xy frame is approximated by a speed sensor less induction drive. There is also no requirement for further non-linear preprocessing. The Four filtered xy signals used in this work do not draw on the precision of a flux observatory. Thus, the use of available

ANN software will not be able to handle this problem. So, We have got this job implementing the whole model in MATLAB. For this Electrical toolbox and ANN toolbox have been used. A feed forward neural network has been used in the simulation. Figure 4.1 Displays the block diagram the implemented model.

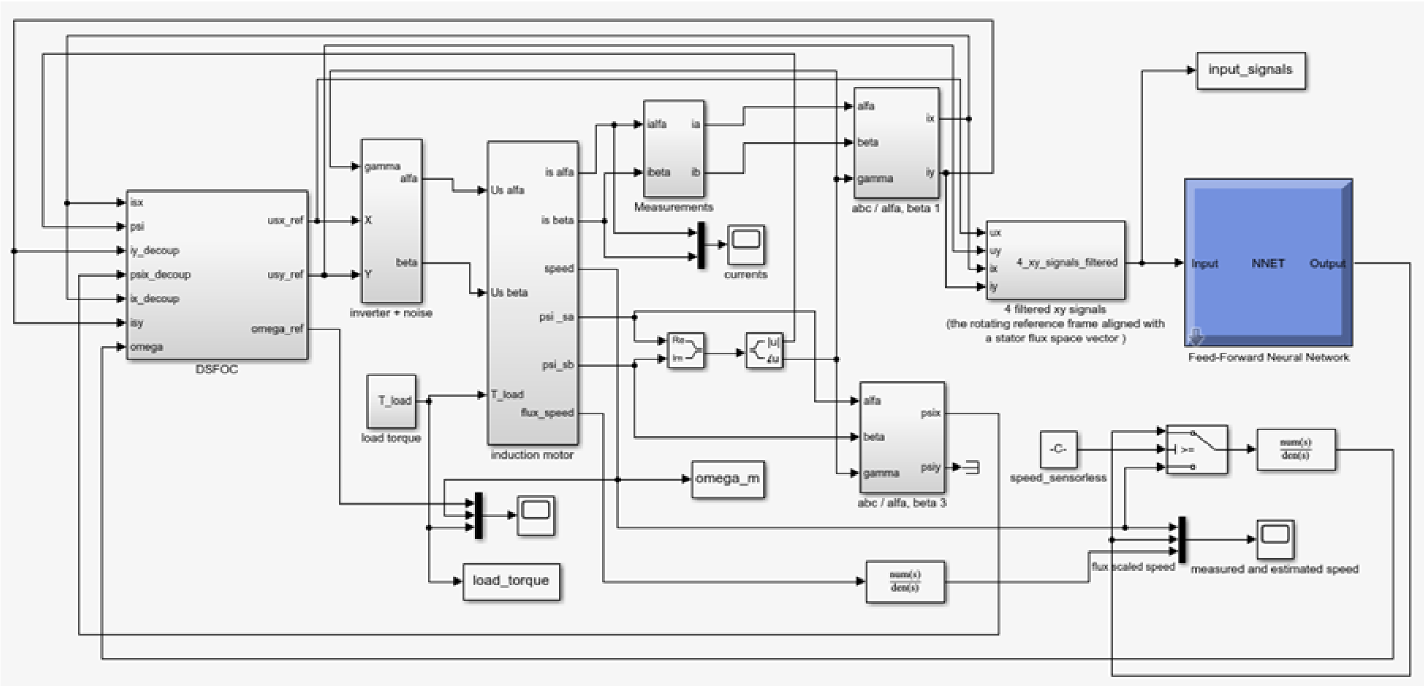

Figure 2 Block Diagram of Model Implemented in Simulink

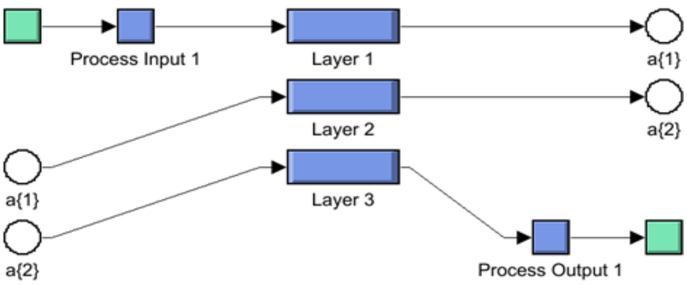

Figure 3 Feedforward ANN used in Present Work

As we have used ANN to detect the speed of rotor, such that the rotary xy frame is approximated by a speed sensor less induction drive. There is also no requirement for further non-linear preprocessing. The Four filtered xy signals used in this work do not draw on the precision of a flux. Thus, results in reduced computational and hardware complexity.

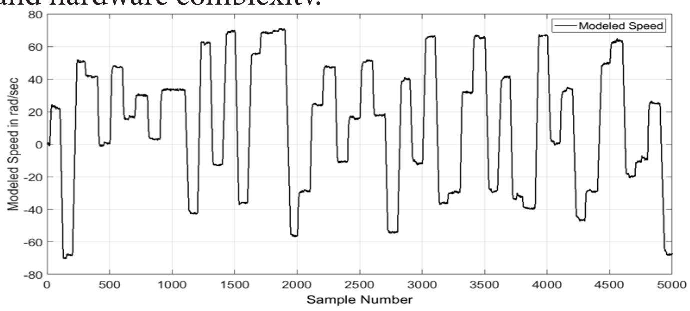

Figure 4 Modeled Speed of Induction Motor

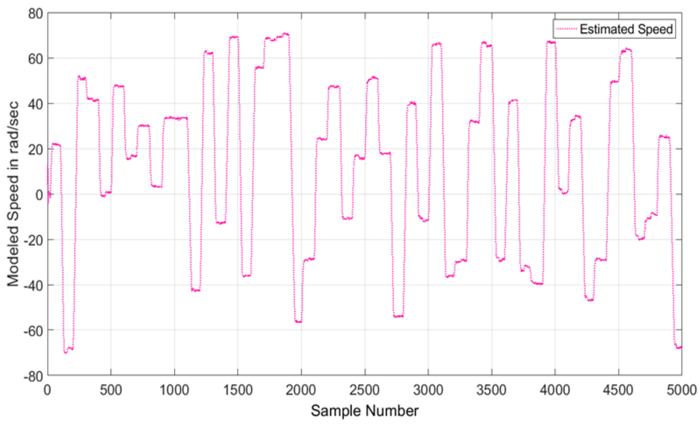

Figure 5 Estimated Speed of Induction Motor

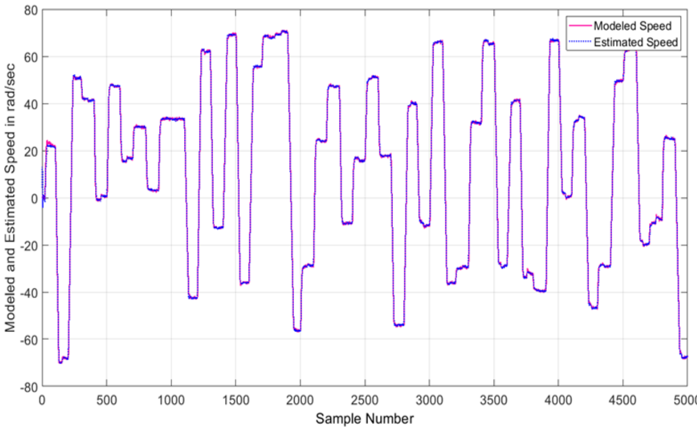

Figure 6 Comparison of Modeled and Estimated Speed of Induction Motor

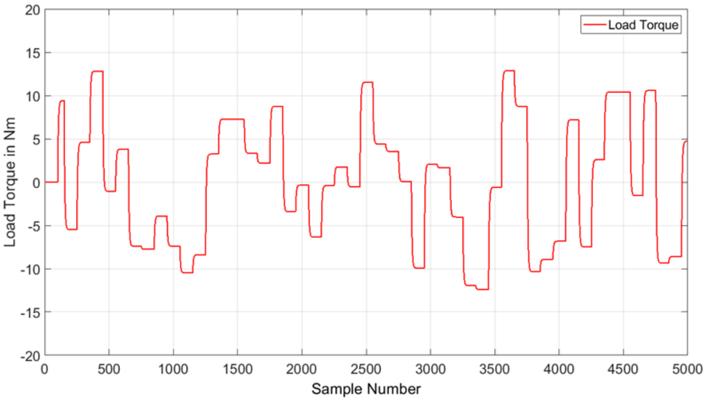

Figure 7 Variation of Torque of Induction Motor

Figures 3 and 4 show the variation modeled and estimated speed of the induction motor. The comparison of these speeds has been shown in Figure 5. Torque variation of the induction motor is shown in figure 6. The rotor speed equation was divided into its numerator and denominator during the proposed work. As seen in Figure 2 the numerator and denominator is added to ANN. The input to ANN is applied after passing through the xy signal filter 250 random input signals were trained for ANN. Comparisons have shown that in calculating the induction motor rpm, the proposed model was nearly 98 percent precise. It has been inferred from general simulation findings that the suggested ANN teaching approach by the denominator and numerator functions independently results in very good results. It contributed to this. The speed recovery with a high level of accuracy by training ANN and the application of the filter at the input of ANN. Thus, the modeled device can be deployed for real-time applications by using appropriate dedicated ANN hardware or by using an application specific integrated gate array.

5. Conclusion

An induction motor (IM) is a type of asynchronous AC motor where power is supplied to the rotating device by means of electromagnetic induction. The use of available ANN software will not be able to handle this problem. So, in this work we have implemented the whole model in MATLAB. For this Electrical toolbox and ANN toolbox have been used. The results shows the variation of modeled and estimated speed of induction motor. From the comparison of these speeds, it has been concluded that the proposed model has almost 98% accurate in estimating the speed of the induction motor. The simulation results it has been concluded that proposed method of training ANN separately by the numerator and denominator functions results in fairly good results. By training ANN in this manner and the use of filter at input of ANN has resulted in the speed recovery with a high degree of accuracy. In future it could be implemented on field programmable gate array the modeled system for real time applications.

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