Speed Control of Induction Motor using Artificial Neural Network

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Abstract— I carried a project on Neural Network based Speed Control of Induction Motor. The scheme consists of a neural network controller, a reference model, and an algorithm for changing the NN weights in order that the speed of the drive can track of the reference speed. In recent years artificial neural networks (ANNs) have gained a wide attention in control applications. It is the ability of the artificial neural networks to model nonlinear systems that can be the most readily exploited in the synthesis of non-linear controllers. Artificial neural networks have been used to formulate a variety of control strategies. A qualified speed tracking and load regulating responses can be obtained by the proposed controller. I will use MATLAB Simulink models, ANN blocks or programs for intelligent and nonlinear control.

Key words: Speed Control, Induction Motor, Artificial Neural Network

I. INTRODUCTION

AC motors, particularly the squirrel-cage induction motor, having a several inherent advantages like simplicity, reliability, low cost and virtually maintenance-free electrical drives. However, for high dynamic performance industrial applications, their control remains a challenging problem. Consequently, performance deteriorates and a conventional controller such as a PID is unable to maintain satisfactory performance under these conditions. Recently, there has been observed an increasing interest in combining artificial intelligent control tools with classical control techniques.

I am going to use latest state of art technology i.e. ANN. The principal motivations for ANN approach is that, uncertainty or unknown variations in plant parameters and structure can be dealt with more effectively, hence improving the robustness of the control system.

II. RECENT TECHNIQUES FOR SPEED CONTROL OF INDUCTION MOTOR

A. Neural Network Speed Controller for Induction Motor Based On Feedback Linearization

The scheme consists of a neural network controller, a reference model, and an algorithm for changing the NN weights in order that the speed of the drive can track of the reference speed in the neural network used.

In this paper for control of motor speed only speed error and derivative of speed error is used and error reduction is independent of complicate and dynamics of system that should be controlled. Neural network key part is a feed forward NN with two inputs and one output. NN is divided into three layers, named the input layer with 2 neurons, the hidden layer with 10 neurons, and the output layer with 1 neuron. The activation function of the input neurons is linear while that of the output layer and hidden layer is sigmoidal, The inputs are speed error, e(k) and derivative speed error ce(k)=e(k)-e(k-1) , they are normalized by the scaling factors Ge and Gce and limited before entering in to NN. The output is multiplied by the scaling factor Go and should be tuned so that the desired output can be produced. NN training is aimed at minimizing J cost function:

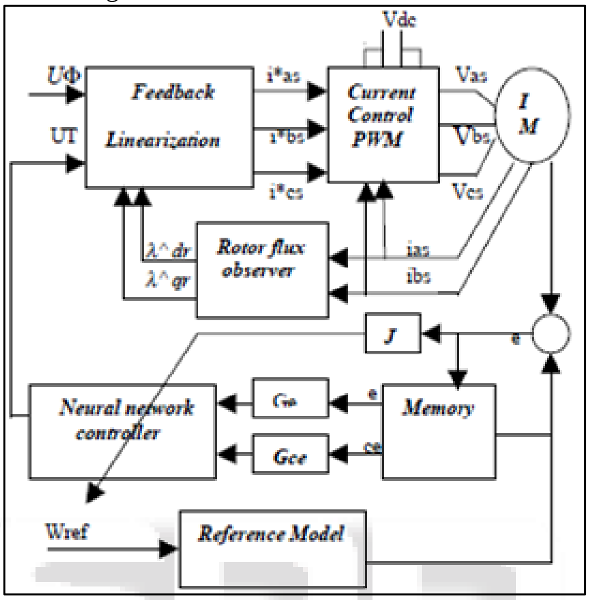


Fig. 1: Neural Network Speed Control System for the Introduction Motor

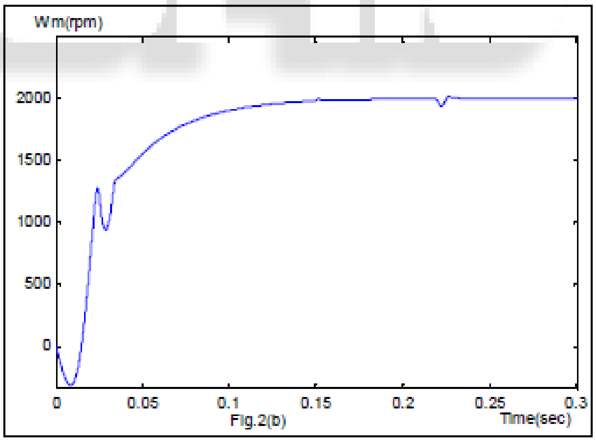


Fig. 2:

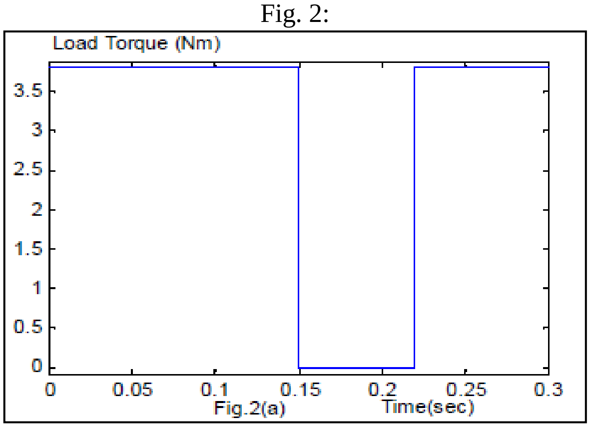


Fig. 3:

B. Adaptive Nonlinear Control of Induction Motor Using Neural Networks

In this papers we propose a new control approach for the induction motor control based on artificial neural networks (ANN) trained online. The two ANN are used for the on-line reconstitution of the state feedback necessary for the FBLC. The training rules used result from a combination between the ANN properties, the adaptive nonlinear control propriety and the nonlinear adaptation rules. Via these three techniques R training rules were extracted, these last transform the tracking errors into a means to adjust the used ANN behaviour so that they adapt with the various operation modes of induction motor. This paper proposes an adaptive control scheme based on ANN trained on-line to reconstitute these feedback states. Indeed, the use of such ANN to control some nonlinear systems permitted to obtain satisfactory performances. To do, a combination between the FLC techniques, the non-linear adaptive control and the ANN properties permitted to extract non-linear adaptation rules allowing the ANN an autonomous training. .To this end, the tracking errors (observed on rotor speed and rotor flux) are transformed via the proposed adaptation rules into a means to adjust, on-line, the ANN behaviors so that they can adapt with the various operation modes of the induction motor.

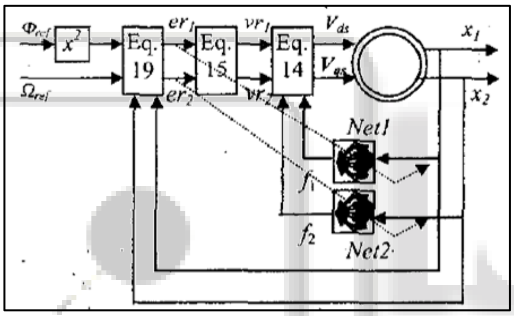


Fig. 4: The ANN Proposed Scheme for the Induction Motor Control

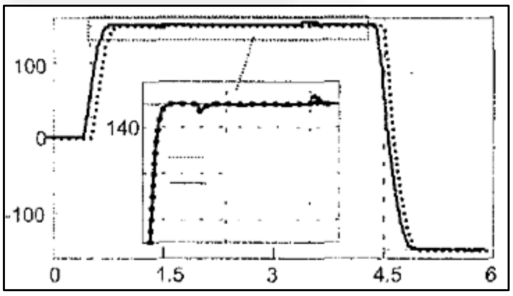


Fig. 5: Evolution of Rotor Speed with Variation of Rotor Resistance

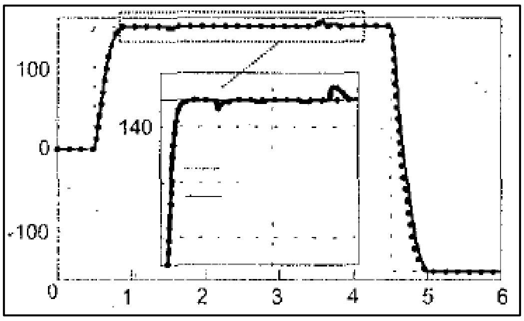


Fig. 6: Evolution of Rotor Speed with Variation of Stator Resistance

C. Sensorless Speed Control of Induction Motor Derives Using a Robust & Adaptive Neuro-Fuzzy based Intelligent Controller

In this paper a novel sensor less adaptive neuro fuzzy speed controller for induction motor derives is formulated here a multilayer perceptron (MLP) neural network with error bakpropagation learning algorithm is designed to estimate velocity. The training algorithm of the NN speed estimator will be as follows.

1) Initially randomize the MLP NN weights between -1 to +1.
2) Obtain the stator voltages with two delays and currents with three delays.
3) Calculate the error between target, (k) r ω and estimated output, ˆ (k) r ω.
4) Adjust the weights of the NN.
5) Calculate the output of the NN, ˆ (k)
6) Repeat 2nd step.

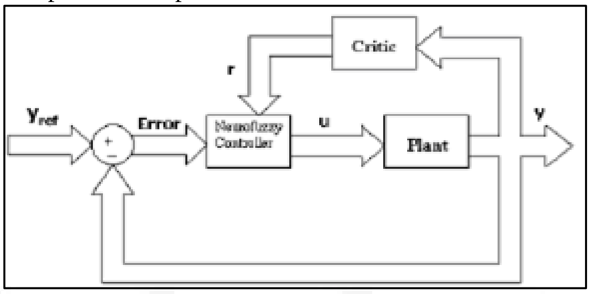


Fig. 7: Block Diagram of Adaptive Neurofuzzy Controller

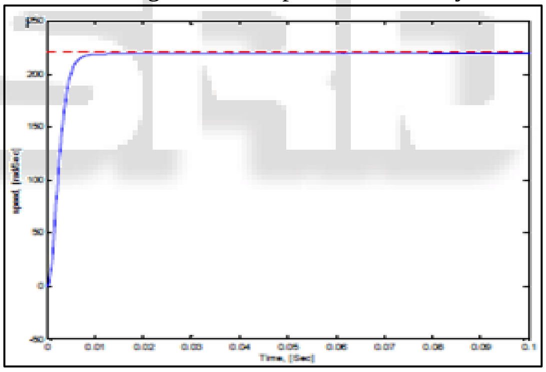


Fig. 8: Speed Response when Speed Command is set as 220rad.s

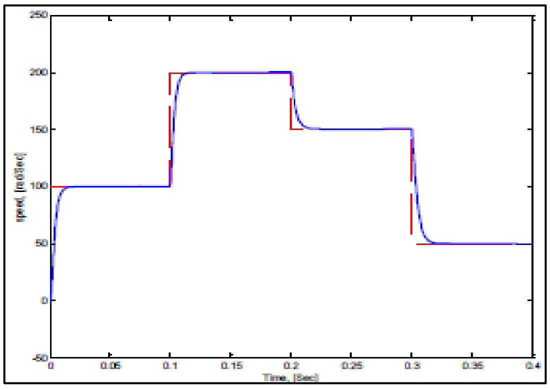


Fig. 9: Speed Response when Speed Command is Changed

III. Speed Control of Induction Motor Drive Using Universal Controller

This paper is divided into two parts. The first part is the MATLAB Simulink simulation. The second part is the hardware implementation of the developed circuit

A. *MATLAB Simulink Simulation*

The circuit shown in Fig. 2 is simulated using MATLAB Simulink's SimPowerSystems software. The absolute circuit consists of a DC Voltage Source, PWM generator, Universal Bridge, Asynchronous machine and a Scope that displays the signals generated throughout the simulation

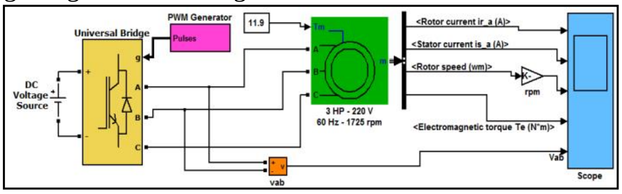


Fig. 10: Complete simulation model in MATLAB Simulink

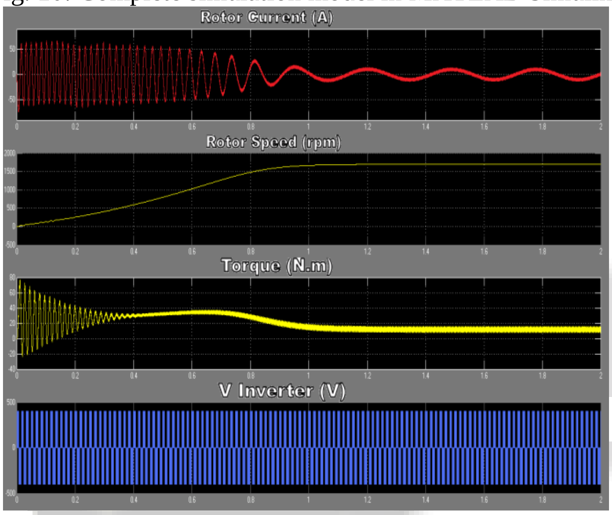
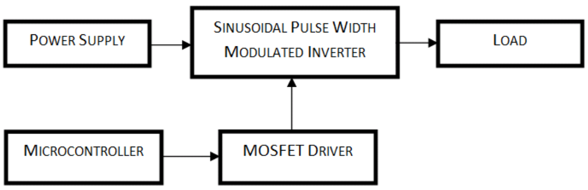


Fig. 11: Simulation waveforms at m = 0.8 at constant load of 11.9N-m

B. *Hardware Implementation*

The block diagram of hardware implementation shown below.



The following test was conducted in the laboratory. A fan load was connected at the output of the inverter and the modulation index was varied using the selector switch.
Input voltage: 100V DC
Output voltage: Single-phase 100V
Induction Motor rating: - 100V, 15/14W, 50/60Hz
Switching frequency: Variable frequency, Variable duty-cycle
PIC controls: AT89C52-24PI

Modulation Index	Frequency (Hz)	Speed (rpm)	Inverter Output (VAC)
0.4	20	268	49.3
0.5	25	401	60.7
0.6	30	537	69.6
0.7	35	676	78.6
0.8	40	932	88.1
0.9	45	1071	92
1	50	1404	100.2

IV. Conclusion

In our project we successfully made several modal which gave us step by step inside into the ANN based speed control of Induction Motor. We were successful in achieving the final results and during the course of project we learned several features of MATLAB such as, working in Simulink with modals, command line programs, ANN commands, and successful modeling techniques.

Results of ANN based control were similar to PI controller. ANN control is adaptable control hence it can be trained for any task. It is flexible also and does not need any hardware configuration changes.

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