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Control of Active and Reactive Powers Of The DFIG By Neural Network Technology

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Abstract: Artificial intelligence (AI) techniques, particularly the neural networks, are recently having significant impact on power electronics and motor drives. Neural networks have created a new and advancing frontier in power electronics, which is already a complex and multidisciplinary technology that is going through dynamic evolution in the recent years. in This paper I use this techniques for control of power active and power reactive of the DFIG and perspective of neural network applications in the intelligent control [5]. in this paper include direct control of active power and reactive power. Additional selected applications in the literature are included in the references. From the current trend of the technology, it appears that neural networks will find widespread applications in power electronics

Keywords: DFIG, PI, neural controller, power system

I- Introduction:

Neural networks have known for some years growing success in various fields of Engineering Sciences; the electrical engineering is no exception to this rule. Unfortunately, the literature is full of examples where the implementation of neural networks is more a recipe for a reasoned approach. In addition, biological connotations of neural networks, and the use of the term learning, often brought great confusion; they led to connect abusively neural networks in artificial intelligence, while they are fundamentally statistical tools. The aim of this chapter is to show how, from the fundamentals, it is possible to achieve genuine methodology implementation, in particular in the modeling framework of the process. We show in particular that, contrary to widespread belief, neural networks are not necessarily black boxes. On the contrary, it is perfectly possible, and even highly recommended to introduce into the neural network, from its conception, all mathematical knowledge available regarding the process to be modeled or control.[1]

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II- **The DFIM Modeling**:

The classical electrical equations of the DFIG in the Park frame are written as follows

$$\begin{cases} v_{ds} = R_s i_{ds} + \frac{d\varphi_{ds}}{dt} - \omega_s \varphi_{qs} \\ v_{qs} = R_s i_{qs} + \frac{d\varphi_{qs}}{dt} - \omega_s \varphi_{ds} \\ v_{dr} = R_r i_{dr} + \frac{d\varphi_{dr}}{dt} - (\omega_s - \omega_r)\varphi_{qr} \\ v_{qr} = R_r i_{qr} + \frac{d\varphi_{qr}}{dt} - (\omega_s - \omega_r)\varphi_{dr} \end{cases} \quad (1)$$

The stator flux can be expressed as:

$$\begin{cases} \varphi_{ds} = L_s i_{ds} + L_m i_{dr} \\ \varphi_{qs} = L_s i_{qs} + L_m i_{qr} \end{cases} \quad \textbf{(2)}$$

The rotor flux can be expressed as:

$$\begin{cases} \varphi_{dr} = L_r i_{dr} + L_m i_{ds} \\ \varphi_{qr} = L_r i_{qr} + L_m i_{qs} \end{cases} \quad \textbf{(3)}$$

The active and reactive powers at the stator are defined as:

$$\begin{cases} P_s = v_{ds} i_{ds} + v_{qs} i_{qs} \\ Q_s = v_{qs} i_{ds} - v_{ds} i_{qs} \end{cases} \quad \textbf{(4)}$$

The active and reactive powers at the rotor are defined as:

$$\begin{cases} P_r = v_{dr} i_{dr} + v_{qr} i_{qr} \\ Q_r = v_{qr} i_{dr} - v_{dr} i_{qr} \end{cases} \textbf{(5)}$$

The electromagnetic torque is expressed as:

$$C_{em} = P(\varphi_{ds} i_{qs} - \varphi_{qs} i_{ds}) \quad (6)$$

With P is the number of pair poles.

III- the indirect control:

The principle of this method consists in not measuring (or estimating) the amplitude of flux but only its position, the idea is proposed by Hasse[2].

III.1- Active and reactive power strategy of control:

When the DFIM is connected to an existing network, this connection must be done in three steps. The first step is the regulation of the stator voltages with the network voltages as reference. The second step is the stator connection to this network. As the voltages of the two devices are synchronized, this connection can be done without problem. Once this connection is achieved, the third step, is the transit power regulation between the stator and the network[3].

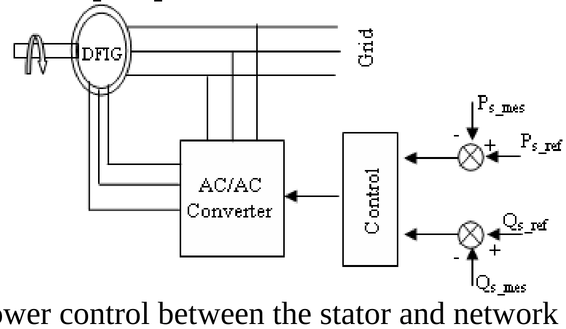

Fig.1.. Power control between the stator and network

Stator courant and rotor courant can be rewritten as follwing:

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$$\begin{cases} I_{ds} = \frac{\varphi_s}{L_s} - \frac{L_m}{L_s} I_{ds} \\ I_{qs} = -\frac{L_m}{L_s} I_{qr} \end{cases}$$
(7)

Stator power and rotor courant can be rewritten as following::

$$\begin{cases} P_s = -vs \frac{L_m}{L_s} I_{qr} \\ I_{qs} = -vs \frac{v_s}{\omega_s L_s} - v_s \frac{L_m}{L_s} I_{dr} \end{cases} \quad (8)$$

Stator voltages and rotor courant can be rewritten as following:

$$\begin{cases} V_{dr} = R_r i_{dr} + L_r \sigma \frac{di_{dr}}{dt} - \omega_r L_r \sigma i_{qr} \\ V_{qr} = R_r i_{qr} + L_r \sigma \frac{di_{qr}}{dt} + \omega_r L_r \sigma i_{dr} + \omega_r \frac{L_m}{L_s \omega_s} v_{qs} \end{cases}$$
(9)

Knowing the relations precedent,it is possible to design the regulators. The global block-diagram of the controlled system is depicted on Figur.4[4]

figure (5.a) represents the active power and the figure (5.b) represents the reactive power of the stator , the figure (5.c) is quadratic in the live and fixed speed rotor currents

interpretation of simulation results:

we note a good continuation of active and reactive power of the stator that is either fixed or variable speed [see figure (5a.5b). it is observed the static error is zero. The currents of the rotor have faster dynamics.

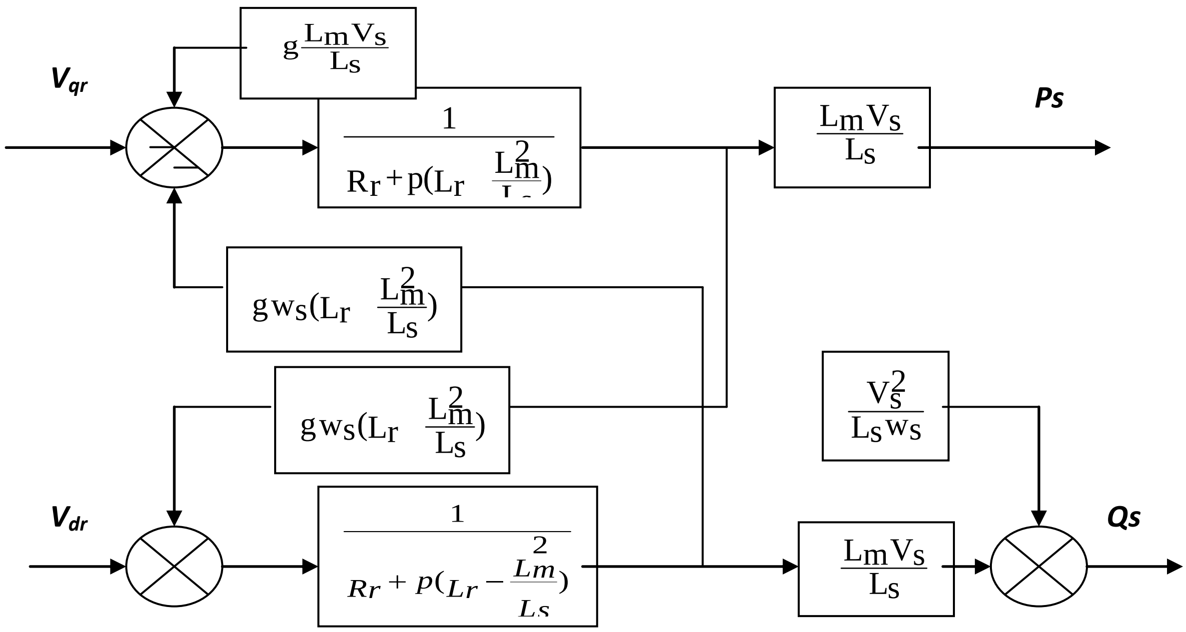

Fig.2 Block diagram of DFIG power control

VI- NEURON NETWORK CONTROL

The idea is to replace the two PI controllers for direct control by neural controllers (RN) simple. For learning, we use retro algorithm propagationof Levenberg-Marquardt (LM) [1].

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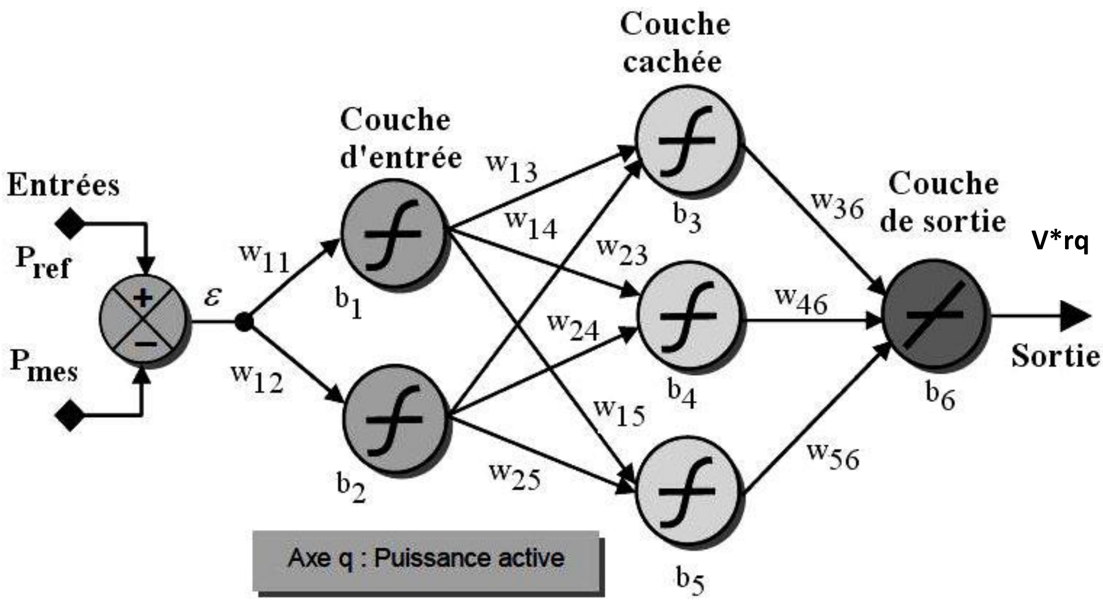
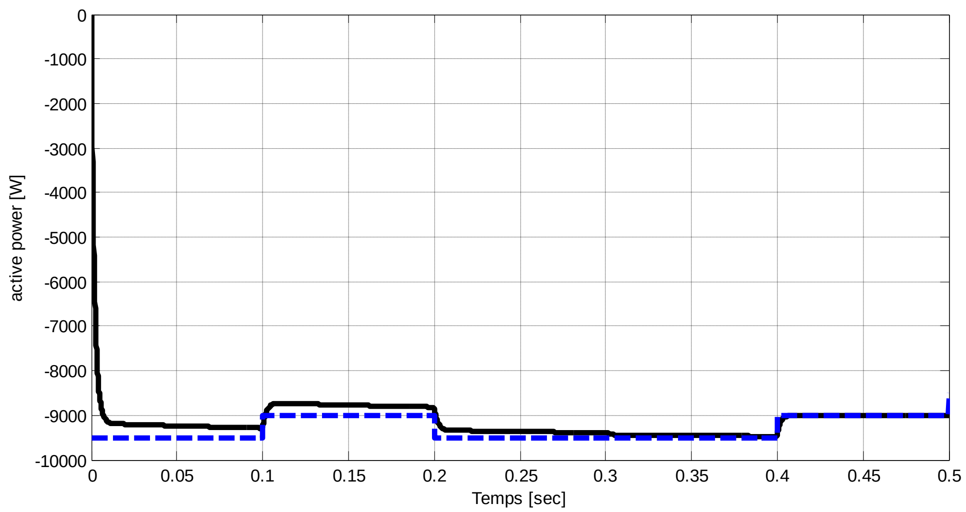


Fig. 3: Multilayer Perceptron: structure(2-3-1) [1]

Each neural network performs a well-defined function depending on the chosen architecture (number of hidden layers and the number of neurons in each hidden layer). The problem is to find a structure that gives better results.

For this, we made several tests to determine the optimal network architecture. The most sensible choice was to take a neural network structure with one hidden layer containing three neurons using the sinusoid activation function, (Fig. 8).

V- results and analysis:



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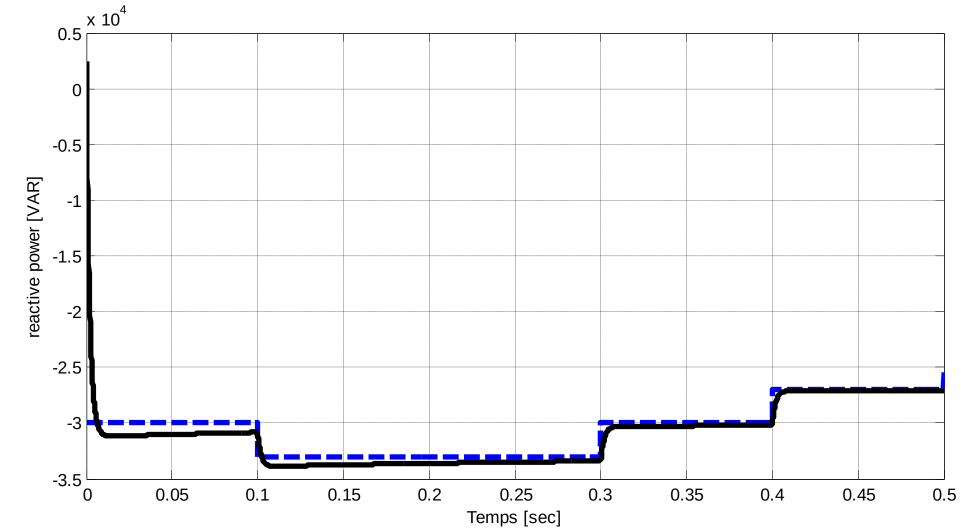

Fig.4. simulation of direct control of active and reactive powers

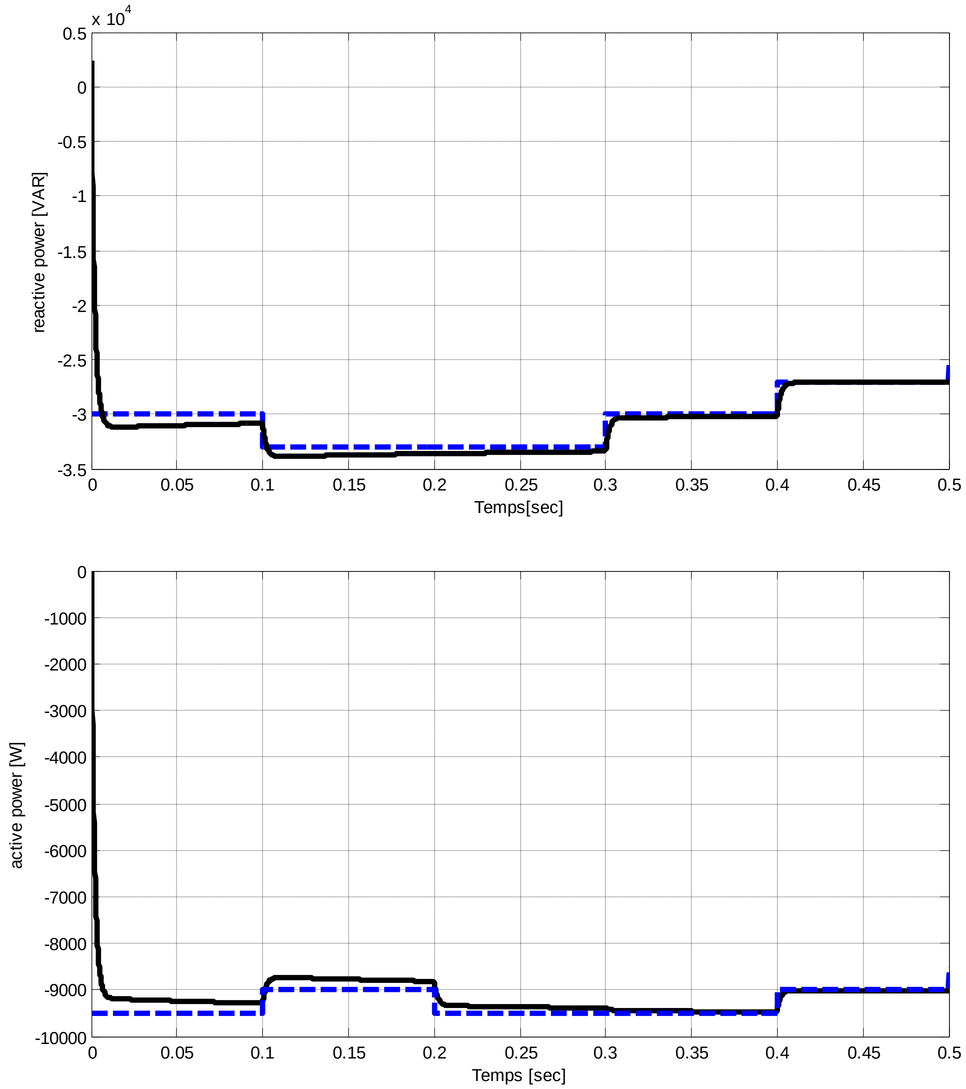

Fig.5. results of neural control

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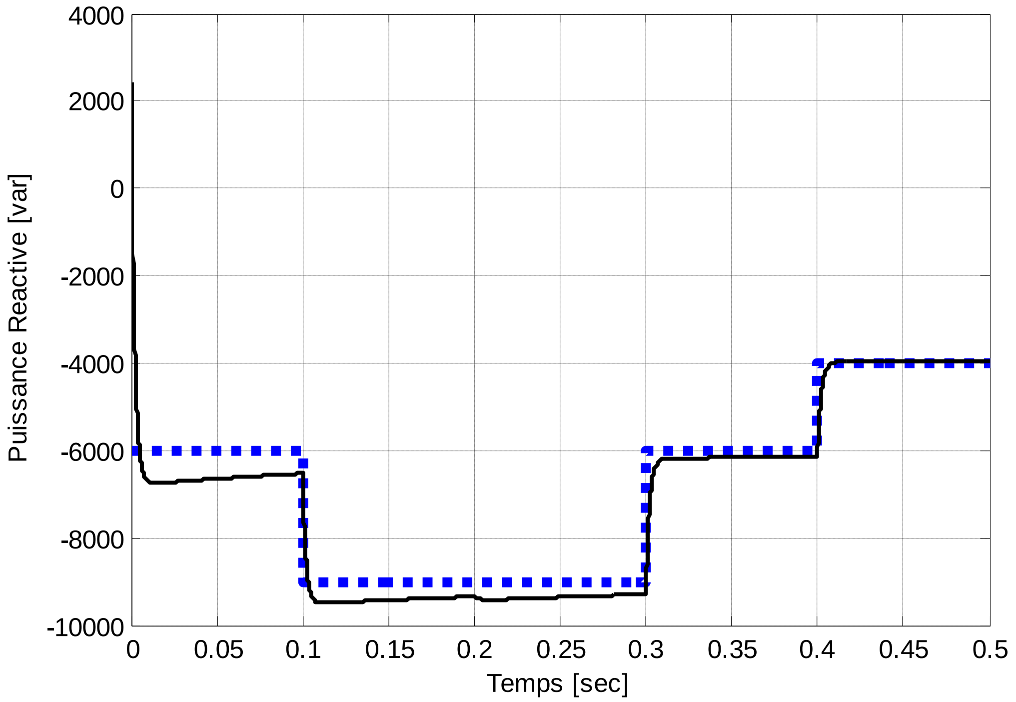

Fig.9 direct control simulation results

Simulation results of the direct control of active and reactive power with neural controllers are given in Figure 9.

The simulation results show good performance in terms of response time and tracking set point for active power and reactive power.

The comparison between the two regulators show that the neural controller has good performance. By cons, for the PI controller, its performance is completely deteriorated.

Conclusion :

The Work done a comparative study of the performance and robustness of Reviewers: Neuronal and PI. Direct vector control of the generator double-fed asynchronous allows for a decoupling and a control independent of the active and reactive power.

the first step, the regulation is made with PI controllers. in the second step , the

command is based on neural networks.

The architecture of restraint neural corrector is 2-3-1. She gave us a hand, to improve the dynamic and static performances of the DFIG and secondly,

to ensure robustness of working of the machine.

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