Artificial Neural Networks for Automatic Classification of Induction Machine Faults

Abla Bouguerne*, Aziz Boukadoum, Mohamed Salah Djebbar

Department of Electrical Engineering, Echahid Cheikh Larbi Tebessi University, Algeria
*Corresponding author's e-mail: bouguerneabla@yahoo.fr

ABSTRACT

In this paper, new classification method of induction motor faults is proposed that permit to give a best solution to the classification problem. This method based on Time–frequency representation for classification of the current waveforms. It is composed of two steps: feature extraction and rule decision. Artificial neural networks (ANN) are used for decision criterion. The diagnosis allows the detection of bearing fault, stator fault and the rotor fault. The flexibility of this method allows an accurate classification independent from the level of load. This method is validated on a 5.5-kW induction motor test bench.

Keywords: Diagnosis; Classification; Induction motor

1 Introduction

In many applications, features are traditionally extracted from standard time–frequency representations. This assumes that the implicit smoothing is appropriate for the classification task. Time–frequency representation (TFR) has been successfully applied for feature extraction of induction machine faults [1]. In this paper, we propose a classification technique based on the design of optimized TFR from a time–frequency ambiguity plane in order to extract the feature vector. The second stage of diagnosis (decision criterion) is achieved by artificial neuronal network [2]. The goal is the realization of an accurate diagnosis system of motor faults such as bearing faults, stator faults, and broken bars rotor faults independent from the level of load.

2 Methodology

The optimal TFR method is applied to diagnose three kinds of induction machine faults, which are the bearing fault, stator fault and rotor fault. Thus, four classes are considered:

1) class of healthy motor
2) class of bearing fault
3) class of stator fault
4) class of broken bars

3 Results and Discussion

All acquisitions are made under steady-state condition over a period of 5s, with a sampling frequency of 20 kHz. Let 100 000 points for each of the measured signals. The data-acquisition set consists of 15 examples of stator current recorded at different load levels (0%, 25%, 50%, 75%, and 100%). Different operating conditions from the machine were considered, namely, healthy, bearing fault, stator fault, and rotor fault. Figure 1 and Figure 2 presents the variation of MSE with the number of hidden neuron for the two stages: training and testing. The training set is carried out on the first ten current signals as shown in Figure 3. The last five current signals are used to test the classification.

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The structure of the network is first defined in Figure 4. In the network, activation functions are chosen and the network parameters, weights and biases, are initialized. The parameters associated with the training algorithm like error goal as shown in Figure 5, maximum number of epochs (iterations), are defined. After the neural network has been determined, the result is first tested by simulating the output of the neural network with the measured input data. This is compared with the measured outputs. Final validation must be carried out with independent data. Figure 6 present the results of ANN classification algorithm with simplified representation of the allocation of new observation to various classes.

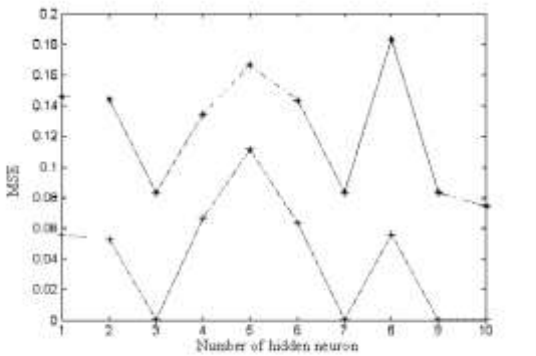

Figure 1: *Variation of MSE with the number of hidden neuron for the two stages: training and testing*

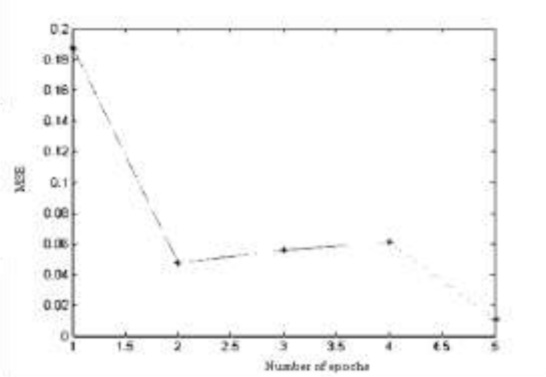

Figure 2: *MSE for testing network chose 7-3*

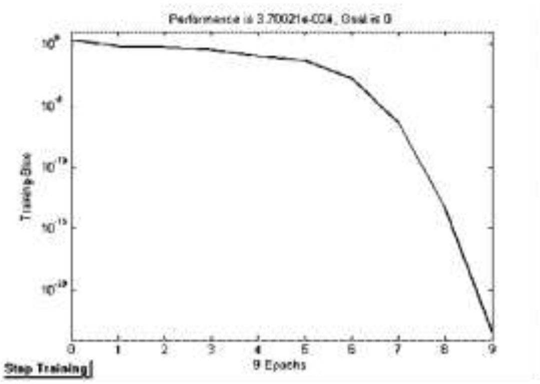

Figure 3: *Learning Network chose 7-3*

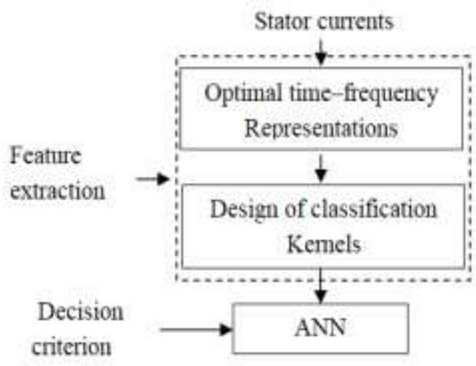

Figure 4: *Classification algorithm*

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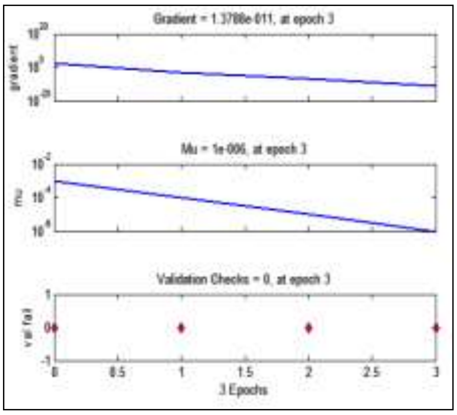

Figure 5: *Simplified representation of the allocation of new observation to various classes*

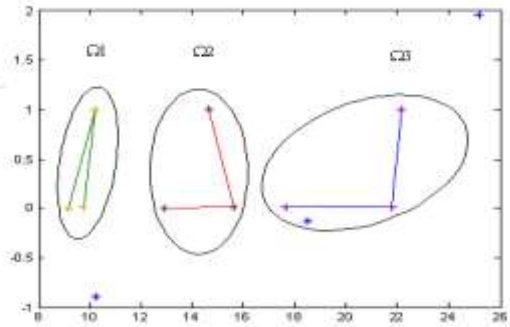

Figure 6: *Training state: parameter representation of back propagation algorithm*

4 Conclusion

In this study we proposed a method for classification induction machine faults based on time-frequency representation and neural network. The first stage of the diagnostic method involves the extraction of feature vector by TFR. The second step is the classification of this feature vector toward appropriate class. This classification is achieved by neural networks. These results verify that the classification method tested with experimental data collected from the stator current measurement at different loads, and with ANN as decision criteria is able to detect and diagnose faults with accuracy, independently of the load condition and the type of the fault.

How to Cite

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