Libya Higher Education Forum
A Vision For the Future

PARAMETER IDENTIFICATION AND CONDITION MONITORING OF INDUCTION MACHINES USING PARTICLE SWARM OPTIMIZATION TECHNIGUE.

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What issue does this research address?

The objective of this research is to employ the Particle Swarm Optimization (*PSO*) to study and analyse the identifiability of the induction motors *IM* parameters based on external measurements. In addition, this approach will be used to indicate the incidence of induction machines' faults and provide information about their nature and location. The proposed parameter identification and condition monitoring technique uses time domain terminal currents and voltages in conjunction with the *PSO* to identify the parameters and indicate the presence of the fault.

What method does this research use?

In this approach, the stator currents are calculated using an *ABCabc* model of the induction motor and compared to the measured currents to find out a set of current errors that are integrated and summed up to give the overall cost function. A stochastic search based on particle swarm optimization (*PSO*) is then carried out to adjust the model parameters off-line in such a way as to minimize the cost function. The new set of parameters provide good information about the location and the nature of the fault.

How does *PSO* work?

The motion for each particle can be determined by the following equations:

$$v_{in}^{k+1} = v_{in}^{k} + c_1 r_1 \left(P_{in}^{k} - x_{in}^{k}\right) + c_2 r_2 \left(g_{in}^{k} - x_{in}^{k}\right)$$

$$x_{in}^{k+1} = x_{in}^{k} + v_{in}^{k+1}.$$

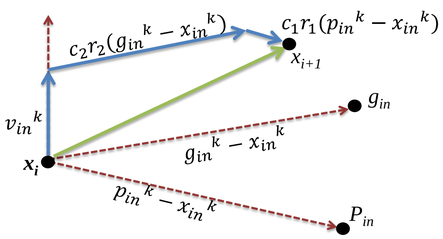


Fig. 1. The three fundamental elements for the calculation of the next displacement of a particle

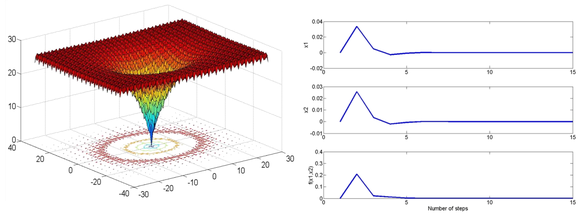


Fig. 2. Ackley function. Minimum 0 at point (0, 0)

How can the research be used?

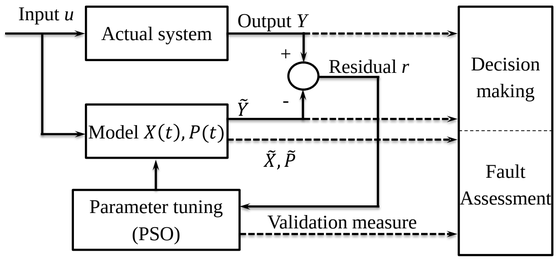
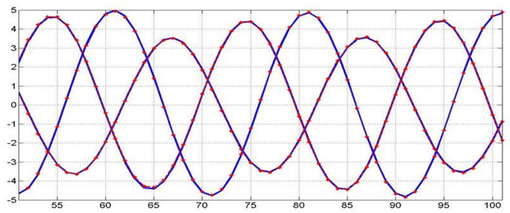


Fig. 3. General structure of Model-based Algorithms.

What results were found to date?

Open-circuited stator winding fault was simulated by adding 5 Ω resistor in series to phase *A* and as a result R_A becomes 4.417+5 = 9.417 Ω. Induction machine model was run with the healthy parameters except $R_A = 9.417\ \Omega$. Then stator currants waveforms were saved and used as measured currents. At slip of 0.1, a steady state data was used and *PSO* was applied to minimize the cost function in order to find the condition of the *IM*.



__ Measured currents, ooo Calculated currents

Fig. 4. Measured and calculated stator currents waveforms using the estimated parameters by PSO.

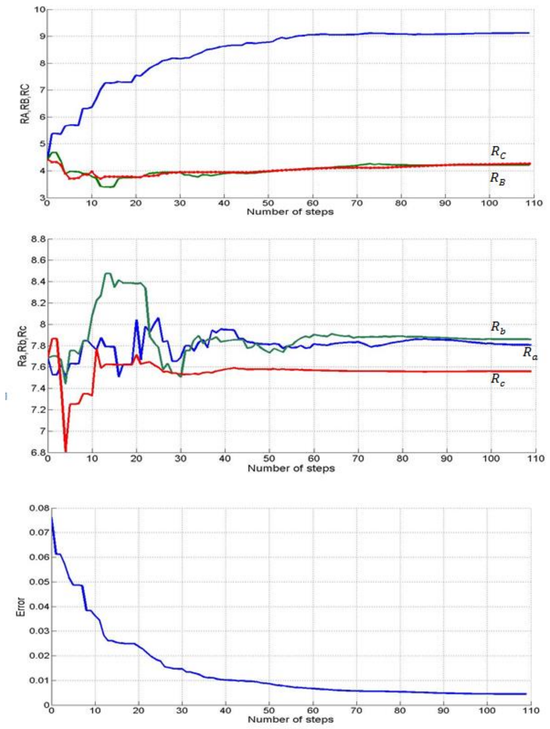


Fig. 4 The estimated parameters and the error function corresponding to the existing best solution of *PSO*.

Who can use the research results?

The research results can be used by Induction machines' manufacturers, operators, and maintenance staff who wish to increase the life span and the reliability of the induction machines and reduce the cost of maintenance.

Conclusion.

The problem of parameter identification of an induction motor based on external measurements using *PSO* has been investigated. In addition, *PSO* was used to detect the presence of a stator developing open-circuited fault based on fault identification technique proposed in Fig. 3. It is clear that, using particle swarm optimization *PSO* based on fault identification technique proposed can provide good information about the nature and the location of the fault. In addition, the stator and rotor resistances identified by this technique are almost similar to the real resistances.