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Diagnosis of Induction Machine Faults using Vibrations Analysis Technique

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INTRODUCTION & AIM

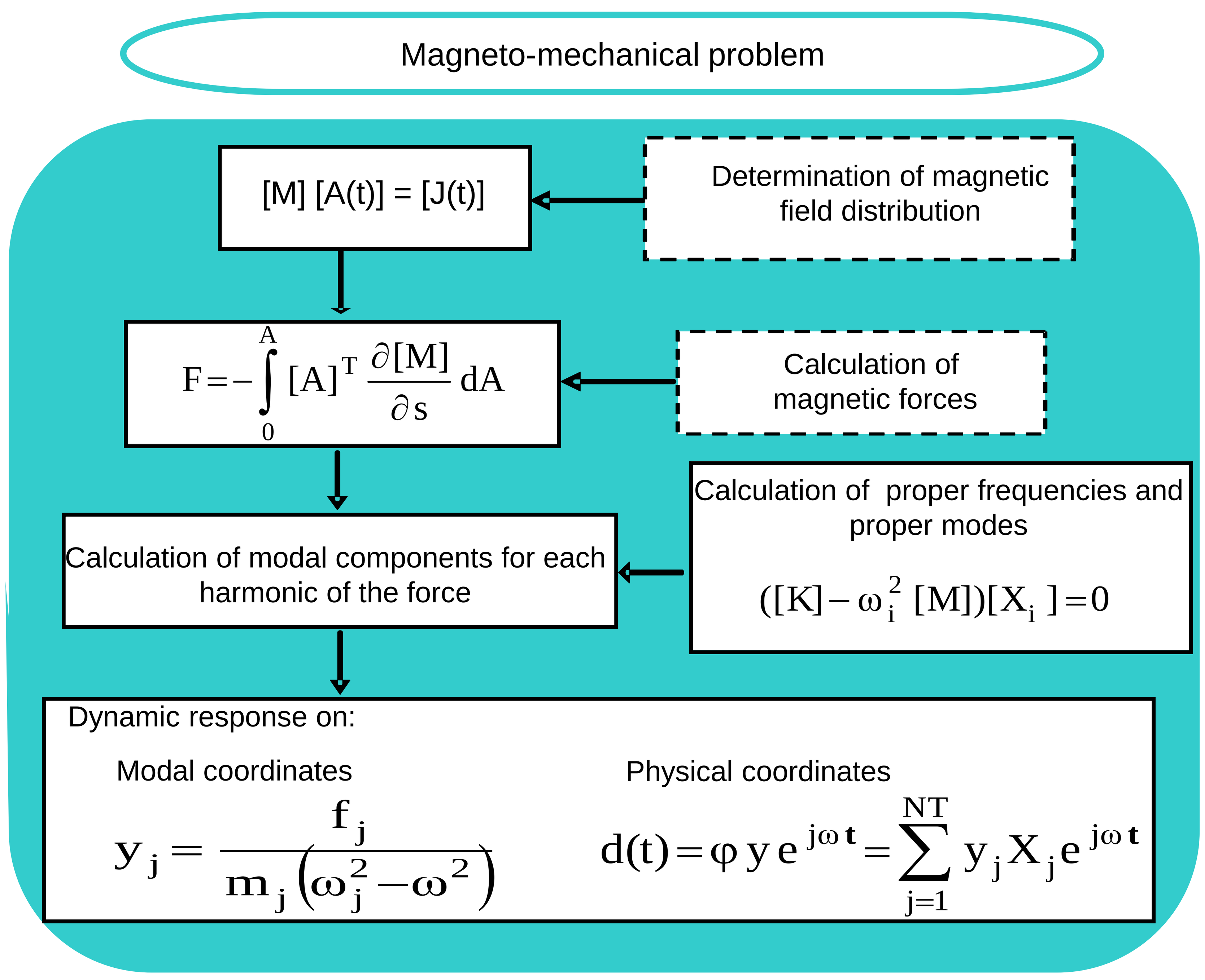
This paper presents a new methodology for the diagnosis of induction machine faults. A modern and efficient diagnosis technique should be non-destructive. In this study, the proposed technique is based on the vibratory behaviour analysis.

Vibration signal analysis is a very interesting and recent technique for the non-destructive testing of the machine malfunctions because any change in the mechanical or electrical conditions of the machine affects its dynamic conditions and thus its vibration behavior. The faults can be identified and located based on the spectral content of the vibration signal.

Vibration monitoring and analysis in rotating machinery provide essential information on emerging anomalies within the system. Such techniques not only enable the detection of specific faults but also facilitate maintenance by revealing their underlying causes. The vibration signatures of a machine operating under load offer substantially more insight into its internal behavior than electrical, infrared, or other non-destructive testing (NDT) methods. Vibrations in rotating electrical machines therefore serve as reliable indicators of potential faults arising during service. The goal of this paper is to summarize the results of an evaluation of vibration analysis techniques as a diagnostic method for three-phase asynchronous motors. For this purpose, an approach based on the Finite Element Method (FEM) is proposed to solve the magneto-mechanical problem.

METHOD

Vibrations in electrical machines are mostly caused by forces acting on their ferromagnetic components. The virtual works method was applied locally for the magnetic force computation. To calculate the dynamic response of the stator to the magnetic force stresses, the dynamic equation must be solved.



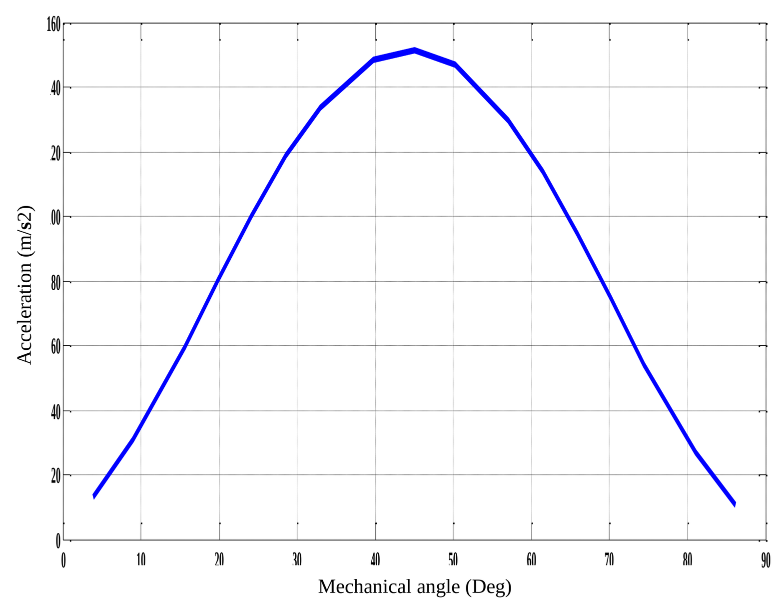
Numerical calculation code based on finite elements method (FEM) was developed under Matlab environment to diagnosing rotor bar breakage, short circuit, bars deformation and other faults. This calculation code was applied in the two cases: when the machine was healthy and when it was faulty.

In this work the Fast Fourier Transform (FFT) was investigated. So, we compared between the frequency spectra of the accelerations, obtained on the frame of the machine in the faulty and healthy cases, to predict the defect.

RESULTS & DISCUSSION

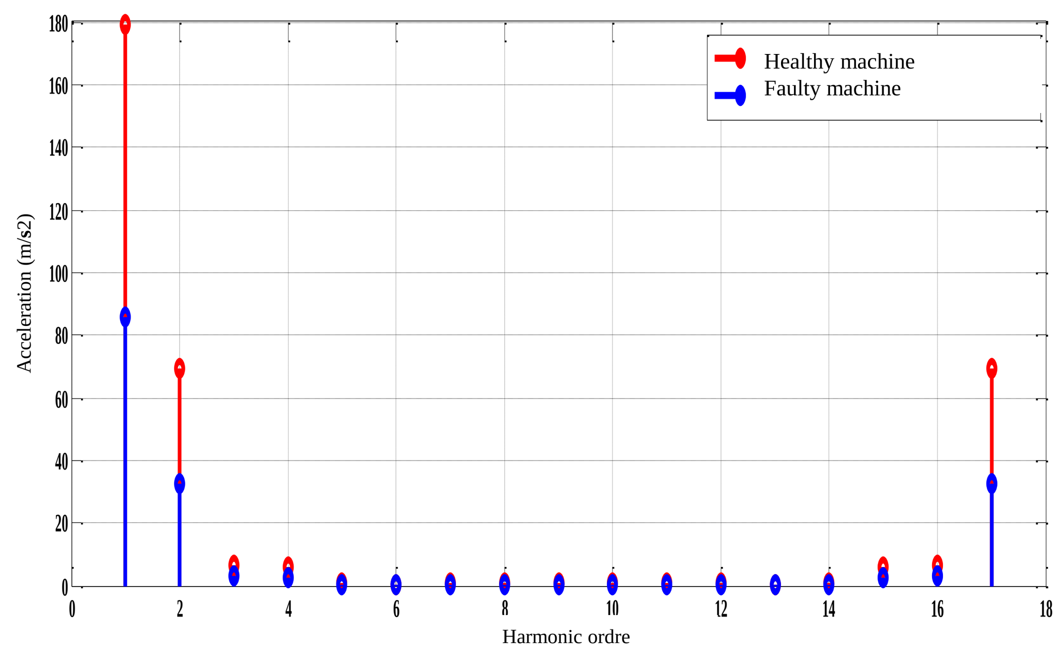
We have tried to modify some of machine's parameters, to create different faults. Therefore, we have intervened in the introduction of the geometric and physical parameters. We have imposed parameters that make machine defective.

Acceleration obtained on the frame of the machine



Bar breakage fault

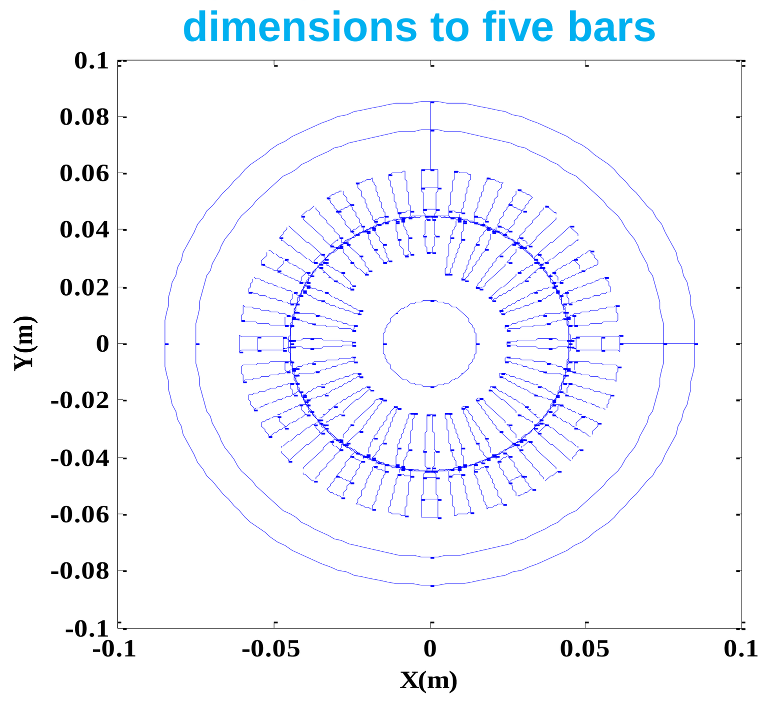
This fault was incorporated into our model by assigning zero electrical conductivity to nine bars.

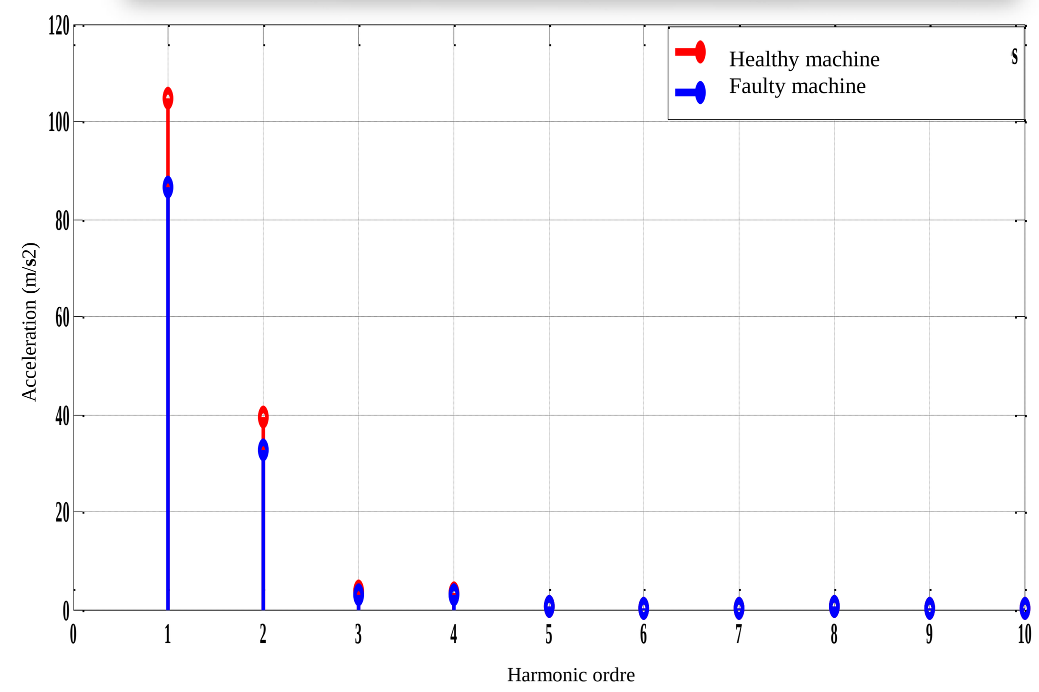


Bar breakage causes a reduction in the mean electromagnetic torque while simultaneously increasing the amplitude of its oscillations. This, in turn, enhances the magnetic forces and consequently increases the oscillations of the rotational speed (acceleration).

Bar deformation fault

This fault was modeled by assigning altered geometrical dimensions to five bars





The rise observed in the acceleration spectrum is limited to the fundamental component and the second-order harmonic, with only minor increases in the third- and fourth-order harmonics. These variations result from the non-uniform magnetic field distribution produced by this type of fault.

CONCLUSION

This study has given more understanding of the dependent roles of vibration analysis in predicting and diagnosing machine faults. The obtained results have proved the interest of this technique for the monitoring of the electrical machines.

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