A1 – Rotating Electrical Machines

PS2 – Asset management of electrical machines

10862

Automated tool for bearing fault diagnosis in induction motors, based on MCSA technique and machine learning algorithm

Guillem GIL-PRIETO[1]*, José A. ANTONINO-DAVIU[2], Daniel TARÍN-CABALLERO[1], Pascual MULLOR-RUIZ[1], Alfredo QUIJANO-LÓPEZ[2]
[1]Instituto Tecnológico de la Energía (ITE) [2]Instituto de Tecnología Eléctrica, Universitat Politècnica de València

Motivation

- The induction motor (IM) certainly is the most implemented electrical machine in low voltage industrial applications. In order to extend its useful life and avoid unnecessary maintenance stops, advanced techniques for predictive maintenance are required.
- Many IM failures take place in the bearings, so they are critical elements for the machine. Although vibration data analysis is the most typical technique used for bearing fault detection, advanced current analysis provides many advantages.
- One pending issue is the fact that the diagnosis still relies on the necessity of a user that interprets the results and identifies the corresponding harmonics or patterns linked with the fault. This constraint limits the possibility of implementing the technique in autonomous systems.
- The aim of this work is to develop an intelligent tool for bearing fault detection in IM, by combining the MCSA technique with machine learning algorithms for automated diagnosis. the developed tool is integrated in an Application Programming Interface (API), from where users can upload the motor current measurement, obtaining the bearing condition.

Method/Approach

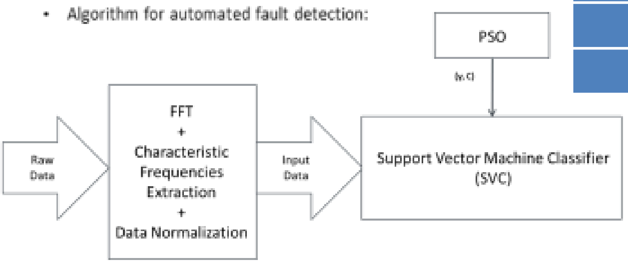
- Advanced current analysis can be performed by two main methods, depending on the regime in which the analysis is applied. The used method has been the classical technique Motor Current Signature Analysis (MCSA), which is applied in steady state regime.
- Failure frequencies in the vibrational spectrum:

Failure	Vibrational frequency (Hz)
External ring	$f_o = \frac{N_b}{2} f_r \left(1 - \frac{D_b}{D_c} \cos\beta\right)$
Bearing balls	$f_b = \frac{D_c}{D_b} f_r \left(1 - \frac{D_b^2}{D_c^2} \cos\beta^2\right)$

- Failure frequencies in the electrical current spectrum:

$$f_c = \left| f_s \pm m \cdot f_{o,b} \right|$$

- Algorithm for automated fault detection:



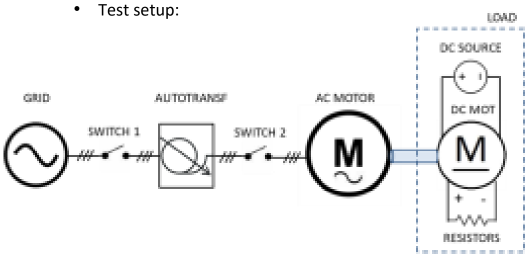
Objects of investigation

- Rated features of the squirrel cage induction motor:

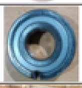
Voltage	Frequency	Speed
(400Δ / 690¥) V	50 Hz	1435 rpm
Power	**Current**	**Cos ϕ**
1.1 kW	2.4 A	0.78

Experimental setup & test results

- Test setup:



- Failure scenarios

Scenario	Description	Picture
Healthy bearing	No damage is performed	
Cut bearing	A transversal cut is performed in the external ring	
Dirty bearing	Different kind of shaving is introduced between the balls	

- Operating conditions for current measuring

Operating condition	U_{AC} (V)	U_{DC} (V)	Description
1	100	0	Not loaded IM (low voltage)
2	200	0	Not loaded IM (medium voltage)
3	200	70	Loaded IM (medium voltage)
4	400	90	Loaded IM (rated voltage)

http://www.cigre.org

A1 – Rotating Electrical Machines

PS2 – Asset management of electrical machines

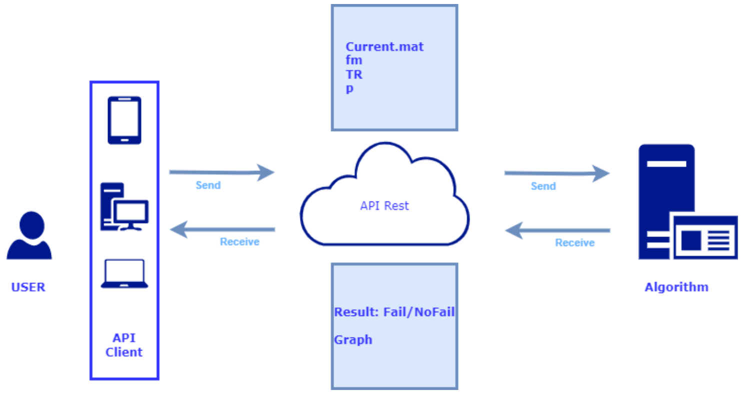
10862

Automated tool for bearing fault diagnosis in induction motors, based on MCSA technique and machine learning algorithm

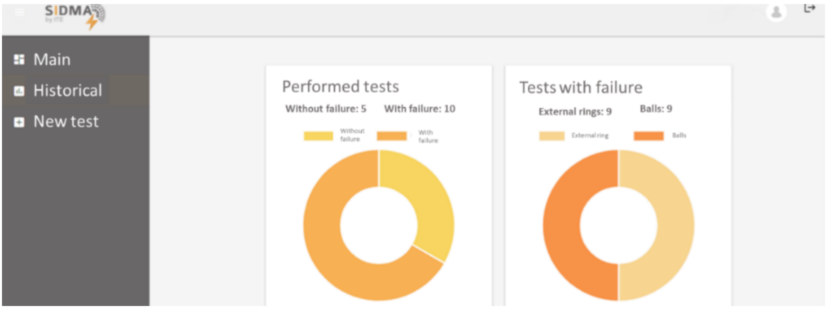
Guillem GIL-PRIETO[1]*, José A. ANTONINO-DAVIU[2], Daniel TARÍN-CABALLERO[1], Pascual MULLOR-RUIZ[1], Alfredo QUIJANO-LÓPEZ[2]
[1]Instituto Tecnológico de la Energía (ITE) [2]Instituto de Tecnología Eléctrica, Universitat Politècnica de València

Application programming interface (API)

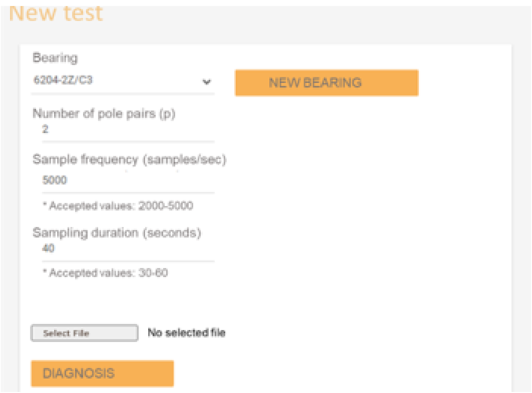
- Architecture:



- Main screen



- New test screen



A1 – Rotating Electrical Machines

PS2 – Asset management of electrical machines

10862

Automated tool for bearing fault diagnosis in induction motors, based on MCSA technique and machine learning algorithm

Guillem GIL-PRIETO[1]*, José A. ANTONINO-DAVIU[2], Daniel TARÍN-CABALLERO[1], Pascual MULLOR-RUIZ[1], Alfredo QUIJANO-LÓPEZ[2]
[1]Instituto Tecnológico de la Energía (ITE) [2]Instituto de Tecnología Eléctrica, Universitat Politècnica de València

Results

- Healthy bearing

- Bearing with failure

Conclusions

- An intelligent detection system has been developed to diagnose failures in induction motor bearings.
- This system includes a machine learning algorithm based on support vector machine.
- The detection system is capable to perform an automated diagnose of the motor bearing status with an approximated overall accuracy of 70%.
- The intelligent detection system has been integrated within an application programming interface (API), which can run the algorithm remotely.
- As a future work, more detection models could be integrated in the diagnosis system in order to cover other common failures in induction motors.

http://www.cigre.org