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Using multi-scale entropy and principal component analysis to monitor gears degradation via the motor current signature analysis

Salim Aouabdi [a,*], Mahmoud Taibi [b], Slimane Bouras [c], Nadir Boutasseta [a]

[a] Université Badji Mokhtar-Annaba, Faculté des sciences de l'ingénieur, Département d'électrotechnique, BP 12. Sidi Amar, 23000 Annaba, Algeria
[b] Université Badji Mokhtar-Annaba, Faculté des sciences de l'ingénieur, Département d'électronique, BP 12. Sidi Amar, 23000 Annaba, Algeria
[c] Université Badji Mokhtar-Annaba, Faculté des sciences de l'ingénieur, Département d'électromécanique, BP 12. Sidi Amar, 23000 Annaba, Algeria

A R T I C L E I N F O

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A B S T R A C T

This paper describes an approach for identifying localized gear tooth defects, such as pitting, using phase currents measured from an induction machine driving the gearbox. A new tool of anomaly detection based on multi-scale entropy (MSE) algorithm SampEn which allows correlations in signals to be identified over multiple time scales. The motor current signature analysis (MCSA) in conjunction with principal component analysis (PCA) and the comparison of observed values with those predicted from a model built using nominally healthy data. The Simulation results show that the proposed method is able to detect gear tooth pitting in current signals.

1. Introduction

Monitoring Gearbox is considered as a key task for many industrial applications. The early detection of tooth failures is crucial in order to optimize maintenance and reduce the financial impact of tooth damage. In this context, gear fault diagnosis has been based on Vibration signals analysis because of behavior of periodic events in the mechanical system [1]. This behavior will be changed in case of any kind of mechanical abnormality [2]. This is why the vibration signals has been shown to give satisfactory results and are applicable in noisy industrial factories [3].

Gears are important machine components in condition monitoring, which are used for transmission of power, motion or both. Under increased power and higher speeds, tribological failures such as scuffing, pitting, mild wear, surface damage and tooth breakage are of major concern [4]. When a local gear fault such as a tooth crack occurs, the vibration signal in a complete revolution will be modified by the effects of a short duration impact at a comparatively low-energy level [5]. The corresponding amplitudes of the peaks in the power spectrum increase as well as the number and amplitude of sidebands [6]. However, the spectral analysis may be unable to detect gear failures in the case of local faults. Which primarily affect sidebands due to the difficulty of evaluating the spacing and evolution of sideband families in the spectrum. The shape of mechanical impacts is associated with mechanical structure resonance excited by the tooth localized fault when the damaged tooth is engaged [7]. Many approaches to detect faults in gears have been developed one of which is vibration signal analysis and acoustic signals, which are used to detect incipient faults in a gearbox [8–10]. Rotating speed and loading

* Corresponding author.
E-mail addresses: aouabdi_sam@hotmail.com (S. Aouabdi), mahmoud.taibi@univ-annaba.org (M. Taibi), bours.6250@yahoo.com (S. Bouras), boutasseta@gmail.com (N. Boutasseta).

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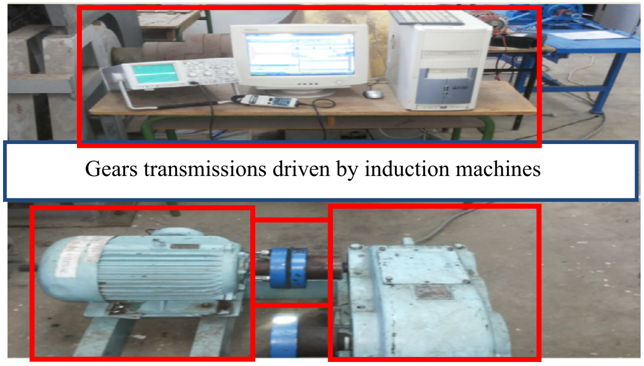

Fig. 1. Schematic of the proposed setup.

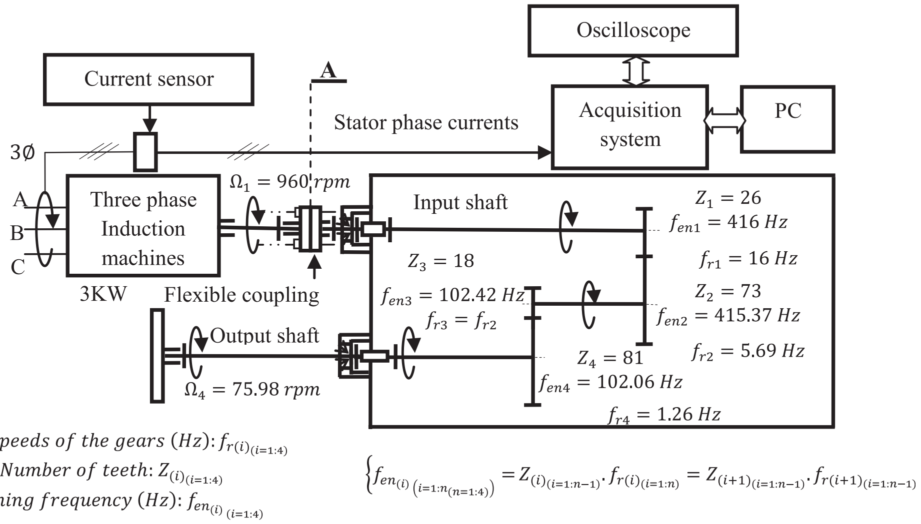

Fig. 2. The schematic of the gearbox experimental system.

N°=	Designation	Nbr	Material
7	Part 1 coupling	1	Steel
6	Flat seal	6	Plastic
5	Hex-head H	6	Steel
4	Part 2 coupling	1	Steel
3	Hex-nut	6	Steel
2	Flat seal	2	Plastic
1	Tube	6	Plastic

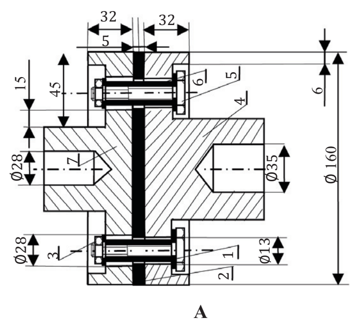

Fig. 3. The gearbox experimental system.