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Automated vibration-based fault size estimation for ball bearings using Savitzky–Golay differentiators

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Abstract

Vibration-based fault diagnosis has been utilized as a reliable method for identifying ball bearings health since the 1970s. Recently, there has been an increased research effort to develop methods for fault quantification with the aim of estimating the fault size to allow the service life of a ball bearing to be extended beyond the detection stage. These studies have shown that the vibration signal from a localized spall (e.g. fatigue defect) in a ball bearing exhibits features corresponding to two main events, namely, the entry into and the exit from the spall. The time span between these two events is correlated with the spall size. Studies have shown that the entry into the spall is the more challenging event to identify, which often requires extensive signal processing techniques. This paper introduces an automated vibration-based technique for estimating the size of a spall in a ball bearing under axial loading conditions similar to those of linear electro-mechanical actuators. This technique is based on the extraction of the entry/exit events from the vibrational jerk, which are numerically determined from accelerometer data. The differentiation of the acceleration data to estimate jerk signal is performed using a variant of Savitzky–Golay (SG) differentiators, which provide enhancement for the detection of the entry and exit points. Sensible spall size estimations have been achieved for 24 different scenarios of fault sizes, rotor speeds and loads measured on a test rig provided by DLR (German Aerospace Center). © The Author(s) 2017.

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