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”DATA2#3 - Vibration-based unsupervised detection of common faults in rotating machinery under varying operating speeds”

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Automated condition monitoring (CM) of Rotating Machinery (RM) has several benefits for modern industry including enhanced safety and reduced maintenance costs. Vibration signals may be easily and inexpensively collected from a RM during its normal operation and include rich information about the RM dynamics the proper exploitation of which may lead to effective CM. However, RM operate oftentimes in harsh industrial environments under varying conditions which affect the vibration signals in a similar manner as potential faults. Thus, the detection of incipient faults without imprints to the time domain and controversial effects in the frequency domain due to their similarity with the different operating conditions necessitates robust methods eliminating false alarms and RM downtime. Although there are numerous of studies on the CM of RM, the vast majority focuses on fault classification using a large volume of labeled data from the faulty RM under all possible operating conditions for supervised training, which is impractical for industry. The detection of common incipient faults in RM under different operating speeds is investigated in this study via two unsupervised Machine Learning type methods using a reasonable amount of data from the healthy RM for their training. The first utilizes Functional Pooled (FP) AutoRegression (AR) models with a scalar operating parameter corresponding to the rotating speed of the RM for the interpretation of its healthy dynamics. The second interprets the healthy dynamics using a cloud of AR models within a Multiple Model framework. Vibration signals are captured by a single accelerometer mounted on a RM consisting of two electric motors coupled via a claw clutch and operating at a wide range of different speeds. The methods' performance is systematically assessed based on hundreds of experiments with the healthy RM, as well as with a slight unbalance, minor wear at the base of a single claw clutch tooth, and mechanical looseness at one of the four RM mounting bolts under a wide range of rotating speeds, not necessarily used in the methods training. The results indicate the superiority of the FP based method that achieves remarkable detection of all considered faults under any rotating speed.

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