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THE INFLUENCE OF LUBRICATION CONDITIONS ON THE PERFORMANCE OF ROLLING-ELEMENT BEARINGS AS MEASURED BY VIBRATION SIGNALS AND ANALYZED USING ARTIFICIAL INTELLIGENCE.

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Introduction

Vibration analysis is an important predictive maintenance tool and plays a fundamental role in monitoring critical industrial equipment. In an industrial environment, due to demanding operational requirements, there is often not enough time to inspect the condition of bearings – components responsible for 55% of equipment failures. Furthermore, 80% of bearing failures are caused by inadequate lubrication conditions.

Objectives

To evaluate the ability of machine learning algorithms to distinguish between different lubrication conditions of a self-aligning cylindrical roller bearing, based on vibration signals measured by an ADXL345 MEMS sensor.

Methodology

Vibration signal acquisition was performed using an ADXL345 MEMS sensor, positioned on the self-aligning roller bearing near the motor, under the following lubrication conditions:

- Non-ideal condition: 0 g, 1 g, 3 g and 5 g
- Ideal condition: 7 g

The grease used in the tests was Tribotec LG 2, supplied by Fuchs Lubrificantes do Brasil Ltda.
Six data collection run were performed for each condition, each lasting 3 minutes at 140 rpm. Four algorithms were used fo the binary classification of the lubrication condition: 1D CNN, Logístic Regression, Support Vector Machine (SVM) with an RBF kernel and Random Forest.

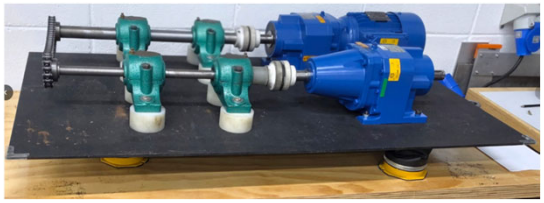


Figure 1: Test bench

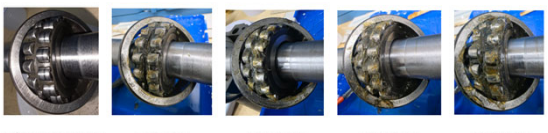


Figure 2: Bearing lubrication conditions

Results and Discussion

Four methods were used: 1D CNN (98,99% accuracy), Logistic Regression (96,26% accuracy), SVM with RBF kernel (99,28% accuracy) and Random Forest (99,57% accuracy). The results were promising and showed high accuracy without the need for wavelet transforms; however, they should be interpreted with caution. It is recommended to expand the experimental dataset to enhance the statistical robustness and generalization capability of the models.

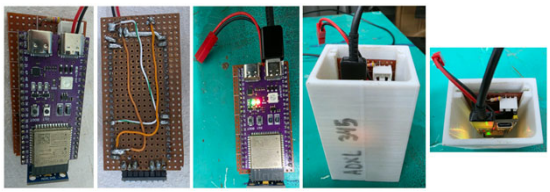


Figure 3: Sensor ADXL345 + ESP32-S3 + case

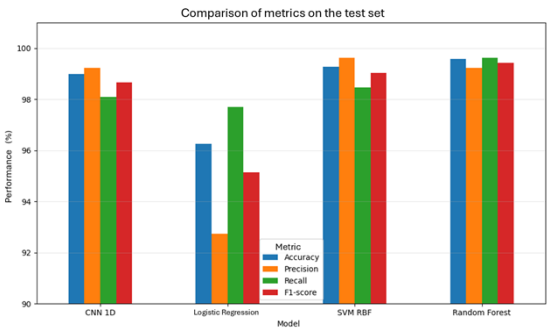


Figure 4: Performance for each method

Conclusions

The results obtained indicate that the evaluated methods have the potential to identify the influence of grease quantity on the operating conditions of sel-aligning cylindrical roller bearings. The proposed approach can contribute to the continuous monitoring of rotating equipment and to the improvement of predictive Maintenance strategies, especially in industrial facilities with a large number of assets and limited availability for on-site inspections.

References and Acknowledgments

JAKOBSEN, Morten Opprud; HERSKIND, Eskild Sune; PEDERSEN, Christina Fischer; KNUDSEN, Mikael Bergholz. Detecting insufficient lubrication in rolling bearings, using a low cost MEMS microphone to measure vibrations. MSSP, Aalborg, ELSEVIER, v. 200, julho, 2023.
JALOWIECKI, Andrzej; FIDALI, Marek; KROL, Adrian. Investigation of Rolling Bearing Lubrication Condition. Diagnostyka, Poznan, PTDT, v. 22, n. 4, p. 51-58, novembro, 2021.
SILVA, D. S. et al. Manutenção preditiva-análise de vibrações na indústria 4.0. Revista Foco, v. 16, n. 11, p. e3628-e3628, 2023.
SOUZA, V.C. et al. Utilização das tecnologias da indústria 4.0 na manutenção preditiva através do monitoramento de equipamentos e instalações. Brazilian Journal of Development, v. 8, n. 1, p. 7063-7083, 2022.
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