The 8th European Congress on Computational Methods in Applied Sciences and Engineering
ECCOMAS Congress 2022
5-9 June 2022, Oslo, Norway

Maneuver identification and fatigue damage regression for predictive maintenance using the scattering transform

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Keywords: *Maneuver identification, fatigue, predictive maintenance, scattering*

Predictive maintenance aims to preemptively replace components before the end of their service life in order to prevent system failures and to reduce maintenance times. This requires monitoring data of the particular system, which is collected using complex sensor setups. Depending on the application, this can lead to high hardware and installation costs, which can be significantly reduced by virtual sensor technology. Here, the desired measurable or derived quantities are estimated from existing sensor data [1].

The Scattering transformation [2] can be used to extract time-invariant features from signals. Applications can be found in audio processing, image recognition, and earthquake detection [3]. Especially for multi-channel dynamic systems, high numbers of coefficients are generated. Using principle component analysis, these can be reduced to few, very meaningful quantities describing the dynamic system state. This low dimensional representation enables applications in maneuver identification and damage regression.

The described methodology is demonstrated using an eBike test setup with multiple acceleration sensors and strain gauges. A semi-supervised approach for maneuver identification is employed, reducing the required amount of labeled data as much as possible. As a result, information on driving speed and surface conditions can be extracted from the low-dimensional representation. The principal component coefficients also exhibit a strong correlation to the fatigue damage at multiple strain gauges. This can be used to parameterize a regression model which predicts the fatigue damage sums from low cost acceleration sensors.

REFERENCES

[1] T. Miu, M. Bonato and Frédéric Kihm, *Fatigue damage estimation in vehicle thermal subsystems from minimal instrumentation thanks to a mixed engineering / Data science approach.* Structural Integrity Procedia, Elsevier, 2021, *In production*

[2] J. Andén and S. Mallat, *Deep Scattering Spectrum.* IEEE Transactions on Signal Processing, vol. 62, no. 16, pp. 4114-4128, 2014

[3] L. Seydoux, R. Balestriero, P. Poli, et al. *Clustering earthquake signals and background noises in continuous seismic data with unsupervised deep learning.* Nat Commun 11, 3972, 2020