Vibration Analysis on Rotating Shaft

Unbalance Detection of a Rotating Shaft Using Vibration Data

https://www.kaggle.com/datasets/jishnukoliyadan/vibration-analysis-on-rotating-shaft

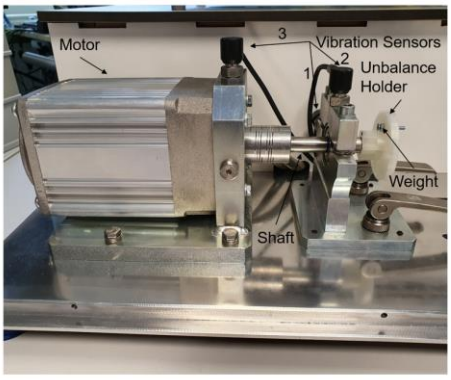
About Dataset

Introduction

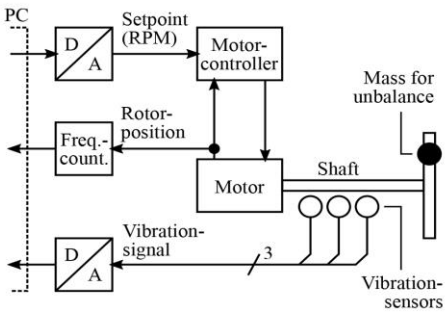
- The **vibration** is defined as cyclic or oscillating motion of a machine or machine component from its position of rest.
- The use of **machinery vibration** and the technological advances that have been developed over the years, that make it **possible** to not only detect when a machine is developing a problem, but **to identify** the **specific nature** of the problem for scheduled correction.
- Fault detection at **rotating machinery** with the help of **vibration sensors** offers the possibility to **detect damage** to machines at an early stage and to **prevent production down-times** by taking appropriate measures.

How Data is collected ?

- The setup for the simulation of defined unbalances and the measurement of the resulting **vibrations** is powered by an electronically commutated **DC motor** (WEG GmbH, type UE 511 T), which is controlled by a motor controller (WEG GmbH, type W2300) and is fixed to the aluminum base plate by means of a galvanized steel bracket.



Measurement setup



Block diagram of the measurement setup

- **Vibration sensors** (PCB Synotech GmbH, type PCB-M607A11 / M001AC) are attached to both the bearing block and the motor mounting and are read out using a 4-channel data acquisition system (PCB Synotech GmbH, type FRE-DT9837).

The DataSet

- Using the setup described in above section, **vibration data** for **unbalances of different sizes** was recorded. The vibration data was recorded at a **sampling rate of 4096 values per second**. By varying the level of unbalance, different levels of difficulty can be achieved, since smaller unbalances obviously influence the signals at the vibration sensors to a lesser extent.
- In total, datasets for **4 different unbalance strengths** were recorded as well as one dataset with the **unbalance holder without additional weight** (i.e. without unbalance). The **rotation speed** was varied between approx. **630 and 2330 RPM** in the development datasets and between approx. **1060 and 1900 RPM** in the evaluation datasets. Each dataset is provided as a csv-file with five columns:

- **1.** V_in : The input voltage to the motor controller V_in (in V)
  2. Measured_RPM : The rotation speed of the motor (in RPM; computed from speed measurements using the DT9837)

3. Vibration_1 : The signal from the first vibration sensor
4. Vibration_2 : The signal from the second vibration sensor
5. Vibration_3 : The signal from the third vibration sensor

Overview of the dataset components:

ID	Radius [mm]	Mass [g]
0D/ 0E	-	-
1D/ 1E	14 ± 0.1	3.281 ± 0.003
2D/ 2E	18.5 ± 0.1	3.281 ± 0.003
3D/ 3E	23 ± 0.1	3.281 ± 0.003
4D/ 4E	23 ± 0.1	6.614 ± 0.007

- In order to enable a comparable division into a **development dataset** and an **evaluation dataset**, separate measurements were taken for each unbalance strength, respectively.
- This separation can be recognized in the names of the csv-files, which are of the form "**1D.csv**": The **digit** describes the unbalance strength ("**0**" = **no unbalance**, "**4**" = **strong unbalance**), and the **letter** describes the **intended use** of the dataset ("**D**" = **development or training**, "**E**" = **evaluation**).

Acknowledgements

Special thanks to Oliver Mey, Willi Neudeck, André Schneider and Olaf Enge-Rosenblatt for their effort. **Please do citation**

@inproceedings{inproceedings,
author = {Mey, Oliver and Neudeck, Willi and Schneider, André and Enge-Rosenblatt, Olaf},
year = {2020},
month = {09},
pages = {1610-1617},
title = {Machine Learning-Based Unbalance Detection of a Rotating Shaft Using Vibration Data},
doi = {10.1109/ETFA46521.2020.9212000}
}

Research paper : https://arxiv.org/abs/2005.12742
Image Credit : Jonathan Borba

Inspiration

- Found out that the data related to vibration analysis is fewer and fewer.
- Bring a non-popular dateset to main stream.
- An appreciation to above mentioned team and their kindness for making this data publicly available.

Keywords : Vibration, Motor, Condition Monitoring, Preventive Maintenance, Mass Unbalance, Rotating Machinery, Deep learning, Machine Learning, Real world, Spectrum Analysis, Signal Processing, Mechanical Data.

NOTE :

- The analysis of vibrations on rotating shafts to **detect unbalances** or to **detect damage to roller bearings** has proven to be very promising.
- **Unbalances** on rotating shafts can cause **decreased lifetimes** of bearings or other parts of the machinery and, therefore, **lead to additional costs**. Hence, early **detection of unbalances** helps to **minimize maintenance expenses**, to avoid unnecessary production stops and to increase the service life of machines.