Different Signal Processing Techniques for Predicting the Condition of Journal Bearings

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ABSTRACT

- Journal bearings are used to support shafts.
- Vibration condition monitoring is to detect, diagnose and prognoses faults [1].
- Show the differences between the time domain, frequency domain and time-frequency analysis (STFT) of Journal bearing vibration signal.

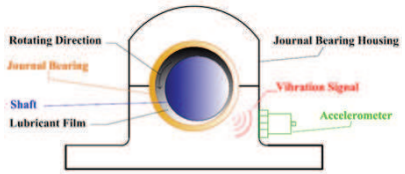

Figure 1: Journal Bearing Vibration Generation

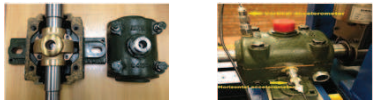

Figure 2: Self-aligning Journal Bearing

THEORETICAL BACKGROUND

- Time domain analysis gives the behaviour of the signal over time which allows predictions and regression models for the signal [2].
- Frequency-domain data are obtained by converting time-domain data using a mathematical technique referred to as Fast Fourier Transform (FFT) [2]
- Time–frequency analysis is short-time Fourier Transform (STFT) investigates waveform signals in both time and frequency domain at same time [2].

$$STFT\ (t', u) = \int_t [f(t).W(t-t')].e^{-i2\pi ut}\ dt$$

Window should be narrow enough to make sure that the portion of the signal falling within the window is stationary.

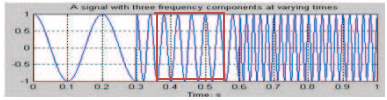

Figure 3: explain how STFT window is stationary portion of the signal [3]

Test Rig Facility

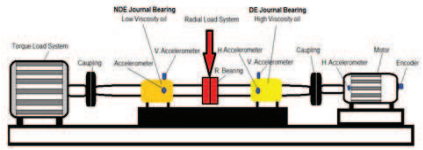

Figure 4: Schematic diagram of test rig

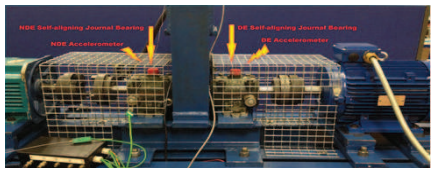

Figure 5: Journal Bearing Rig

Results and Discussion

- The time domain and frequency domain of journal bearings at high speed, high radial load and low viscosity oil

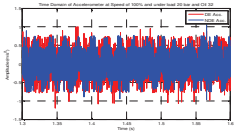

Figure 6: time domain

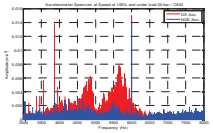

Figure 7: frequency domain

- Time-frequency STFT presentation

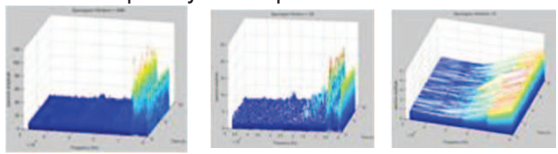

Figure 8: Different STFT window (2048,128,8)

Conclusion

- Time-frequency not only presents the frequency content of the signal but also shows when it occurs.
- STFT Narrow window means good time resolution, poor frequency resolution.
- STFT wide window means good frequency resolution, poor time resolution.

References

1.Laakso, K., T. Rosqvist, and J.L. Paulsen, The use of condition monitoring information for maintenance planning and decision-making2002: Technical Report. NKS-80.

2.Jardine, A.K.S., D. Lin, and D. Banjevic, A review on machinery diagnostics and prognostics implementing condition-based maintenance. Mechanical Systems and Signal Processing, 2006. 20(7): p. 1483-1510.

3.Anonymous, Vibration Analysis and Signal Processing in LabVIEW, 2012, National Instruments.

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