Detection of hidden periodicity in signals disturbed by additive non-Gaussian noise. Application to machine condition monitoring.

Agnieszka Wyłomańska[1],
joint work with Wojciech Żuławiński[1], Jerome Antoni[2],
Radosław Zimroz[3]

[1] *Faculty of Pure and Applied Mathematics, Wrocław Tech, Poland*
[2] *INSA Lyon, LVA, France*
[3] *Faculty of Geoengineering, Mining and Geology, Wrocław Tech*

We address the problem of detecting hidden patterns in signals that exhibit periodic correlation (PC); however, they are affected by non-Gaussian noise with unknown characteristics, a scenario commonly encountered in many areas of interest. Conventional approaches for identifying periodically correlated behavior typically operate in the time or frequency domain. Although our study incorporates these traditional methods, we enhance them by introducing robust alternatives to standard estimators of the autocovariance function and discrete Fourier transform.

Using robust tools, we develop improved versions of popular statistical methods that were originally intended to uncover hidden periodicity in "pure" PC models. Our work considers two types of PC model and two categories of additive noise, resulting in PC signals disturbed by non-Gaussian noise. Under such conditions, detecting hidden periodicity becomes significantly more challenging than in conventional scenarios. We apply our techniques to real-world datasets from the machine condition monitoring area, which is a main motivation for our research.

[1] W. Żuławiński, J. Antoni, R, Zimroz, A. Wyłomańska: Robust coherent and incoherent statistics for detection of hidden periodicity in models with non-Gaussian additive noise, *EURASIP J. Adv. Signal Process.* **71**, 2024

[2] W. Żuławiński, J. Antoni, R. Zimroz, A. Wyłomańska: Applications of robust statistics for cyclostationarity detection in non-Gaussian signals for local damage detection in bearings, *Mechanical Systems and Signal Processing* **214**, 111367, 2024