Non-Gaussian noise in rotating machines: sources, impact to local damage detection procedures and possible solutions

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Abstract

Local damage detection in rotating machines is one of the most important research problem in condition monitoring. There are many available solutions that are based on properties of informative signal (Signal of Interest, SOI) such as impulsiveness and/or periodicity (cyclostationarity), amplitude modulation in time domain, etc. As signal is non-stationary (due to impulsive nature it is wideband in frequency domain), the time frequency domain is often selected as a basis for further analysis. All these techniques are very effective even for really poor signal-to-noise ratios (or in other words in case of a weak SOI signal that could be considered as early stage of fault development). Unfortunately, the situation is changing dramatically if noise associated to almost all real signals is not Gaussian. Such a case is not so obvious for many researchers, especially if they work only with test rig data (a non-Gaussian noise is not present there). In the paper, we will present several examples of various machines that may produce strongly non-Gaussian signals. Non-Gaussian background noise is related to technological processes performed by these machines. It could be also related to measurement and data transmission systems as reported in work of (**1**). Another possible situation is just random, single excitation (shock) that may appear during measurement (**2**). A Machine located nearby or a specific design of mechanical systems could be also a source of non-Gaussian noise in case of acoustic measurement (**3**) How does non-Gaussian noise may affect diagnostic procedures? Obviously it depends on the case, but in general, most of procedures are based on mean removal, normalized variance, etc. Non-Gaussianity of background noise may imply lack of variance (not defined for heavy tailed distribution). It may affect synchronous averaging (**4**). Detection of impulsive SOI cannot be based on impulsiveness criteria anymore (kurtosis will react to high amplitude spikes, not to cyclic impulses). It could be surprising, but for heavy tailed noise the autocovariance function might not be allowed to use (variance may not exist). There are some solutions related to outliers removal, robust estimators, alternative measures of dependence. They will be illustrated in the presentation.

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