Information Quality and Its Acquisition Time: New Challenges in Technical Condition Monitoring

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Abstract

Diagnostics and condition monitoring of machines require the implementation of a structured process that begins with data acquisition from observation, followed by the identification and selection of useful information, the definition of relationships between information measures and their assignment as representations of assumed distinguishable technical conditions, and finally classification. The data acquisition (observation) stage must be effective, while subsequent activities related to information selection and signal processing, aimed at obtaining separable symptoms of the technical condition (recognition), strongly depend on the quality of the data and information.

Time constitutes a key parameter associated with both observation and recognition. In the case of machine observation or accompanying phenomena, the observation time determines the information capacity. In prognostic diagnostics, this requires long observation windows to enable trend analysis, whereas predictive or fault diagnostics may rely on short-term observations. In monitoring and diagnostic strategies based on accompanying phenomena, such as vibrations or electromagnetic emissions, an important parameter is the appropriate selection of the sampling time, which should be adequate to the dynamics of the physical phenomenon under observation. Another parameter confirming the importance of time in machine monitoring and diagnostics systems is transmission speed, which significantly determines the time required for data acquisition and, in subsequent stages, for obtaining information, as well as for the results of selection and classification. At this stage, the time required for signal processing aimed at extracting useful information and calculating specific symptom measures is also crucial. This depends on the level of advancement of the adopted signal processing methods, the implemented computational algorithms, and the available hardware and software resources.

For effective, efficient, and reliable state recognition, the quality of information is of fundamental importance. It can be broadly defined as the ratio of the actual to the expected usefulness of information. The identification of distinguishable parameters determining information usefulness depends on the expectations of the recipient. In machine monitoring and diagnostic systems, this is most often the ability to distinguish between states (machine condition), at a minimum as operational and non-operational (qualitative assessment), but more frequently including intermediate states, even with differentiation of fault types. Useful information may also describe the degree of wear or degradation, which requires

distinguishing between qualitative and quantitative information. Consequently, the final sets of information usefulness may define various types of faults as well as different levels of their severity. As such, a clear and unambiguous definition of information quality always requires an individualised approach. Nevertheless, there are fundamental and common parameters strongly correlated with information quality, namely reliability, effectiveness, and selectivity of information acquisition.

Considering the importance of information in machine diagnostics and monitoring, measurement (observation) becomes fundamental. Measurement enables signal acquisition, which constitutes the communication channel between the machine and the human operator (diagnostician). Therefore, the quality of information depends critically on successive stages of the measurement process: from defining the phenomenon under observation, through the selection of sensors and other components of the measurement system, appropriate sensor placement and mounting methods, assessment of signal quality determinants, proper planning and reliable execution of measurements, to correct data archiving with consideration of measurement uncertainty. The highest quality of the measurement signal directly determines the level of quality of the information derived from it.