Vibration Feature for Detecting Eccentric Workpiece/Runout Faults During Continuous Gear Grinding Processes

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Continuous gear grinding is a well-established and widely used process in the industry for large-scale production gears. It offers an economic/efficient process for finishing gears, which shapes the micro-geometry of the gear tooth flank and improves its surface quality. The resulting quality of ground gears depends on several factors, namely the tool performance, the machine stability as well as the correct clamping/positioning of the workpiece. The grinding step is very crucial since it has a direct impact on the operating quality of gears and in particular on the running noise behaviour of the end product.

The potential of online vibration based gear grinding monitoring has been explored and demonstrated in the previous work [1] as a means of quality control that could lead to the overall reduction of production losses and to the prevention of sending defective parts to customers. A number of features which could be used to monitor the grinding processes and to identify a specific type of defects have been proposed & experimentally validated to some extent. The types of faults include i) high feed rate, ii) high infeed, iii) non-flat workpiece, and iv) eccentric workpiece. However, a further investigation on a new test campaign revealed that none of the features developed in [1] was sensitive and robust enough to detect eccentric workpieces during the grinding process. It is worth mentioning here that an eccentric workpiece fault is unlikely to happen, but it is analogous to a runout on the incoming workpiece quality.

In this paper, a qualitative model to predict the vibration signature due to eccentric workpieces/runouts is developed and discussed. Based on the qualitative understanding, a novel feature to detect eccentric workpieces/runouts during gear grinding processes based on vibration signals has been developed. The newly developed feature has been validated on real vibration signals captured during the emulation of process malfunctions on an industrial gear grinding machine. The experimental results show that the novel feature is sensitive and robust for detecting workpiece eccentricities of about 40 microns. It is also shown in this study that the feature is insensitive to other types of gear grinding faults, which is important for diagnostics/root-cause analysis purposes.

Reference:

[1] K. Gryllias, B. Kilundu, S. Devos, Y. Vonderscher, B. Vandewal, *Condition monitoring of gear grinding processes*, Surveillance 9.