Towards real-time automated early gear fatigue cracking failure detection

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When designing complex systems, e.g., automotive drivetrains, much of the design work uses standard formulas, dedicated commercial modelling and simulation tools, and company experience. Experimental testing is needed in verifying models. Ideally, for gear components, test termination should occur when a single tooth has either a sizable crack or a single tooth breakage.

The ability to stop a gear fatigue test before catastrophic failure has many advantages. However, today, a widely accepted approach is not available. This case study applies a vibration-based condition monitoring methodology to detect early gear fatigue cracking failures. The gear studied is part of an all-wheel-drive drivetrain system. Vibration signals from four run-to-failure fatigue tests at two constant torque-speed combinations were used as input to time-synchronous averaging and autoregression model generation. The applied methodology shows promising results for early failure detection, and the process is feasible for implementation in an automated environment. Real-time analysis is also possible since the autoregression model generates a healthy state TSA signal during the early testing stages. However, the time to failure detection varies with operating conditions, with low sensitivity at high-speed and low-torque conditions.

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