

ABSTRACT

In this thesis, fault diagnosis and prognosis approaches for gear subjected to pitting failure mode have been developed. The diagnosis process here is divided in three stages: health indicator (HI) construction, gear pitting severity level identification and classification. A correlation coefficient of residual (CCR) vibration signal based HI is proposed for gear pitting severity assessment. The proposed CCR HI shows significant variation from one health stage to another health stage of the gear, which makes it relatively more robust and practically useful. A binary segmentation and Random Forest classifier methodology is applied on the CCR HI for identification and online classification of the gear pitting severity levels respectively.

All three types (sensor data-driven, physics-based and hybrid) of prognosis approaches are developed in this thesis for gears. Based on the CCR indicator, a data-driven Random Forest Regression (RFR) model is proposed for remaining useful life (RUL) prediction. For RUL prediction in absence of a run-to-failure condition monitoring data, a physics-based prognosis model is developed. Using this model, improvement in RUL prediction with time is observed when predicted gear damage state is replaced with actual pitting area, which is obtained from visual inspection of gear tooth surface. This approach is termed as Type-I hybrid prognosis approach. To obviate the necessity of the periodic visual inspection, the pitting area on the gear tooth surface is predicted based on the value of CCR HI using a RFR model. This approach that uses the predicted pitting area in the physics-based prognosis model is termed as Type-II hybrid prognosis approach. In both the Type-I and Type-II hybrid prognosis approaches, it is observed that a further improvement in the RUL prediction accuracy is possible when the physics-based model parameters are updated based on the measured/predicted pitting area.

The proposed diagnosis/prognosis approaches are validated on up to eight experimental run-to-failure time history data using a specially designed and developed test rig.