Predictive approach of rotating equipment, gears and bearing faults

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Abstract:

The operational maintenance of civil or military aircraft fleets is a major economic and safety issue for the aeronautical sector. In this context, the control of the non-failure of rotor components, such as bearings and gears, is a major concern. Early prediction of the occurrence of these failures according to usage is a solution to reduce the risk of long term aircraft downtime, to anticipate supplies, and to improve safety.

To date, the propulsion systems kinematic chains are not equipped with monitoring sensors. Monitoring the rotor components requires invasive and heavy instrumentation, sometimes impossible to implement, due to the available space and ambient temperatures. Moreover, the acquisition of dynamic signals from the sensors generates large volumes of data that must be stored and post-processed.

The method proposed here can be deployed from a single sensor placed on a shaft line. In the ideal case, following requirements shall be fulfilled: the sensor shall be without contact with the rotating part and shall be able to measure relevant data to monitor the whole shaft line. A particular attention was made on the instrumentation side and on the signal processing to be undertaken to get relevant information.

The health of the organs can be evaluated from global indicators, resulting from a learning phase (Machine Learning), via the implementation of a semi-supervised algorithm.

The early fault detection algorithm was tested using test data collected on a dedicated endurance test bench. Endurance tests were split in two sets of experiment:

- Endurance on bearing with ball indention,
- Endurance with crack initiation on one pinion tooth.

A digital twin of the bench was used to anticipate the life of a healthy pinion, by recalibrating the numerical model from the first readings taken on the bench, in terms of loading and dynamic response.

At the end of the learning phase, it was thus possible to establish a link between the speed of rotation and the loading torque (information generally available on board), and the state of health of the monitored components.

The first results obtained on a partial bench demonstrate the ability to identify early changes of state based on global indicators on a use case. These generic methods also open new perspectives in land and maritime transport or in the energy sector.

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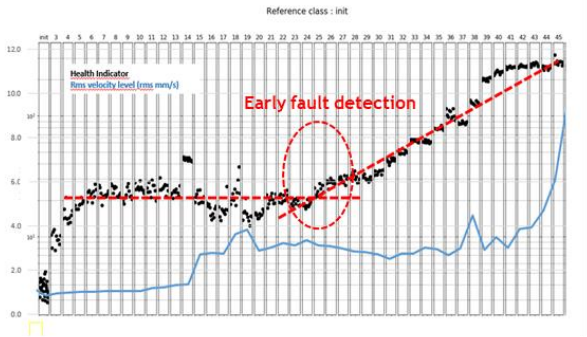

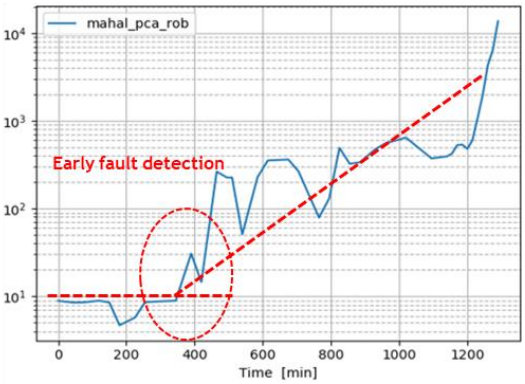

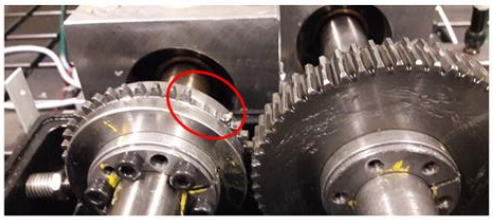

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