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# Wind turbine gearbox condition monitoring: Experimental validation of a thermal network model

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Condition monitoring is an important part of predictive maintenance. Early detection of incipient faults prevents major component failures and allows for the implementation of predictive repair strategies. Gearboxes are responsible for up to one third of all lost wind turbine availability[1], each failure downtime of around 600 hours[2]. Deterioration of the drivetrain components will often be reflected in an increase in losses, as a result of increased friction or a reduced efficiency of energy transfer in the cooling mechanism, resulting in elevated temperatures[3]. Monitoring temperature changes are useful to understand how the thermal behaviour of a gearbox can change as a result of a fault. In the author's previous research, a thermal network model of a "healthy" gearbox was produced. The model was partially validated by prelimary experimental data using an 11kW wind turbine gearbox test rig located at University of Strathclyde. Figure 1 shows the how this research links together.

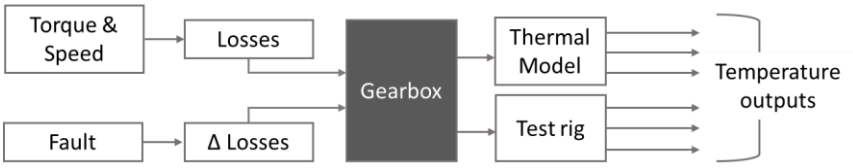


**Figure 1: Process to understand gearbox thermal behaviour**

The confidence in the preliminary experiment is limited due to the simplistic nature of the data aquisition (DAQ) equipment. The DAQ system itself plays a significant role, as temperature measurement method influences diagnostic capabilities. A number of studies in literature used experimental methods to use temperature to detect faults[4], in most cases the input variables and measurement uncertainty weren't quantified. This research focusses on improving the certainty of the experimental data by redeveloping the DAQ system and experiment strategy to improve accuracy. Figure 2 shows all aspects of experiment that have been taken into consideration to ensure validity, reliability and reproducibility.

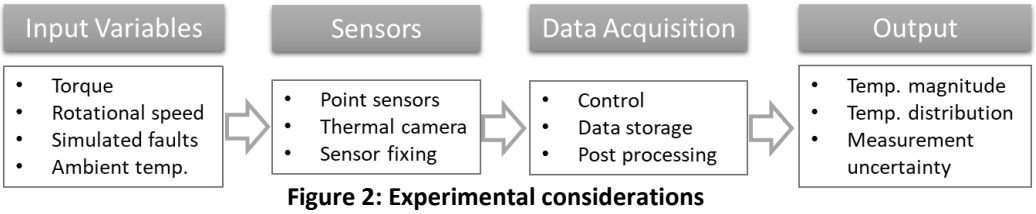


**Figure 2: Experimental considerations**

The experiment was carried out on a "healthy" gearbox, with 8 point sensors and a thermal camera. The rotational speed was fixed and the torque was varied to reflect the wind turbine operation. The results show the way in which heat propagates through the gearbox, and are compared to the thermal model to identify normal operational losses. Faults were then simulated on the test rig with the addition of heat at component locations. The magnitude and location of the applied heat were varied to imitate failure modes. The results show how the additional heat propagates to other parts of the gearbox and indicate the extent to which a fault can be detected. These results can also be used to validate the simulated faults in the thermal model. The outcome of this research can determine if temperature measurements can be used to detect and locate faults, to make condition monitoring more accurate.

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