Determination of Machine Condition using Neural Networks

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Condition monitoring is a developing discipline in machinery maintenance. Data such as vibration levels, temperatures, oil analysis values etc, are acquired from plant, and analyzed to determine the condition of the plant at the time of measurement. Software packages are currently available to allow graphical display of the data, with varying levels of diagnostic tools available to assist engineers in performing data analysis. This abstract outlines the development of a condition monitoring system at Blyth Power Station, owned by National Power, the major electricity generating company in the United Kingdom. The abstract goes on to describe research into the development of a data analysis system employing neural networks trained to recognise machinery defects.

Blyth Power Station is located on North East coast of England, with a generating capacity of 1,180MW, and is one of the oldest coal-fired sites in the United Kingdom. The Station recognised the requirement to move away from traditional, manpower-intensive strategies of planned or breakdown maintenance, towards a condition-based maintenance policy for critical areas of auxiliary plant [1]. To achieve this, the Station entered into a collaborative agreement with the University of Sunderland to develop and implement a condition monitoring system for use within the Station, and to investigate the use of artificial intelligence in data analysis.

Figure 1 below shows a typical frequency spectrum acquired from a Cooper rolling element bearing. The spectrum is obtained by performing a Fast Fourier Transform on the time domain vibration signal, after a band pass filter and envelope filter have been applied to it. In this spectrum, a large peak is visible at the frequency specific to an outer race defect (ORD).

This clear and well-defined spectra shows distinct characteristics relating to the bearings. The plant is readily accessible, and the transducer can be placed close to the bearing being monitored. In many cases, the picture is far more vague, through background noise, difficulty of access, low frequency applications etc; for example, data collected from coal mill gearboxes is a much more complex problem for analysis [2].

Neural Networks for Data Analysis

Initial work employed the well-documented multi-layer perceptron using back-propagation [2]. This network topology was applied to the analysis of data from rolling element bearings, similar to that shown in Figure 1. Whilst this problem domain is not particularly complex, the amount of data collected makes an automated system desirable. Two versions of the Neural Bearing Analyzer (NBA) were developed; first, one which took a limited amount of information from the frequency spectrum as its inputs, and had as its output classes degrees of severity of defect in each individual bearing component, and second, one which took the whole of the frequency spectrum (400 datum points) as its inputs, and had a simplified output class set for overall bearing condition. The second system proved difficult to train, with problems in achieving convergence to within a suitable RMS error threshold. However, once convergence was achieved, its performance in classification of live data was very good when compared to the diagnosis of a consultant condition monitoring engineer, agreeing in 93% of test cases. This network topology is now being used to analyze more complex data, and other topologies such as Self-Organising Maps are also being investigated [2].

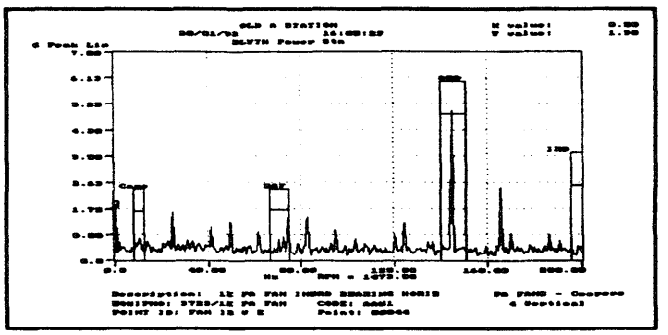

Figure 1 - FFT spectrum from a Cooper bearing

References

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