

Some Experiments in the Application of Neural Networks to Machine Condition Monitoring

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Abstract

This paper describes the results of some experimental work in machine condition monitoring with the use of Neural Networks. The emphasis of the paper is put on the machine vibration analysis, normally performed by highly skilled mechanical engineers to ascertain the operating condition of rotating devices, such as gearboxes or fans.

The method consists of measuring and recording digitised forms of frequency spectra and time signals representing machine vibration in predetermined measurement points. The signals are then analysed and compared with the previously registered machine condition. All differences and trends are carefully examined in search of developing faults (Eshleman 1983). Spectral analysis is a long and involved task requiring the skill, knowledge and experience of qualified personnel. Thus, it is proposed to mechanise the analysis phase of machine condition monitoring with the use of Neural Networks automatically detecting signal deviations from the accepted safety range.

The Neural Net training set usually consists of a number of expert selected critical signal features, such as energy peaks, RMS over the frequency range, time signal phase shifts, cepstrum points or Chebyshev values. The series of experiments presented in this paper focuses on the detection of two commonly occurring faults in fume tower fans (see Figure), their unbalance (increasing amplitude in the rotational frequency) and load unbalance (uniform increase of amplitude in all harmonics). The training set for each of the analysed fans contains 33 exemplars, each consisting of 20 real numbers representing the amplitude of the fan rotational frequency and its 19 harmonics, plus their classification into faulty and normal categories. The first of our experiments aimed at training a pattern associator (McClelland and Rumelhart, Ch4) which required 5946 training cycles to achieve 0.05 m.s.e., the other two experiments used a backpropagation algorithm (McClelland and Rumelhart, Ch5) with varying number of hidden units. A network with 5 hidden units needed significantly fewer number of training cycles (~900) to achieve the same level of misclassification as a pattern associator. An attempt to reduce the number of hidden units to 2, resulted in increased learning time (to 1891), without the loss of classification accuracy. Results obtained from these experiments clearly

show the feasibility of the neural approach to machine condition monitoring.

References

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