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Classifying Turbomachinery Blade Mode Shapes Using Artificial Neural Networks

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Abstract : Currently, extensive signal analysis is performed in order to evaluate structural health of turbomachinery blades. This approach is affected by constraints of time and the availability of qualified personnel. Thus, new approaches to blade dynamics identification that provide faster and more accurate results are sought after. Generally, modal analysis is employed in acquiring dynamic properties of a vibrating turbomachinery blade and is widely adopted in condition monitoring of blades. The analysis provides useful information on the different modes of vibration and natural frequencies by exploring different shapes that can be taken up during vibration since all mode shapes have their corresponding natural frequencies. Experimental modal testing and finite element analysis are the traditional methods used to evaluate mode shapes with limited application to real live scenario to facilitate a robust condition monitoring scheme. For a real time mode shape evaluation, rapid evaluation and low computational cost is required and traditional techniques are unsuitable. In this study, artificial neural network is developed to evaluate the mode shape of a lab scale rotating blade assembly by using result from finite element modal analysis as training data. The network performance evaluation shows that artificial neural network (ANN) is capable of mapping the correlation between natural frequencies and mode shapes. This is achieved without the need of extensive signal analysis. The approach offers advantage from the perspective that the network is able to classify mode shapes and can be employed in real time including simplicity in implementation and accuracy of the prediction. The work paves the way for further development of robust condition monitoring system that incorporates real time mode shape evaluation.

Keywords : modal analysis, artificial neural network, mode shape, natural frequencies, pattern recognition
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