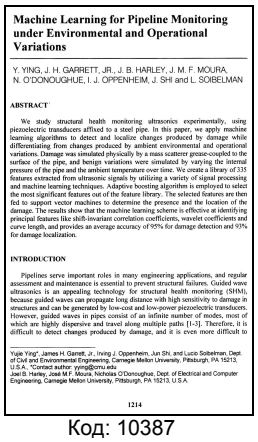

Machine Learning for Pipeline Monitoring under Environmental and Operational Variations

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ABSTRACT

We study structural health monitoring ultrasonics experimentally, using piezoelectric transducers affixed to a steel pipe. In this paper, we apply machine learning algorithms to detect and localize changes produced by damage while differentiating from changes produced by ambient environmental and operational variations. Damage was simulated physically by a mass scatterer grease-coupled to the surface of the pipe, and benign variations were simulated by varying the internal pressure of the pipe and the ambient temperature over time. We create a library of 335 features extracted from ultrasonic signals by utilizing a variety of signal processing and machine learning techniques. Adaptive boosting algorithm is employed to select the most significant features out of the feature library. The selected features are then fed to support vector machines to determine the presence and the location of the damage. The results show that the machine learning scheme is effective at identifying principal features like shift-invariant correlation coefficients, wavelet coefficients and curve length, and provides an average accuracy of 95% for damage detection and 93% for damage localization.

INTRODUCTION

Pipelines serve important roles in many engineering applications, and regular assessment and maintenance is essential to prevent structural failures. Guided wave ultrasonics is an appealing technology for structural health monitoring (SHM), because guided waves can propagate long distance with high sensitivity to damage in structures and can be generated by low-cost and low-power piezoelectric transducers. However, guided waves in pipes consist of an infinite number of modes, most of which are highly dispersive and travel along multiple paths [1-3]. Therefore, it is difficult to detect changes produced by damage, and it is even more difficult to

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Ключевые слова:

Содержание.

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