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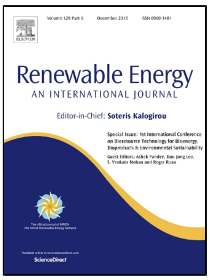

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Linear and Nonlinear Features and Machine Learning for Wind Turbine Blade Ice Detection and Diagnosis

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Abstract

The mass of ice on wind turbines blades is one of the main problems that energy companies have in cold climates. This paper presents a novel approach to detect and classify ice thickness based on pattern recognition through guided ultrasonic waves and Machine Learning. To successfully achieve a supervised classification, it is necessary to employ a method that allows the correct extraction and selection of features of the ultrasonic signal. The main novelty in this work is that the approach considers four feature extraction methods to validate the results, grouped by linear (AutoRegressive (AR) and Principal Component Analysis) and nonlinear (nonlinear-AR eXogenous and Hierarchical Non-Linear Principal Component Analysis), and feature selection is done by Neighbourhood Component Analysis. A supervised classification was performed through Machine Learning with twenty classifiers such as Decision tree, Discriminant Analysis, Support Vector Machines, K-Nearest Neighbours, and Ensemble Classifiers. Finally, an evaluation of the classifiers was done in single frequency and multi-frequency modes, obtaining accurate results.

Key Words: *Feature Extraction, NARX, NLPCA, NCA, Machine Learning, Guided Waves, Ice, Wind Turbine Blade, Classifiers.*