Comparative Analysis of Novel Deep Belief Network Over Decision Tree Algorithm for the Detection of Cracks in Large Marine Structures

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Abstract

Crack detection in large marine structures, particularly submarines, is a critical task for ensuring structural integrity, operational safety, and mission reliability under harsh underwater conditions. Traditional inspection methods face limitations due to poor visibility, high pressure, and restricted accessibility, making automated image-based detection techniques increasingly important. This study presents a comparative analysis of a Novel Deep Belief Network (NDBN) and a Decision Tree (DT) algorithm for detecting surface cracks in underwater submarine structures. A publicly available surface crack image dataset was used, comprising positive and negative crack samples. Both models were trained and evaluated using identical experimental conditions to ensure fairness in comparison. Performance was assessed primarily based on classification accuracy and statistical significance. Experimental results demonstrate that the Novel Deep Belief Network significantly outperforms the Decision Tree model, achieving a mean accuracy of 99.83%, compared to 83.09% obtained by the Decision Tree. Statistical validation using an independent sample t-test confirms that the observed performance difference is statistically significant ($p < 0.05$). The findings indicate that the hierarchical feature-learning capability of deep belief networks enables more robust and accurate crack identification compared to conventional tree-based methods. This work highlights the potential of deep learning approaches for reliable underwater structural health monitoring and supports their application in enhancing the safety, maintenance, and longevity of large marine structures.

Keywords

Crack Detection, Decision Tree, Deep Belief Network, Image Classification, Marine Structures, Structural Health Monitoring.