LA-UR-24-27850

Author(s): Kendric Hood

Mentors: Nathan DeBardeleben

Title: Echo State Networks: An Approach to Non-Intrusive Anomaly Detection in Manufacturing

Abstract:

This poster and presentation investigates the applicability of Echo State Networks (ESN) for developing non-destructive tests (NDT) with non-intrusive load monitoring (NILM) in manufacturing. Specifically, we evaluate its performance with Gas metal arc welding (GMAW) compared to other models. Our findings demonstrate that ESNs can effectively utilize raw data without requiring subject matter experts for preprocessing or feature engineering. For GMAW we show that the power drawn by the welder is sufficient to accurately identifying anomalies with an ESN model. ESNs can learn from only one data point, one example weld. This is due to their use of the pseudo-inverse matrix method for model training. Allowing implementation of NILM in a wide range of manufacturing processes where large amounts of training data is unavailable or impractical to collect. Our comparative analysis reveals that alternative models, such as transformers, demand significantly more data and are unrealistic in scenarios with limited data availability. Through a comparative analysis of different artificial neural networks (ANN), we show that ESNs can out preform common models in terms of accuracy, implementation overhead, and complexity.