AI-Driven Predictive Maintenance in Oil and Gas Using Deep Learning: An Experimental Study

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Abstract

Equipment failure in the oil and gas industry leads to costly downtime, operational disruptions, and environmental risks. Predictive maintenance (PdM), supported by modern Artificial Intelligence (AI) techniques, offers a more proactive and efficient alternative to traditional maintenance approaches. This paper presents an AI-driven PdM framework built using a Long Short-Term Memory (LSTM) deep learning model trained on the AI4I 2020 dataset from the UCI Machine Learning Repository. The model predicts machine failures and estimates Remaining Useful Life (RUL) from sensor readings. The proposed method achieved 87% accuracy, 84% precision, and 89% recall for failure prediction, with an RUL estimation root mean squared error (RMSE) of 12.5 hours. A lightweight Flask-based deployment demonstrated practical real-time usability, achieving a simulated 22% reduction in downtime and an estimated cost savings of $1.1 million across ten failure events. The results highlight the potential of deep learning as a practical tool for predictive maintenance in the oil and gas industry.

Keywords

Predictive Maintenance, Oil and Gas, Deep Learning, LSTM, Artificial Intelligence.