Summit to: Computational Material Science

Predictive Maintenance of Industrial Machinery using Machine Learning Algorithms

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EXTENDED ABSTRACT: Industrial machinery serves vital roles across various sectors such as automotive, oil and gas, wind energy, manufacturing, hydropower, mining, and recycling. Predicting faults in mechanical components poses challenges due to the presence of numerous elements within a single machine, including gearboxes, bearings, shafts, rotors, etc. These parts are susceptible to faults such as broken gearbox teeth, horizontal misalignment, vertical misalignment, underhang bearing faults and overhang bearing faults. These severe faults can lead to complete breakdowns, costly repairs and production losses so detecting faults in these components early is crucial to prevent. Detecting issues promptly helps mitigate critical damage and unexpected shutdowns, ensuring uninterrupted operation and minimizing downtime. The profound impact of gearboxes and rotary machines on both industrial operations and production efficiency underscores the necessity for robust and informed approaches. This study uses the concept is called Predictive maintenance (PdM), which is implemented to effectively manage maintenance plans of the assets by predicting their failures with data driven techniques. In these scenarios, data is collected over a certain period of time to monitor the state of equipment. The objective is to find some correlations and patterns that can help predict and ultimately prevent failures. The research specifically targets the assessment of faults in gearbox, utilizing dataset which includes gearbox dataset. These datasets were analyzed to predict the faults using machine learning and deep neural network models. The performance of the model was evaluated for the datasets with binary and multi-classification problems using the different machine learning models and their statistics. The study delves into solution which relies on machine learning (ML) and deep learning (DL) techniques, including decision trees, AdaBoost, random forests, and deep neural networks (DNNs) to forecast various types of faults in industrial components. By leveraging these advanced methods, we aim to provide predictive insights that empower maintenance teams to pre-emptively address issues by repairing or replacing components before faults occur. This proactive approach can significantly enhance operational efficiency and minimize costly downtime associated with unexpected failures in industrial machinery. To effectively monitor these components, a variety of sensors are required to measure and observe their behaviour individually. For the machinery fault prediction dataset, data utilized to develop the machine learning (ML) and deep neural network (DNN) models were sourced from the Spectra Quest machinery fault simulator. For the binary classification problem involving gearbox faults, both random forest and deep neural network models demonstrated equally strong performance, achieving the highest F1-score and AUC score of

approximately 0.98, and with an error rate of only 7%. Our research outcomes underscore the remarkable fault prediction prowess of Random Forest (RF) and Deep Neural Network (DNN) models in discerning different types of faults in gearboxes. These advanced models outperform traditional approaches such as decision trees and AdaBoost, highlighting their efficacy in enhancing fault detection accuracy and reliability.

Keywords: Predictive maintenance; DL; ML; Industrial Machinery; Deep Neural Network.

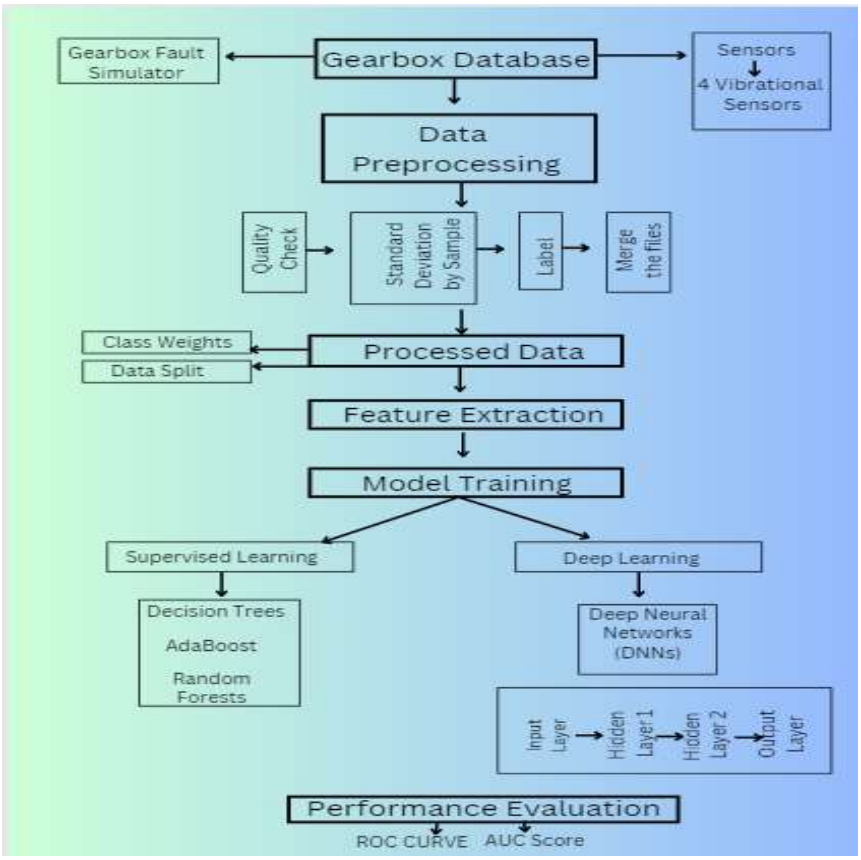

Figure 1. System Architecture – Visual representation of the project workflow, encompassing data preprocessing, class weight, data splitting, feature extraction, model training, and prediction, illustrating the sequential steps leading to the final solution.

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BIOGRAPHY

Bhashi is pursuing her Bachelor of Technology (B.Tech) degree from Indira Gandhi Delhi Technical University for Women (IGDTUW), located in New Delhi, India. She is a dedicated researcher interested in the amalgamation of Mechanical and Automation, Engineering Materials, Artificial Intelligence (AI) and Machine Learning (ML) with diverse sectors such as healthcare, biology, and social causes. From December 2023 Miss Bhashi is serving as a Research Intern in the Mechanical Engineering Department at Indian Institution of Technology Delhi (IITD). In her research pursuits, Miss Bhashi is deeply committed to unlocking the boundless potential of artificial intelligence (AI) and machine learning (ML) across a spectrum of dynamic applications. Her research interests traverse a rich landscape of cutting-edge domains, including the realms of Materials Science, Mechanical Engineering, Machine Learning, Artificial Intelligence, Deep Learning, Image Processing, and Data Science.