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Predicting Machine Failures and Failure Modes Using Supervised Machine Learning Techniques

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Abstract

Nowadays, predicting machine failures is a significant challenge faced by many industries. Machine failure can lead to unplanned downtime, production losses, safety risks, and increased maintenance costs. Predictive Maintenance Techniques (PdM) can help mitigate these risks by predicting machine failures before occur. The objective of this study is to utilize Machine Learning (ML) Techniques to assist maintenance engineers in minimizing machine downtime and maintenance expenses. This study involved developing two supervised ML models to predict failure and failure modes of machine. The study used various supervised ML algorithms to determine the most accurate algorithm. The models were developed using a four stage process, Data Pre-Processing, Training, Evaluation, and Deployment. A synthetic dataset was used to conduct a study on a Milling Machine to demonstrate the effectiveness of the proposed models for failure prediction. The accuracy, recall, precision, and F1 score performance were evaluated to verify the results of Model 1 and Model 2. The results indicated that the Random Forest was the most effective algorithm for predicting failures in Model 1 and Model 2, with an accuracy of 98% and 97%, respectively, and F1-score values close to 1 for class 0 (No Failure) and values close to 0.7 for class 1 (Failure) for Model 1. Regarding Model 2, the F1-score values provided seemed that the model performed well in most classes except class 4 (Random Failures) and class 5 (Tool Wear Failure). The findings confirm the effectiveness of ML based predictive maintenance models in enhancing maintenance decision making and reliability.

Keywords
Predictive Maintenance, Machine Learning, Failure Prediction, Reliability Engineering, Maintenance Optimization.

Biography
Majd Al-Atrash is an Industrial Engineer with over ten years of professional experience in industrial operations, maintenance engineering, and quality management. She is currently a graduate student in the Master's program in Maintenance Engineering and Quality Management at the University of Jordan. Majd works in the industrial and operations field, where she is responsible for procurement and operational support of specialized industrial, medical, and non-medical systems, with a strong focus on maintenance planning, process improvement, and operational efficiency. Her professional interests include predictive maintenance, reliability engineering, quality improvement, and the application of data-driven and machine learning techniques in industrial systems. Majd has practical experience in applying performance indicators and continuous improvement methodologies to enhance system reliability and reduce downtime. Her research interests focus on integrating machine learning models with maintenance strategies to support decision-making and optimize industrial operations.

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