LITERATURE REVIEW

The prediction of machine failures is a critical component of industrial maintenance, with significant implications for operational efficiency and cost savings. This review examines various studies focused on the binary classification of machine failures, highlighting methodologies, feature selection techniques, and practical implications in industrial settings. By adopting machine learning (ML) technology, which offers the capability to analyze complex data patterns and make accurate predictions, we aim to assess the effectiveness of ML-based approaches in predicting machine failures based on historical machine state data. Additionally, this review seeks to identify trends, challenges, and best practices in the application of ML for failure prediction, ultimately aiming to improve the reliability and efficiency of predictive maintenance strategies in industrial settings.

Battifarano et al. (2018) provide a foundational study that utilizes logistic regression, a binary classification technique, to predict future machine failures based on the current state of machinery [1]. This study emphasizes the practicality of logistic regression due to its interpretability and efficiency, particularly in scenarios where binary outcomes (failure/no failure) are essential for decision-making. The authors demonstrate that logistic regression can effectively handle machine state data, paving the way for more advanced machine learning methods.

Building on the theme of binary classification [2], Shaheen et al. (2023) introduce an innovative approach by integrating joint reserve intelligence with feature selection techniques. This study not only focuses on predicting machine failures but also highlights the importance of selecting the most relevant features to improve prediction accuracy. The incorporation of feature selection helps in reducing the dimensionality of the data, thereby enhancing the performance of the binary classification model. The authors argue that intelligent feature selection is crucial for dealing with high-dimensional datasets commonly encountered in industrial applications.

The impact of feature selection on machine failure prediction is further explored by Bezerra et al. (2024) [3]. This paper investigates various machine learning algorithms and the role of feature selection in improving their predictive capabilities. The study systematically evaluates how different feature selection techniques affect the performance of binary classifiers in predicting machine failures. The findings underscore that appropriate feature selection can significantly enhance model accuracy and reliability, making it a vital step in the predictive maintenance process.

Lee and Seo contribute to the discussion by focusing on early failure detection in paper manufacturing machinery using nearest neighbor-based feature extraction [4]. Their approach emphasizes the extraction of critical features that are indicative of potential failures. By employing nearest neighbor techniques, the study effectively identifies patterns that precede machinery breakdowns, thus facilitating timely interventions. The relevance of feature extraction in enhancing binary classification models is evident from their results, which show improved early detection rates.

Time series data plays a pivotal role in machine failure prediction, as demonstrated by Jansen et al. [5] and Pinciroli Vago et al [6]. Both studies delve into the use of industrial time series data for predicting machine failures, albeit with different methodologies. Jansen et al. employ a comprehensive analysis of time series patterns to forecast failures, while Pinciroli Vago et al. focus on multivariate time series data in an industrial case study. These studies highlight the complexities and advantages of using time series data in binary classification models, emphasizing the need for robust algorithms capable of handling temporal dependencies.

Expanding on the theme of machine learning algorithms for failure prediction [7], Noorsaman et al. (2023) explore various machine learning models applied to the operational reliability of onshore gas transmission pipelines. This study compares different algorithms, assessing their effectiveness in predicting failures, a task fundamentally rooted in binary classification. The comparative analysis provides insights into the strengths and weaknesses of each algorithm, guiding practitioners in selecting the most appropriate model for their specific use case.

There are also broader perspectives on predictive maintenance and machine learning technologies. Sharma et al. (2022) conduct a comparative study of machine learning algorithms for fault diagnosis, relevant to the binary classification of machine failures [8]. Meanwhile, Zufle et al. present a predictive maintenance methodology that predicts time-to-failure, indirectly contributing to the binary classification discourse by focusing on the predictive maintenance framework [9].

Schmidt and Wang (2015) offer a general literature review on predictive maintenance, providing valuable context for understanding the broader trends and future directions in the field [11]. Although less specific to binary classification, their review highlights the evolution of predictive maintenance practices and the increasing reliance on data-driven approaches. This work complements the more targeted studies by situating them within the broader landscape of predictive maintenance research.

Finally, comprehensive reviews by Leukel et al. (2021) and Bousdekis et al. (2019) provide a systematic overview of the adoption of machine learning for failure prediction and decision-making in predictive maintenance, respectively [10,12] . These reviews synthesize current research trends, challenges, and future directions, offering a holistic view of the field and reinforcing the significance of binary classification in predicting machine failures.

These studies emphasize the importance of predictive maintenance for industrial systems, showing that data-driven strategies can reduce downtime, lower costs, and improve efficiency. They highlight the role of binary classification and feature selection in enhancing maintenance strategies and discuss the effectiveness of machine learning, deep learning, and ensemble methods in predictive maintenance modeling. Integrating process analysis, anomaly detection, and real-time monitoring can further improve predictive models, leading to more reliable operations in industrial settings.

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