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A novel method for evaluation of the maintenance impact in the health of industrial components

A. Muñoz San Roque; D. González Calvo; F.J. Bellido López; M.A. Sanz Bobi; T. Álvarez Tejedor

Abstract-

This study presents a novel method for evaluating maintenance effectiveness in industrial systems, built around the concept of “risk curves” as quantitative indicators of failure. By integrating Failure Modes and Effects Analysis (FMEA) with machine learning-based anomaly detection models, the proposed approach constructs risk curves by aggregating normalized deviations from monitored variables. These curves reflect the progression of failure modes in real time and enable a quantitative and accurate assessment of the impact of maintenance actions.

A key contribution of this research is the use of risk curves as an innovative method to continuously track the potential emergence of failure modes and quantify how maintenance actions contribute to reducing their associated risk. Applied to a feedwater pump in a combined-cycle power plant, these curves successfully detected critical failures, such as bearing wear and leaks, months in advance of traditional methods. Moreover, they provided a data-driven means to assess the effectiveness of maintenance actions, demonstrating their role as a determinant factor in improving component condition and mitigating failure risk.

The findings highlight the potential of this methodology to enhance maintenance strategies, reduce downtime, and foster improved collaboration between operation and maintenance teams. This research represents a significant advancement in maintenance evaluation, offering a scalable and data-driven framework that bridges existing gaps in failure diagnostics and decision-making processes.

Index Terms- Maintenance Effectiveness; Failure Indicator; Predictive maintenance; PHM; RCM

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