ABSTRACT

Title of thesis: Implementation and optimization of predictive maintenance strategies through vibration analysis in mechanical systems

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Predictive maintenance (PdM) is transforming industrial maintenance by overcoming the disadvantages of traditional reactive and preventive techniques through real-time condition monitoring to enhance mechanical system efficiency and reliability. This study discusses crucial factors such as sensor selection, signal processing, and machine learning integration while focusing on getting the best out of PdM through vibration analysis in rotating machinery and SPM analysis.

By evaluating vibration sensors, advanced signal processing techniques (such as Fast Fourier Transform and Wavelet Transform), and an integrated monitoring solution platform (Condmaster) leveraging machine learning models (such as CNNs and LSTMs) for accurate fault detection, the study establishes a PdM framework. Optimizing sensor configurations, identifying fault features, and making the model interpretable with a focus on IoT and edge computing for real-time monitoring are key objectives to minimize false alarms.

Research was also carried out at the Arconic plant in Szekesfehervar, Hungary, where machine condition monitoring is done by the SPM method. The working principles of the leveler machine are discussed together with the setup and installation of the SPM control system as well as data analysis. It discusses how efficiently the monitoring method has been able to detect faults and possible future improvements and developments in enhancing better performance and reliability for the system.

The proposed framework can reduce costs, increase availability, and be compliant with Industry 4.0 by out-performing the conventional methods. The results provide useful insights for the industry as well as for future research in the development of intelligent maintenance systems.

Keywords: Industry 4.0, signal processing, machine learning, rotating machinery, vibration analysis, SPM, and predictive maintenance.