ME Seminar

Development of Data-Driven, Physics-Based and Hybrid Fault Prognosis Strategies for Machine Elements

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ABSTRACT

The failure of rotating mechanical systems leads to unplanned outages, compromised product quality, decreased productivity, and increased operating and maintenance costs. To mitigate these challenges, machine learning (ML) based data-centric models are often employed for health assessment, encompassing anomaly detection, fault diagnostics, and prognostics for predicting remaining useful life. However, the scarcity of training data, especially for unreported damages, poses a significant limitation in the development of these ML models. Physics-based models, which utilize the understanding of damage progression, offer an alternative by reducing the data requirements of data-driven models. Despite their potential, these models can exhibit high modeling errors due to assumptions and simplicity. The hybrid model (combining data and Physics through different mechanisms) presents an opportunity to overcome these limitations and enhance prediction accuracy. The talk focuses on the development of data-driven, physics-based, and hybrid prognostics strategies under data availability and modeling constraints.

ABOUT THE SPEAKER

Pradeep Kundu is currently working as an Assistant Professor in the Department of Mechanical Engineering at KU Leuven, Belgium, and a member of the KU Leuven Institute for Artificial Intelligence (Leuven.AI). Before joining KU Leuven, he worked as a Post-Doctoral Fellow and Research Associate at the University of Cincinnati, USA, and the University of Strathclyde, UK, respectively. His research focused on the broad domain of utilizing the potential of Industrial Artificial Intelligence and Digital Twin to solve Asset Health Management and Quality Control problems. His research helps industries in reducing unplanned outages, increasing productivity, automating quality control, and reducing operation and maintenance costs. His current research work encompasses two key areas: (i) Addressing data scarcity in Machine Learning model development by generating synthetic data through Digital Twin technology. (ii) Improving the interpretability and robustness of Machine Learning models using Digital Twin technology, Physics-Informed Machine Learning, Hybrid Modelling, and Statistical Regression Models. He has published around 50 articles in reputed journals and conferences. He has delivered four keynote speeches, two-panel talks, and over 20 invited lectures. He serves as a guest/handling/associate editor for 4 journals, including his current role as an associate editor for Measurement, Elsevier Journal. He contributed to over 10 conference committees, including organization of 15th Prognostics and System Health Management Conference 2025 as General Chair. He has received several awards, including runner-up for PHM Europe 2022 Data Challenge, overseas visiting doctoral fellowship from SERB, etc.

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