SCIENCES & BIOENGINEERING SCIENCES

The Research Group
Artificial Intelligence Lab

has the honor to invite you to the public defence of the PhD thesis of

Fabian Ramiro Perez Sanjines

to obtain the degree of Doctor of Sciences

Title of the PhD thesis:

Methods Merging Artificial Intelligence and Signal Processing for Enhanced Vibration Based Fault Detection in Wind Turbines

Promotors:
Prof. Dr. Ann Nowé (VUB)
Prof. Dr. Jan Helsen (VUB)

The defence will take place on

Thursday, January 9, 2025 at 5 p.m. in D.2.01

The defence can also be followed through a live stream here.

Members of the jury

Prof. Dr. Pieter Libin (VUB, chair)
Prof. Dr. Jens Nicolay (VUB, secretary)
Dr. Pieter-Jan Daems (VUB)
Prof. Dr. Yi Guo (Technical University of Denmark, DK)
Asst. Prof. Dr. Isel Grau Garcia (Eindhoven University of Technology, NL)

Curriculum vitae

Fabian graduated with a BSc in Systems Engineering at the Universidad Mayor de San Simon in 2013.

After working for five years as a Software Developer, he obtained his MSc in Computer Science with a specialisation in Artificial Intelligence at the Vrije Universiteit Brussel in 2019.

Afterwards, he started a PhD at the Artificial Intelligence Lab and the Acoustics & Vibration Research Group at the Vrije Universiteit Brussel.

His research focuses on integrating artificial intelligence and signal processing methods for the condition monitoring of wind turbines.

Abstract of the PhD research

This thesis focuses on using machine learning for condition monitoring, specifically for wind turbines, to reduce operational costs. Condition monitoring involves continuously observing turbine health, enabling condition-based maintenance and control.

However, applying machine learning methods presents some challenges, especially when dealing with real-world data that can be noisy or incomplete. Moreover, there are other problems, such as dealing with unbalanced datasets, the interpretability of the models, and the need for health labels in the vibration signals.

Otherwise, traditional condition monitoring approaches use signal processing methods to calculate health indicators, which are then analysed for anomaly detection. These methods also face challenges, such as needing expert manual analysis of extensive data. Moreover, calculating all health indicators introduced in the literature is not feasible due to high demands for memory, storage, and processing resources.

This dissertation aims to develop an interdisciplinary approach, integrating artificial intelligence and traditional signal processing methods to develop a condition monitoring pipeline. This approach exploits the strengths of both fields: using signal processing for physical model explanations and machine learning for automation and handling real-world data.

This research makes some contributions to condition monitoring. First, it implements an end-to-end scalable condition monitoring pipeline architecture capable of processing and analysing vast amounts of data. Second, it develops a multi-armed bandit framework to efficiently select the most effective health indicators for fault detection, thereby addressing the infeasibility of calculating all potential indicators. Lastly, it introduces a deep learning autoencoder method for analysing complex spectral health indicators, combining signal processing with machine learning to handle large amounts of unbalanced, unlabelled data.

All contributions were validated using real wind turbine data, confirming their robustness and applicability in real-world scenarios. This research exemplifies an interdisciplinary effort, bridging artificial intelligence and traditional condition monitoring methods such as signal processing.