A Conceptual Framework for Data-driven Reliability-centred Evolutionary and Automated Maintenance of Offshore Wind Farms

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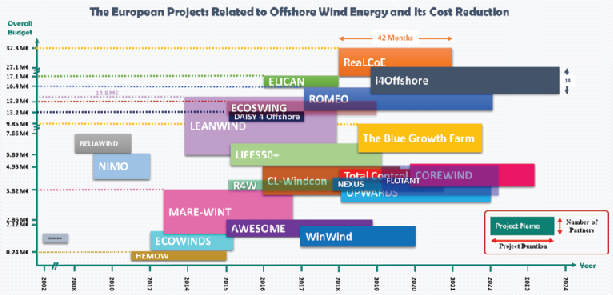
Abstract

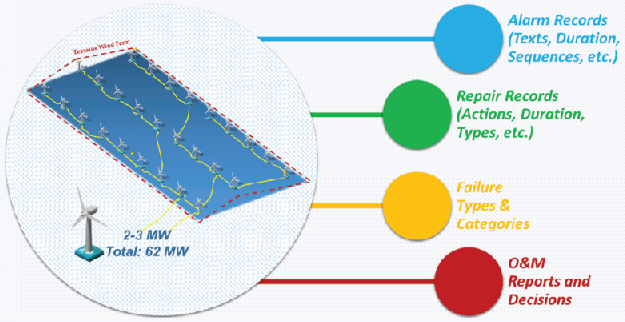
This paper proposes a novel framework for data-driven reliability-centred evolutionary automated maintenance for offshore wind farms that includes four stages: I) to achieve real-time reliability and availability of the wind farm, estimates of Remaining Useful Life (RUL) of components are embedded to a Semi-Markov Process (SMP) within HIP-HOPS, an automated reliability estimation tool. II) using deep learning, a system is then built through which possible maintenance procedures and its requirements are recommended. III) a multi-objective optimization algorithm uses estimates of reliability and possible maintenance actions to generate and update an optimized maintenance plan for an offshore wind farm. IV) finally, in the context of reinforcement learning, the maintenance plan is judged by experts and is adjusted in subsequent iterations.

EU Projects



Case Study

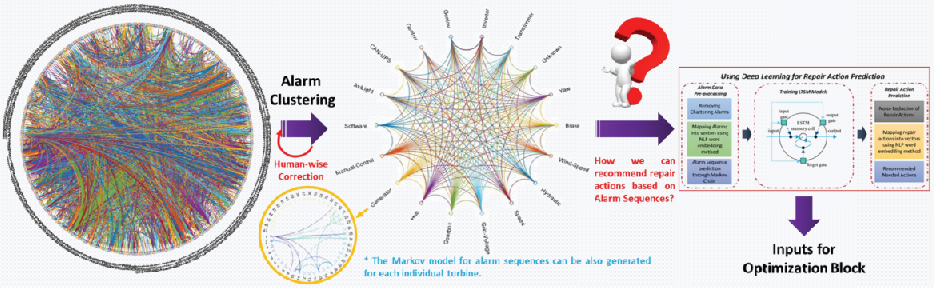
Teesside Offshore Wind Farm is used as a case study for this research. It comprises 27 2.3MW turbines and the data used for this study..



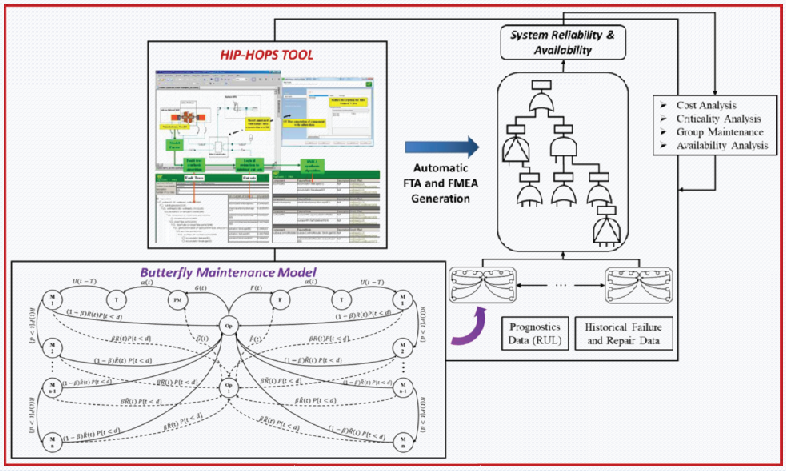
Objectives

- Developing a repair action recommender and modelling alarm sequences
- Providing optimized and automated maintenance planning considering reliability factors
- Evaluation in a real case study of the offshore wind farm.
- Making the tool more realistic through reinforcement learning.

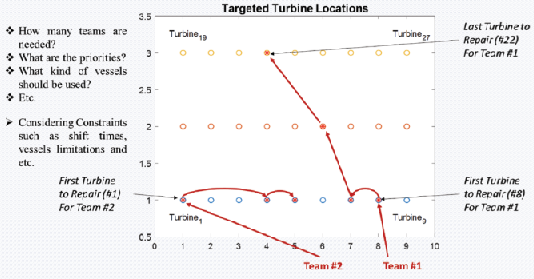
I Alarm Sequences and Their Link with Repair Actions



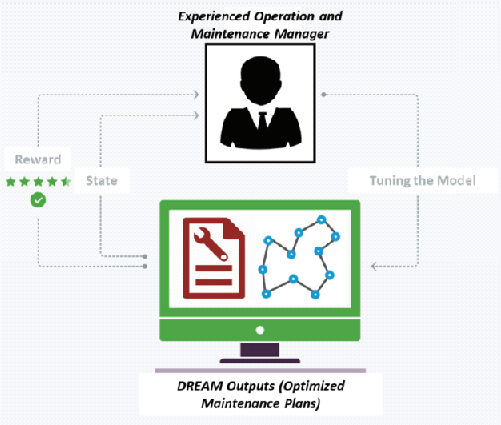
II Online Availability Markov Model



III Evolutionary Optimization for Maintenance



IV Reinforcement Learning Procedure



Conclusions

The paper has focused on the development of bio-inspired optimisation techniques that use fault prognosis and alarm sequences to continually produce and update an evolving optimal plan of O&M. This plan explores the enormous design space of possible and optimal dynamic maintenance schedules, optionally taking constraints such as logistics, respecting constraints, optimising reliability and energy profiles whilst minimising maintenance costs and reducing downtime. The framework also uses the idea of reinforcement learning to update the results and learn from an O&M manager and make the maintenance plans more realistic. The paper gives an overview of the system with details of this system to be included in future papers.

References

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