DREAM: Data-driven Reliability-centred Evolutionary Automated Maintenance for Offshore Wind Farms

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Abstract

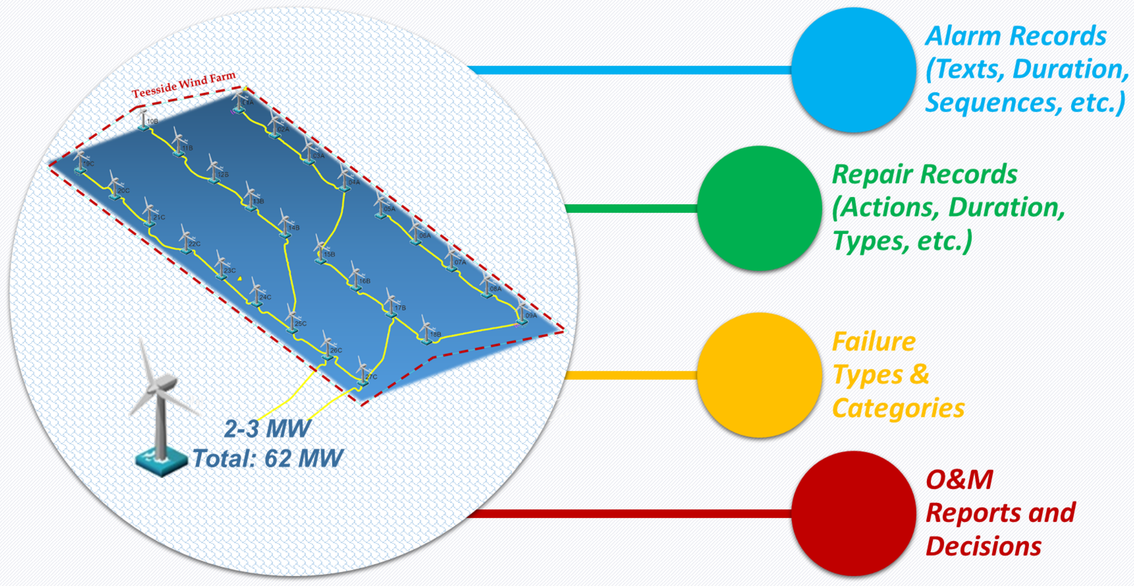
The associated costs of Operation and Maintenance (O&M) in offshore wind farms can be significantly reduced through condition monitoring, data analytics and intelligent maintenance planner. This can be achieved via combining optimization algorithms, fault prognosis and reliability models. The research is focusing on the development of bio-inspired optimisation techniques that exploit fault prognosis 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, optimise reliability and energy profiles whilst minimising maintenance costs and reducing downtime.

Objectives

- *Development of a tool to derive an experimental platform to provide a data-driven reliability-centred evolutionary automated maintenance. This tool can be an extension of the HIP-HOPS .*
- *Evaluation in a real case study of the offshore wind farm. More information regarding the case study is provided in the next section.*
- *Using the tool in parallel with O&M managers to tune the platform through reinforcement learning.*

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 include alarms, repair actions, maintenance procedures, etc. The following figure shows the wind farm's layout and the list of the available data.



DREAM Framework

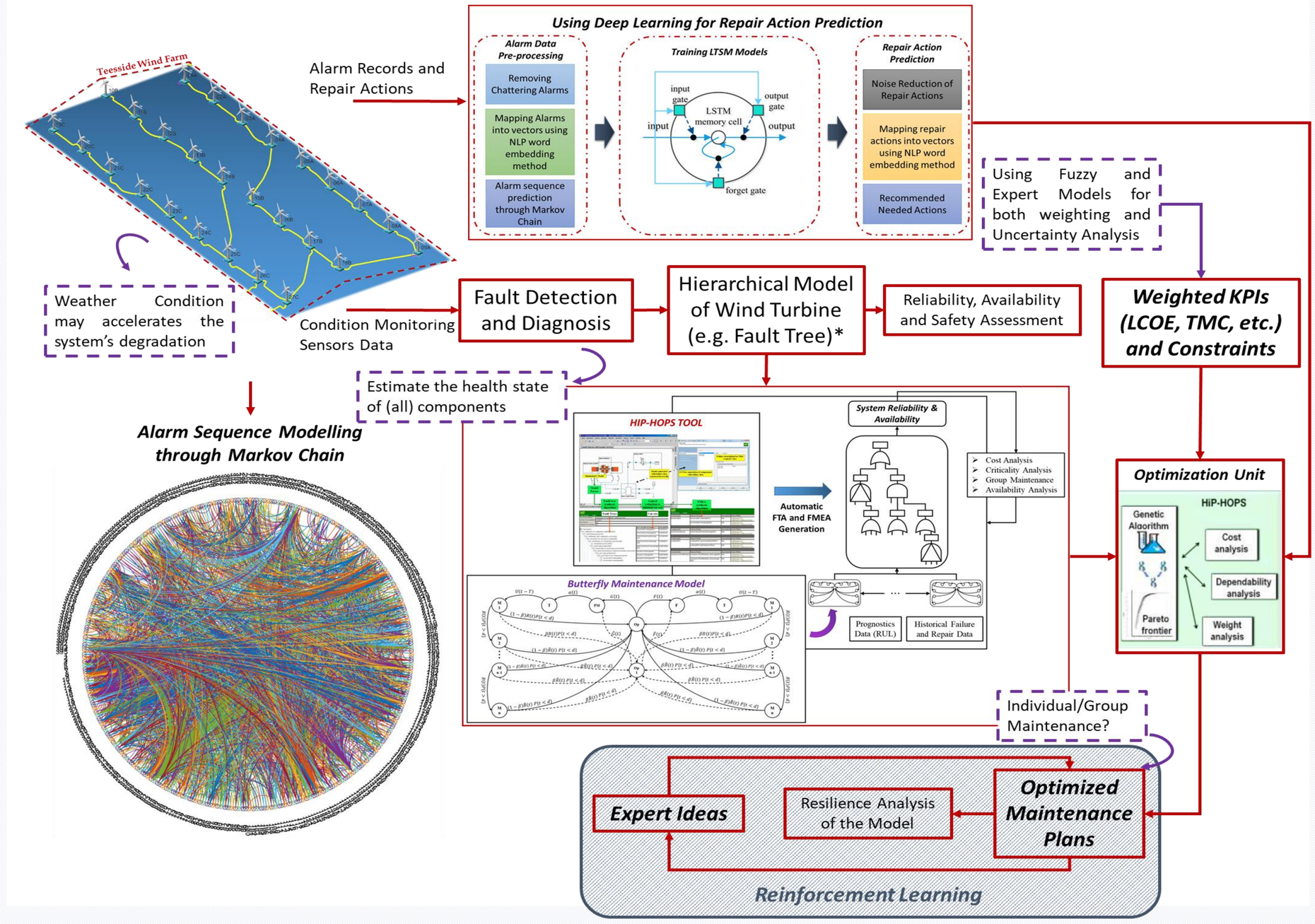
This paper proposes a novel framework for data-driven reliability-centred evolutionary automated maintenance for offshore wind farms that includes four steps:

Firstly, condition monitoring data is used for estimation of Remaining Useful Life (RUL) from which expected failure distributions are projected and fed to a Semi-Markov Process (SMP) within HIP-HOPS, an automated reliability estimation tool, in order to project reliability and availability in real time.

Secondly, using natural language processing and deep learning, a system is built through which possible maintenance procedures and its requirement are recommended.

Thirdly, an evolutionary optimization algorithm uses estimates of reliability and possible maintenance actions to continually generate and update an optimized maintenance plan for an offshore wind farm.

Finally, in the context of reinforcement learning, the maintenance plan is judged by experts and is adjusted in subsequent iterations.



Conclusions

Overall, the framework explores the enormous design space of possible dynamic maintenance schedules, optionally taking constraints such as logistics, respecting constraints, optimise reliability and energy profiles whilst minimising maintenance costs and reducing downtime. An implemented simple automated maintenance planner in Princess Amalia Wind Park in The Netherlands 302000 Euros over 5 months [1] and it is believed that this tool can provide more benefits.

References

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