EPSRC NHP-WEC Research Project 2nd Advisory Board Meeting

Work Package 2

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UNIVERSITY OF HULL | ENERGY AND ENVIRONMENT INSTITUTE

UKRI Engineering and Physical Sciences Research Council

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WP2: Survivability, Reliability and Optimised Control of Devices in the Marine Environment

Project plan

- Smart sensor and data acquisition
- Intelligent condition monitoring
- Predictive Maintenance
- Optimised control strategy

Smart sensor and data acquisition

Current sensor placement technologies

- Structural Health Monitoring: Immune monkey, distributed wolf,…
- Power take off system

Evaluation criteria

- Model assurance criteria
- Fisher information matrix
- Information entropy
- Energy based criteria
- …

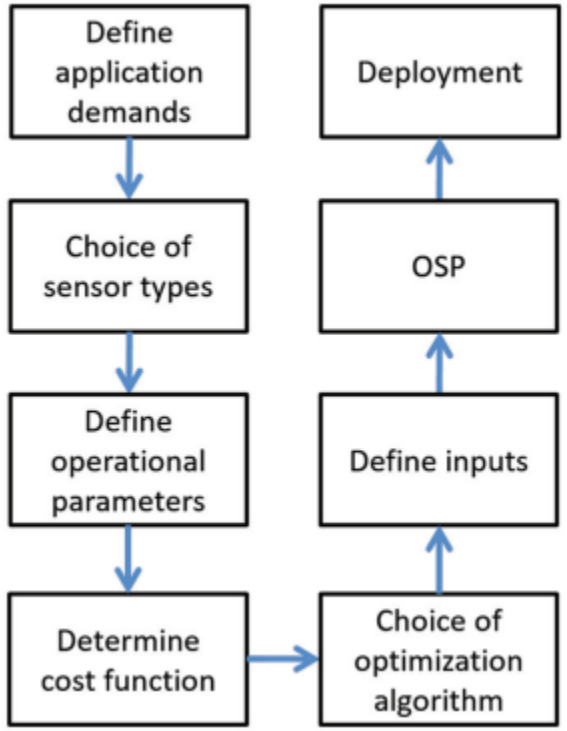
Optimisation methodologies

- GA
- Dragonfly
- …

Case study

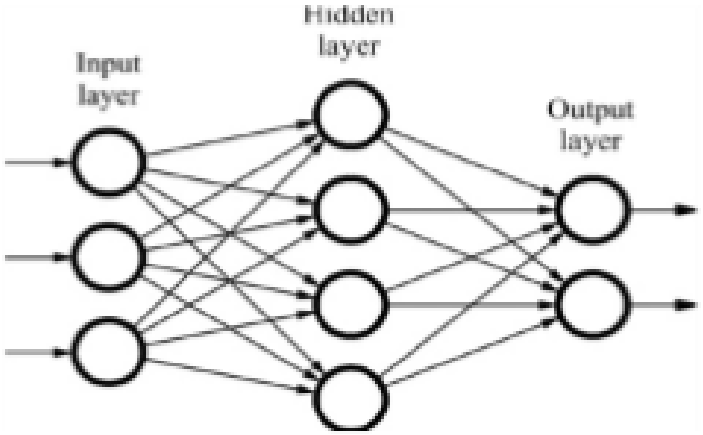
- Application in SHM
- Application in PTO

Sensor placement optimisation



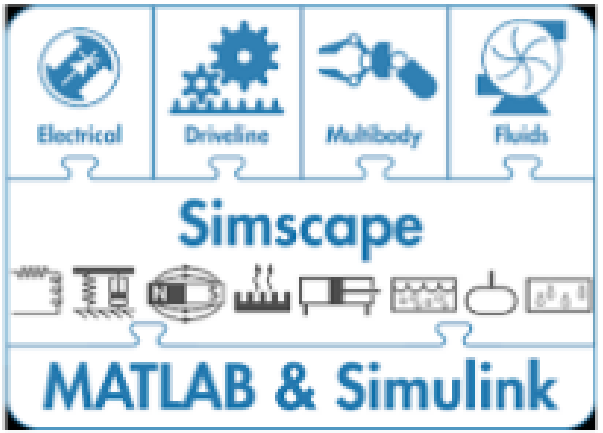
Intelligent condition monitoring

Data driven modelling



Applications:
- Operations Optimisation
- Anomaly Detection
- Predictive Maintenance

Physical Modelling



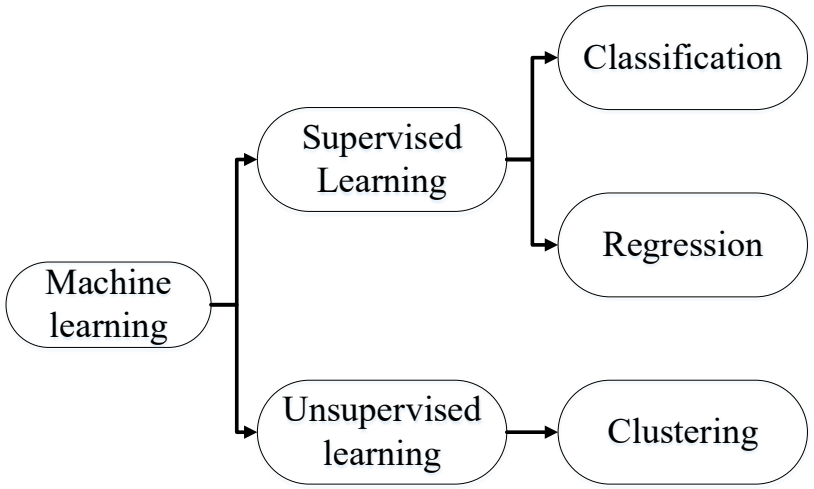
Data driven:
Degradation model

Data and physical combined:
Kalman filter

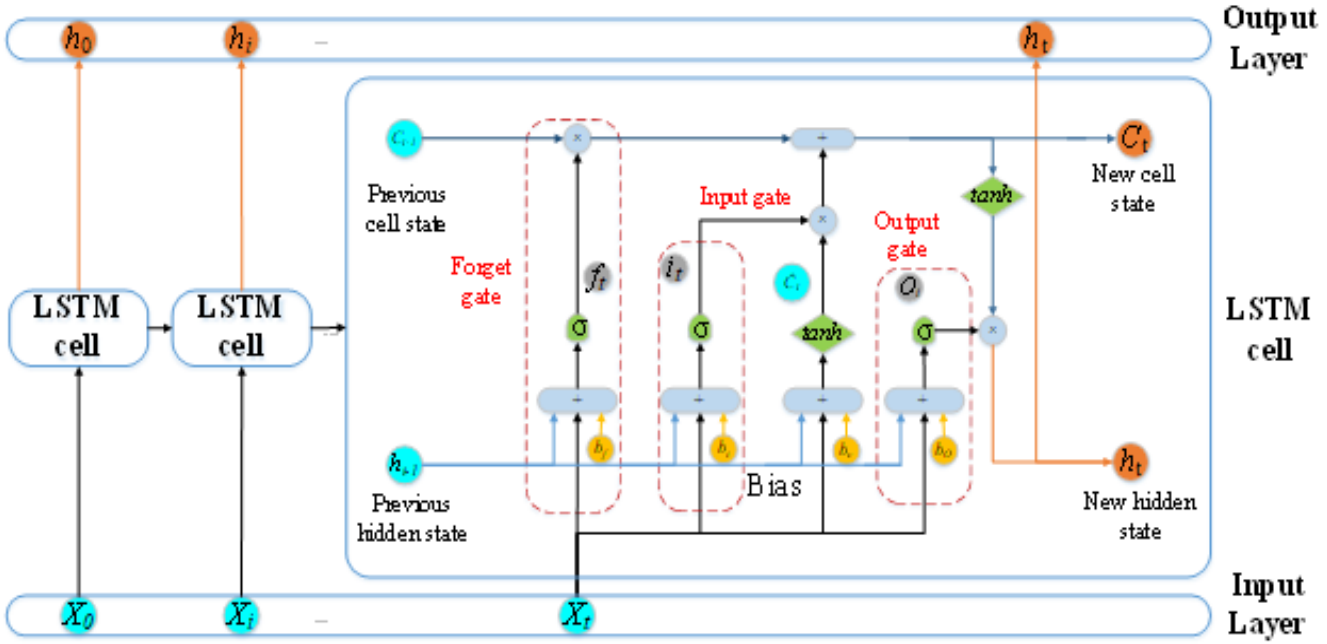
Physical based:
Physical model

Intelligent condition monitoring

How it works in WEC system condition monitoring

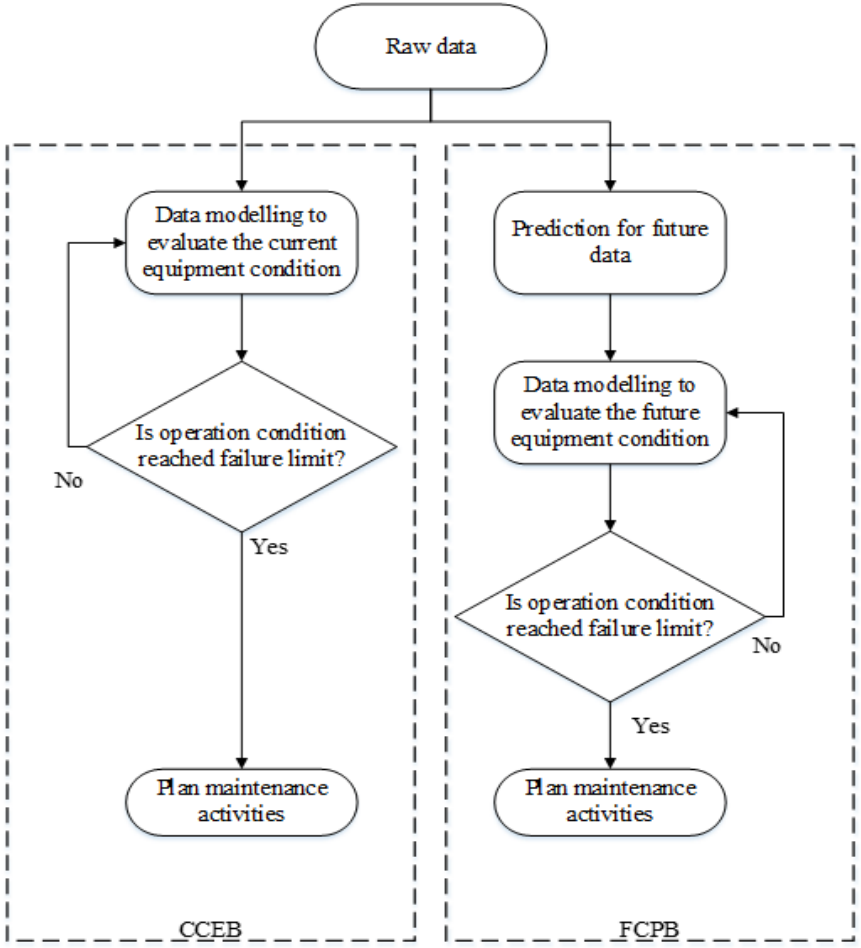


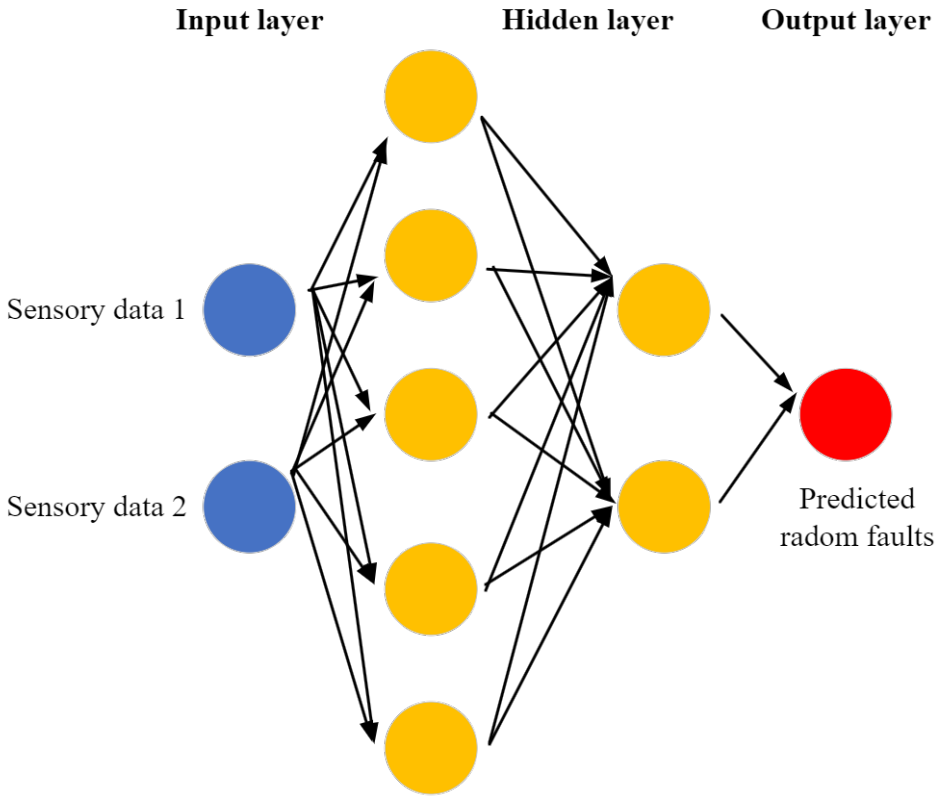
Example: LSTM network



(Y. Wu and X. Ma, "A hybrid LSTM-KLD approach to condition monitoring of operational wind turbines," *Renewable Energy*, vol. 181, pp. 554–566, Jan. 2022, doi: 10.1016/j.renene.2021.09.067.)

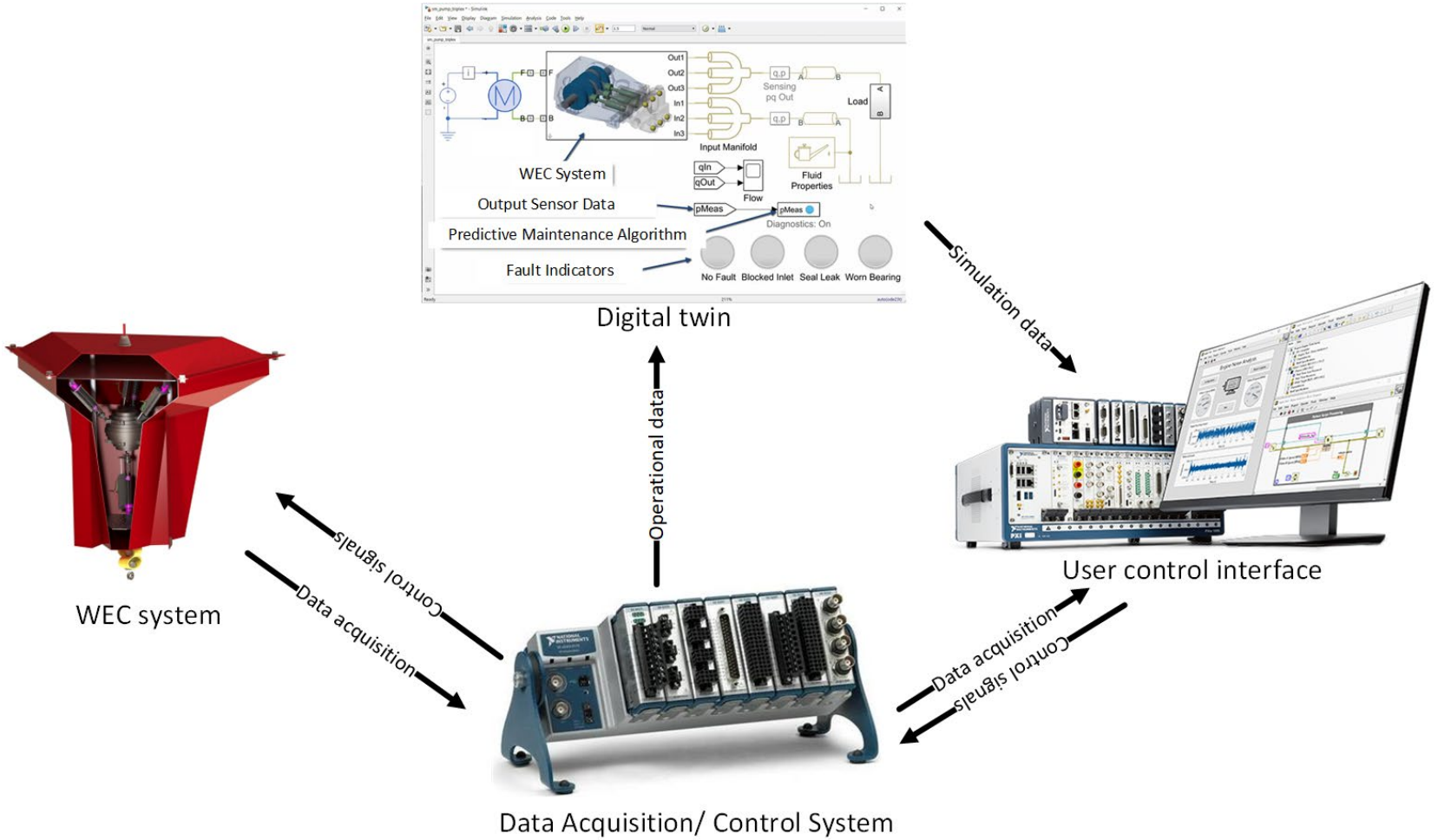
Predictive Maintenance





(M. Benbouzid, T. Berghout, N. Sarma, S. Djurović, Y. Wu, and X. Ma, "Intelligent Condition Monitoring of Wind Power Systems: State of the Art Review," *Energies*, vol. 14, no. 18, p. 5967, Sep. 2021, doi: 10.3390/en14185967.)

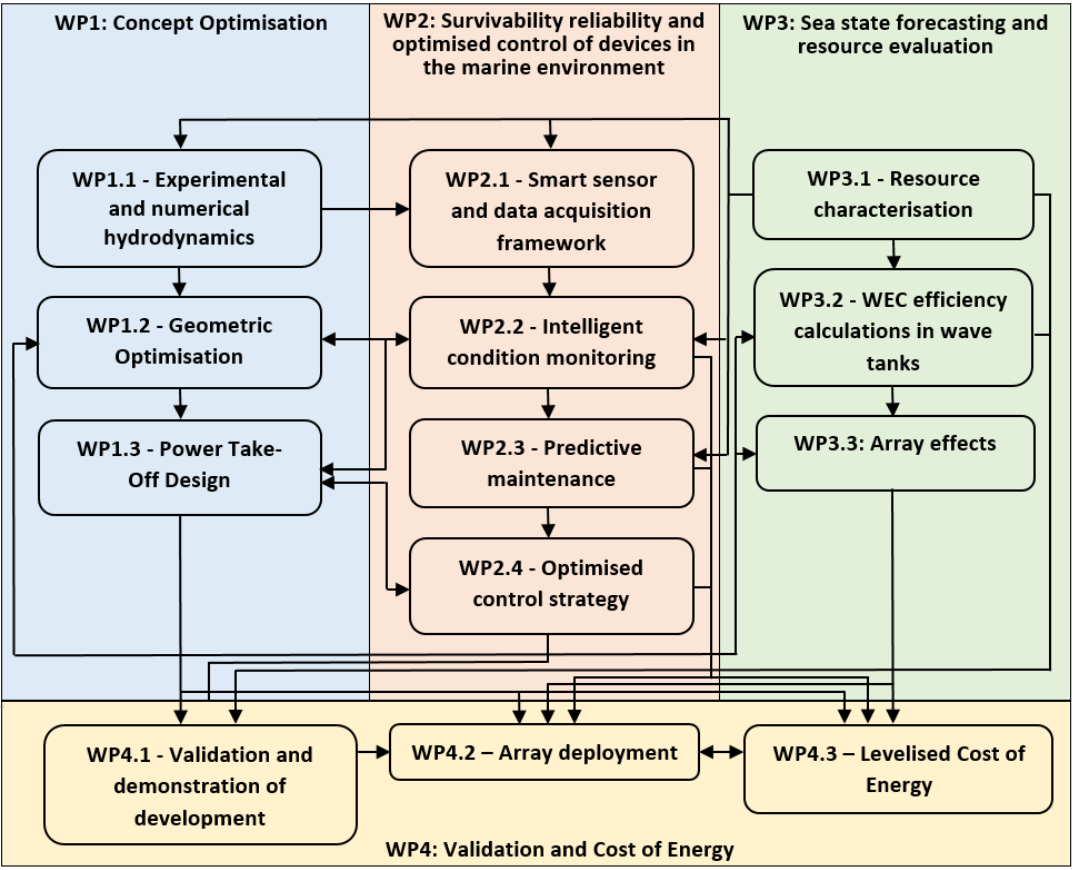
Optimised control strategy



Control difficulties

- Nonlinear behaviour of the flow turbine sensors, especially the classic flow sensor.
- Phase shift between the desired inflow to the accumulators and the measured inflow.
- Dynamic behaviour exhibited by the valve.
- Different control gains needed whenever a system variable is changed.

Work plan



WORKPLAN

Tasks / Quarter	1	2	3	4	5	6	7	8	9	10	11	12
WP1: Concept optimisation												
Experimental and numerical hydrodynamic analysis												
Geometric Optimisation												
Power Take-Off Design												
WP2: Survivability, Reliability and Optimised Control of Devices in the Marine Environment												
Smart sensor and data acquisition system												
Intelligent condition monitoring												
Predictive maintenance												
Optimised control strategy												
WP3: Sea state forecasting and resource evaluation												
Resource characterisation												
WEC efficiency calculations in wave tanks												
Array effects												
WP4 – Validation and Cost of Energy												
Validation and demonstration of development												
Array deployment												
Levelised Cost of Energy												

Thanks!

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