System-level Co-design and Control of Large Capacity Wave Energy Converters with Multiple PTOs

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To be presented at Supergen ORE Hub Fourth Annual Assembly

The Consortium

- Queen Mary University of London:
  - Guang Li (Control)
- Exeter University
  - Mike Belmont (Wave prediction)
- University of Manchester
  - Judith Apsley (Test rig design and dry testing)
  - Matteo Iacchetti (Power electronics)
  - Samuel Draycott (Hydrodynamics)
  - Peter Stansby (Device design)
- Industrial partners: M4 Wave Power, Mocean Energy, Eco Wave Power.

M4WavePower

Moored MultiMode Multibody

Outline of the project

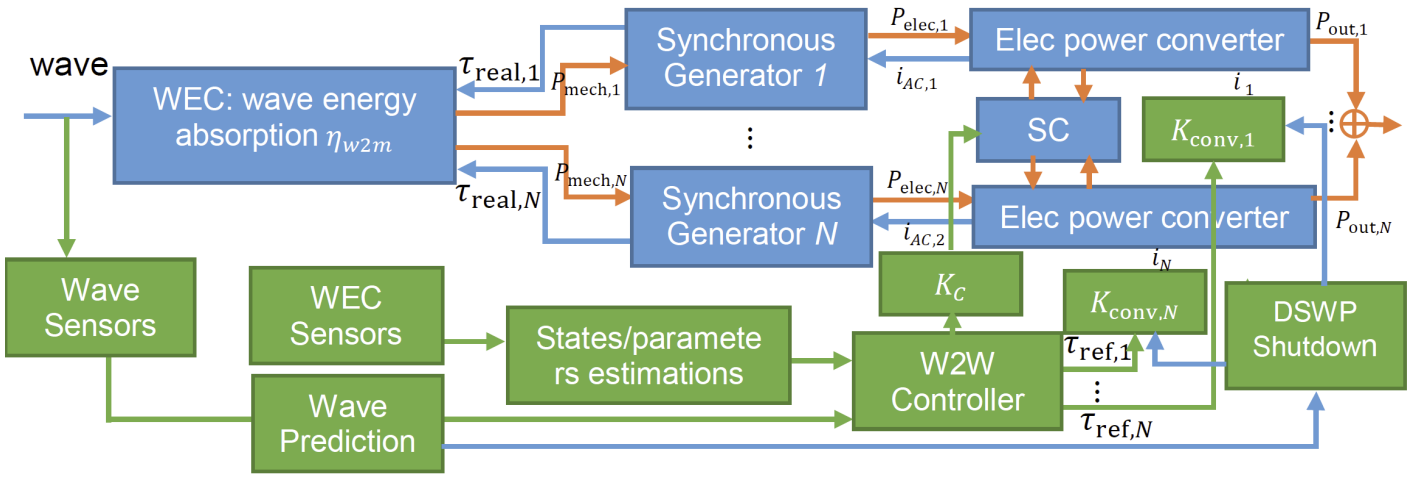


Fig. 2: Control system block diagram

- WP1: Modelling for all the subsystems: wave-to-wire model.
- WP2: Multi-directional wave prediction and shutdown.
- WP3: Control framework based on the wave-to-wire model.
- WP4: Co-design of the whole system.
- WP5: HIL for validation of control and co-design.

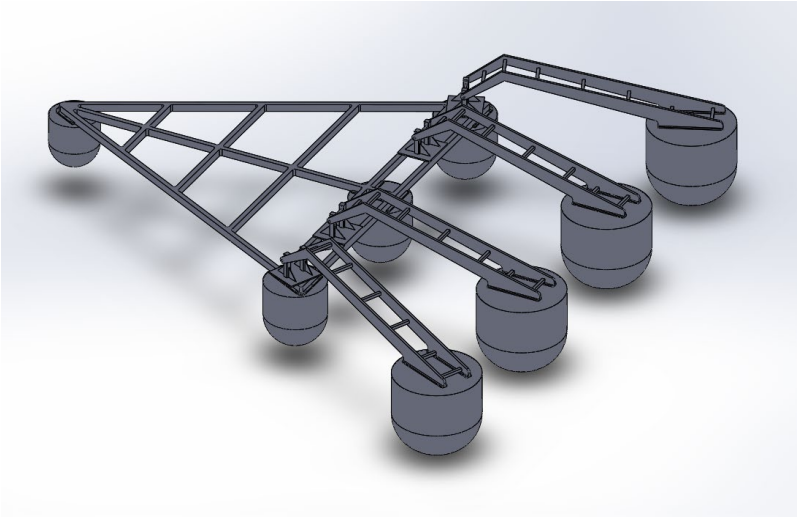


Fig. 1: M4 with 3 PTOs

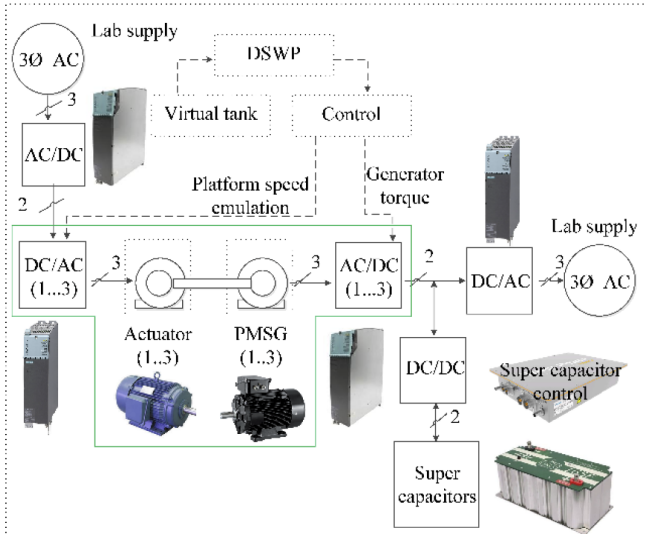


Fig. 3: HIL test rig for M4 control: Components: Gear box, generator, supercapacitor, electronic converters, microcontroller and numerical tank

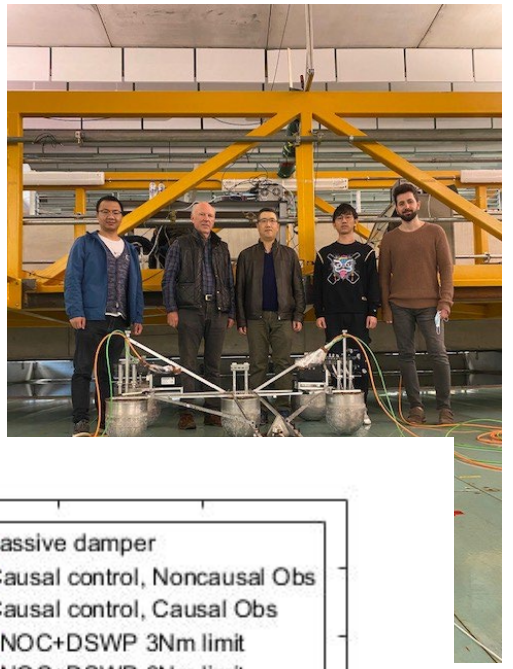
Progress

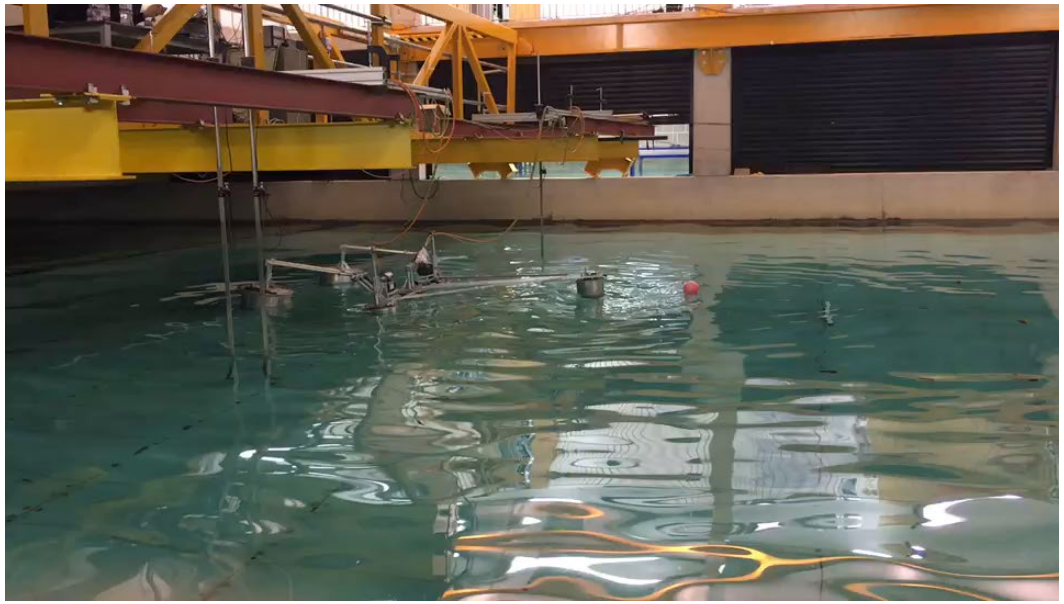
- Project started in September 2021.
- Two PDRAs (Queen Mary, Manchester) have started working. Another PDRA will be recruited soon.
- The hydrodynamic model has been extended to multi-directional waves.
- The model has been validated in directional wave conditions.

  P. Stansby, E. C. Moreno, S. Draycott, and T. Stallard, “Total wave power absorption by a multi-float wave energy converter and a semi-submersible wind platform with a fast far field model for arrays,” J. Ocean Eng. Mar. Energy, 2021.
- Fast Wave Profile Estimation created for Multi-directional Deterministic Sea Wave Prediction.
- Initial design of HIL test rig is drafted.

Workpackages		Year 1				Year 2				Year 3			
	Lead	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12
WP1.1 Wave-to-wire modelling and virtual tank	UoM												
WP1.2. Control-oriented W2W model	QMUL												
WP2.1. Multi-DSWP integration into control.	UoE												
WP2.2. Multi-DSWP shutdown and integration into control	UoE												
WP3. W2W control framework development	QMUL												
WP4. Co-design of the WEC system.	QMUL												
WP5.1. W2W test rig design and construction	UoM												
WP5.2. Dry testing on W2W test rig	UoM												
WP6. Evaluation and exploration of the proposed techniques	QMUL												

M4 tank testing at Plymouth – additional work





- 2 PTOs controlled by Linear Noncausal Optimal Control.
- Deterministic sea wave prediction (DSWP) was employed.
- Control task: maximise mechanical power

Control performance comparison:

- Noncausal optimal control>Causal optimal control>passive

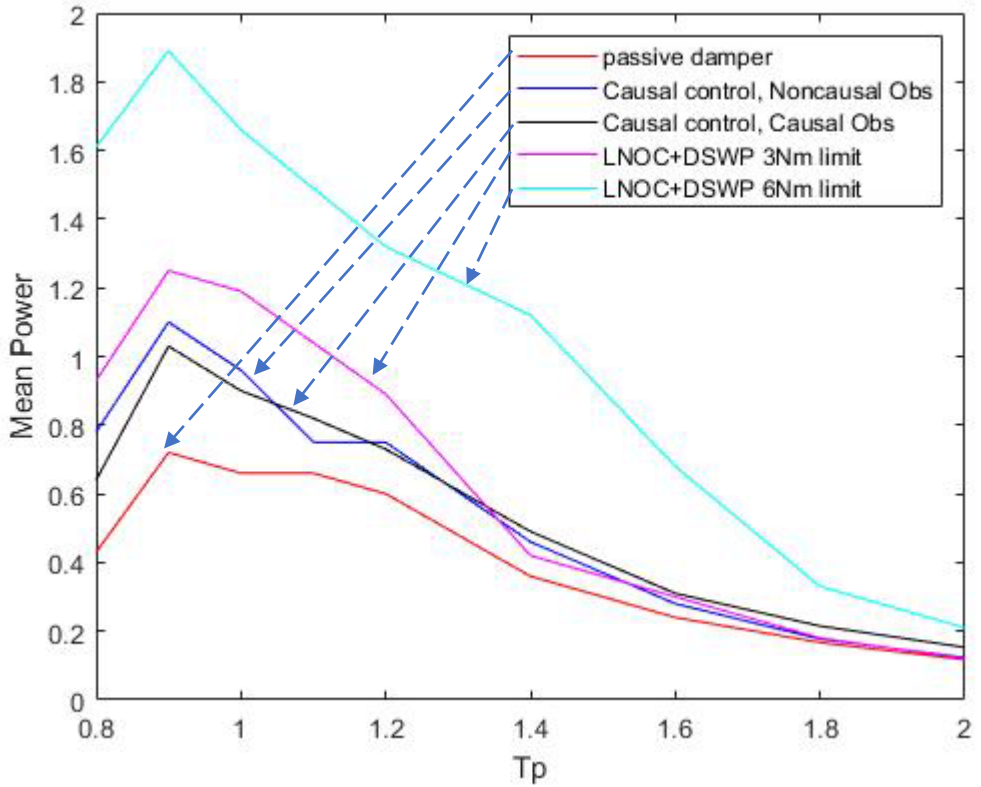


Fig. 4: Mean power comparison of LNOC and passive damper.

Thank you!