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Rogue-wave-energy: wave-to-wire mathematical modelling

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A novel wave-energy device design [1,2] will be presented based on the following features: (i) an electro-magnetic generator based on cylindrical magnets moving through induction wires around a cylindrical tube, like in the IP wave-buoy, (ii) a convergence in a breakwater to amplify the incoming waves, like in the TapChan device, and (iii) a wave-activated buoy with magnets attached, like in the Berkeley wedge, constrained to move in a slight arc or in a rectilinear manner. Its workings will be demonstrated in a first, operating proof-of-principle. A monolithic mathematical model is established by coupling the three variational principles for the hydro-dynamic wave motion, using the potential-flow approximation, the constrained wave-activated buoy motion, and the electro-magnetic generator together into one grand variational principle. The resistive losses in the electrical circuit and the energy harvested in the (parallel LED) loads are subsequently added to the dynamics. After linearisation of the resulting full 3D nonlinear model around a state of rest and application of the shallow-water approximation, we discretize the linear dynamics in a compatible, i.e. geometrically consistent, manner using a finite-element approach in space and symplectic integrators in time. Preliminary numerical modelling and simple optimization will be shown and these are promising. Finally, further optimisation of the device for different geometries and for a given wave-climate as well as alternative designs will be discussed.

References

- [1] O. Bokhove, A. Kalogirou, W. Zweers 2019: From bore-soliton-splash to a new wave-to-wire wave-energy model. *Water Waves* **1**.
- [2] O. Bokhove, A. Kalogirou, D. Henry, G. Thomas 2019: A novel rogue-wave-energy device with wave amplification and induction actuator. In: 13th European Wave and Tidal Energy Conference 2019, Napoli, Italy.