A new latching control technology for improving wave energy conversion

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Abstract

In improvingwave energy conversion, control and optimisation technologies have been developed. In the developed control technologies, latching control is a very effective control technology because it can significantly improve wave energy conversion. In implementing latching control technologies, one technical barrier is the determination of the latching duration or the delatching moment, one of the two critical technical and engineering barriers for implementing latching control technology. Almost all the developed latching control technologies have required the detailed future information so that the control can align up the velocity and the excitation for a phase control.

To remove this difficult requirement, a new latching technology has been developed recently, in which the latching duration can be easily decided based on the wave period, and for justifying the proposed technology, a new method called as 'time-out' has also been proposed. This presentation summarises the development and gives some examples for applications of the new technology in real sea states. From the examples, it can be seen that the new technology can very much improvement of the wave energy production from sea waves.

Control and optimal technologies

Control & optimal technologies

- Constant damper
  - should be tuned/optimised for maximising power conversion from regular or irregular waves;
- Damping optimisation
  - a pure damper for maximising power conversion based on the wave frequency (optimised damping coefficient is frequency dependent);
- Full reactive control
  - a control to keep the WEC resonance with wave excitation for phase optimum;
  - optimised damping for amplitude optimum;
- Latching control
  - latching and de-latching to implement phase optimum (sub-optimum);
  - damping optimisation for amplitude optimum;
  - different technologies to decide latching duration (predictive method, measurements of waves...)
- New latching Control*
  - A simple method for deciding latching duration based on regular wave period;
  - Latching duration can be decided using the energy period, Te, so that the detailed and accurate future information is not necessary;
  - Damping optimisation may be necessary for maximising power conversion.

Point absorber wave energy converter

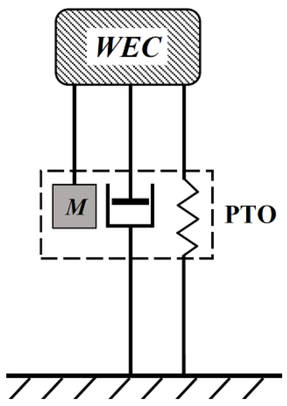


Fig. 1 A point absorber with a full PTO referencing to the seabed

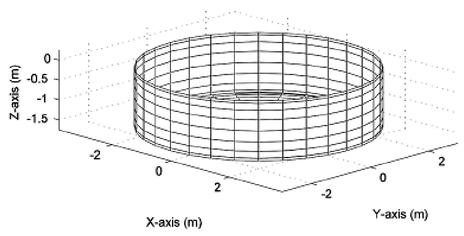


Fig. 2 Point absorber float

Diameter:	D=6m
Draft :	L=1.5m
Displacement:	V=42.4m^3

New latching control

The main purpose of the new latching control is for simply and more practically determining the latching duration in regular and irregular waves in a manner that the detailed and accurate future information is not necessary. In regular wave, it is decided purely on the wave period, and in irregular waves, it is calculated based on the energy period, a statistical value for real waves, which is much easier to obtain.

- For regular waves, latching duration is given by

$$T_{latch} = \frac{T_w - T_0}{2}$$

with T_w being the wave period, and T_0 the point absorber resonance period

- In irregular waves

$$T_{latch} = \frac{T_e - T_0}{2}$$

with T_e being the wave period

Comparison of power conversion

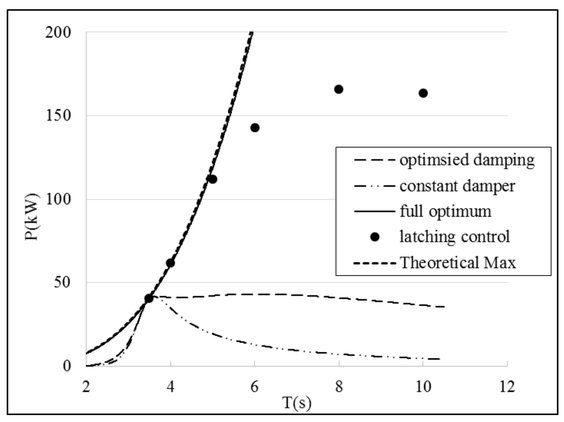


Fig. 3 Power conversion comparison

Latching control in regular and irregular waves

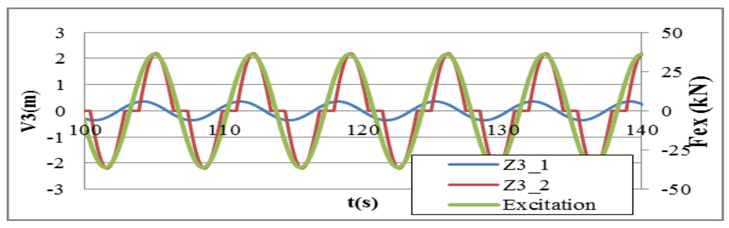
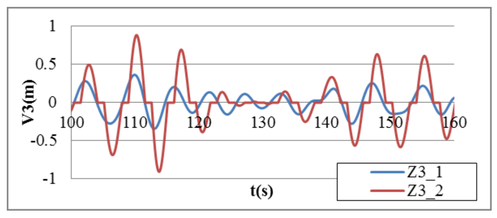


Fig. 4 New latching control for phase optimum in regular waves



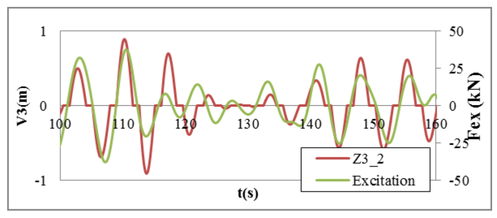


Fig. 5 New latching control for phase optimum in irregular waves

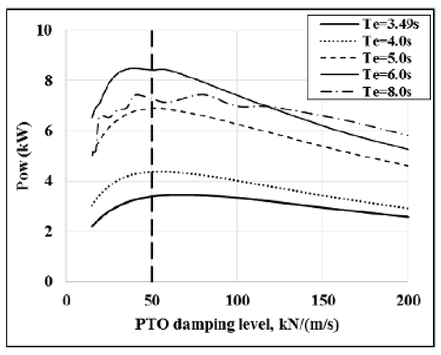


Fig. 6 New latching control for improving power production in irregular waves

Conclusions

-By employing the new latching control technology, in regular waves, the new control can achieve the phase optimum very much though it may still be considered as a sub-optimal control.

-In irregular waves, a sub-optimal phase control may be achieved partially, due to the fact that the new latching control applies a constant latching duration for a given sea state, but it still can be seen that a good phase optimum can be obtained, especially for those large waves. As a result of this, the latching control has increased the power conversion significantly in irregular waves.

Acknowledgements

This material is based upon works supported by the Science Foundation Ireland (SFI) under the Charles Parsons Award at Hydraulics and Maritime Research Centre (HMRC). Statistics and data were correct at the time of writing the article; however the authors wish to disclaim any responsibility for any inaccuracies that may arise.

Selected References

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