

Direct Drive Wave Energy Converter Control in Irregular Waves

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Work stream 5: <Power take-off and conditioning>

Introduction

The reactive control of a wave energy converter (WEC) to extract power from a direct drive linear generator in irregular waves is presented. By introducing reactive control at a single frequency, the motion of the WEC is generally in phase with the incoming waves without the need for wave prediction. Amplitude and force constraints have to be considered into the system. A continuously varying average voltage method is presented to control the power converter.

System Description

- Figure shows the whole system of wave energy converter under end stop systems.
- Output currents have variable frequencies and amplitudes need to be controlled to achieve mechanical resonance.
- A back-to-back power converter is applied. Rectifier is used to control currents and inverter is used to control DC link voltage.

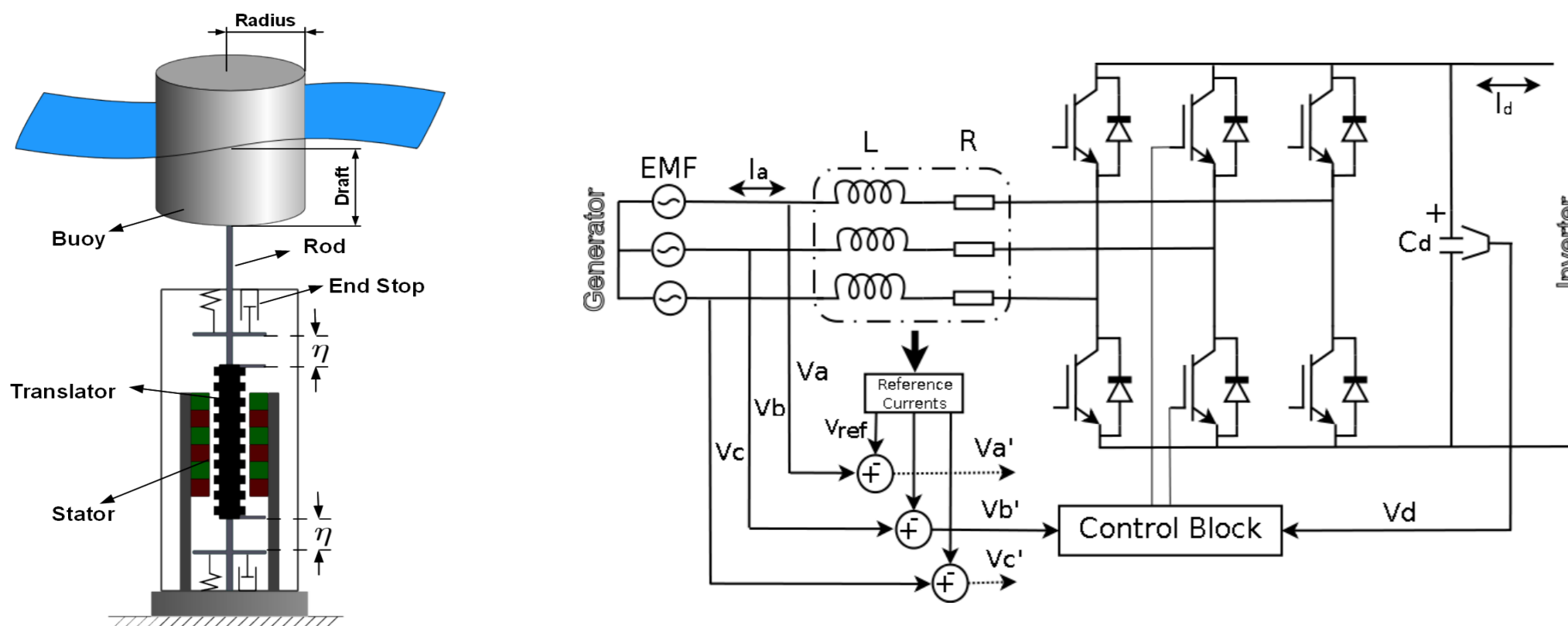


Fig. 1: System description

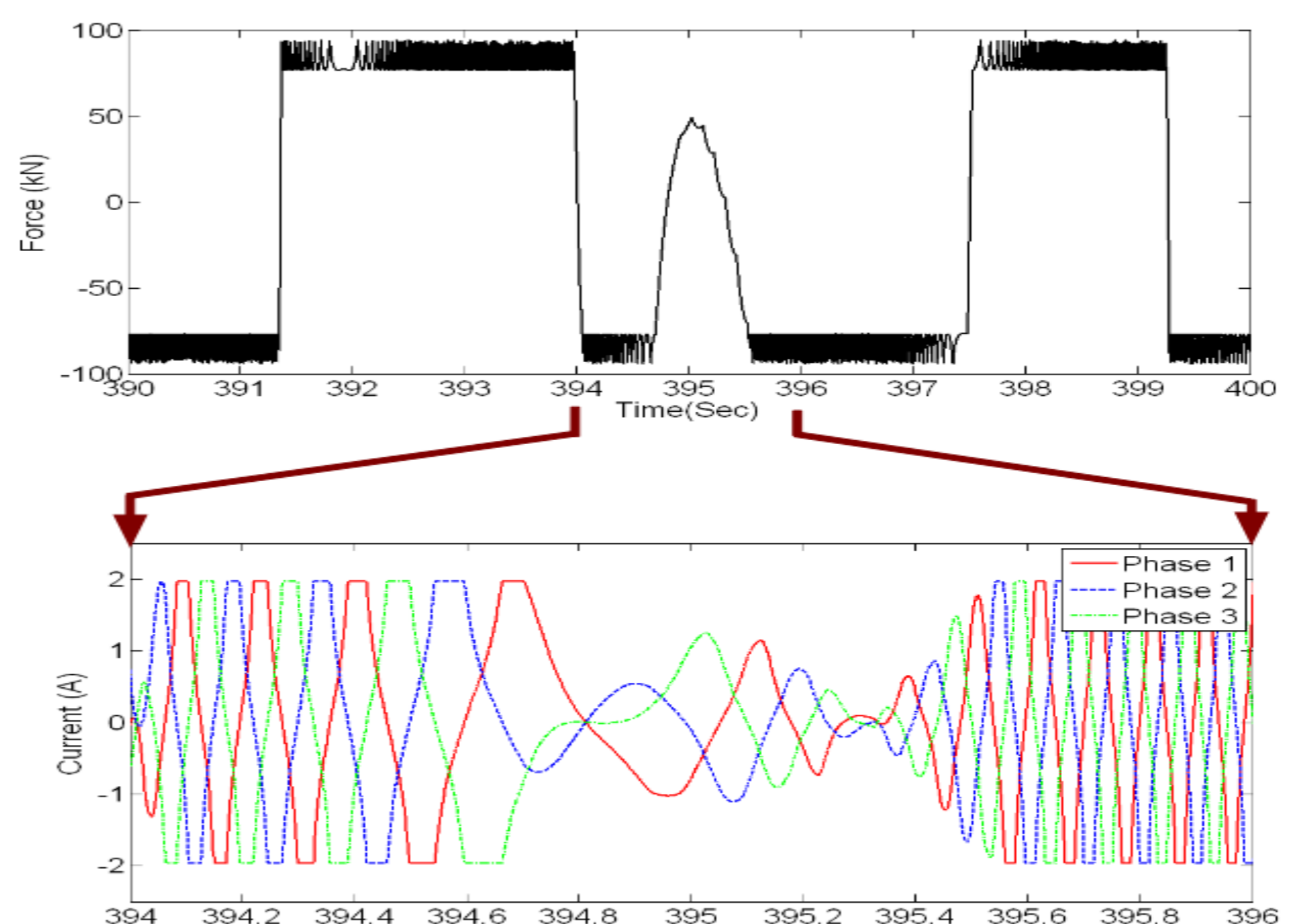
Control Method

The Mechanical system can be described using an electrical system. Based on the maximum power transfer theorem, load impedance should match the intrinsic impedance. The wave energy converter can be considered as a simple mass-spring-damper which can be represented by an RLC circuit. Therefore, the load is also considered as an RLC circuit.

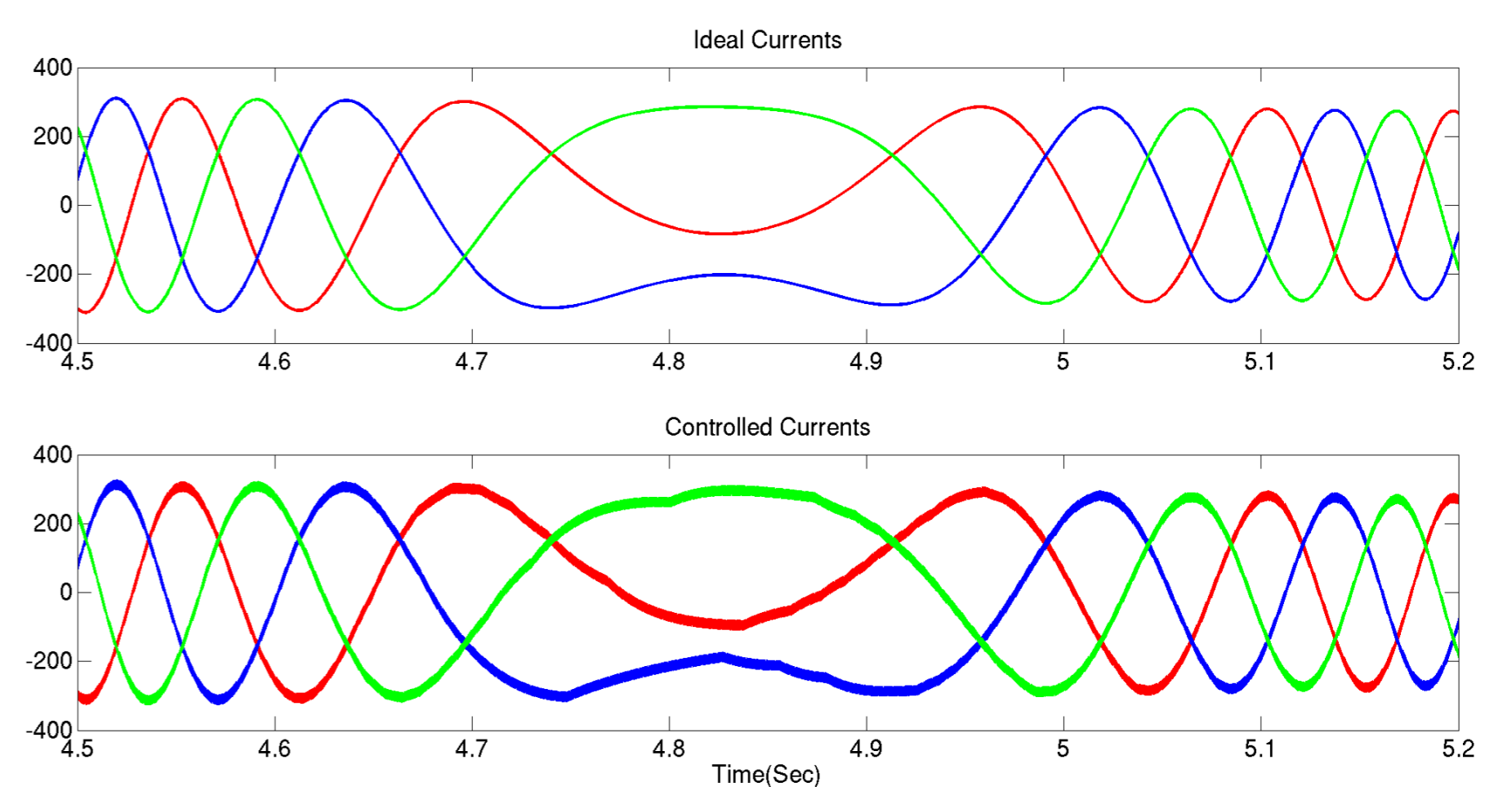
$$F_{pto} = -[m + M_s]a(t) + B_s u(t) - cx(t)$$

Simulation Results

Figure shows PTO force and currents generated from linear generator under both force and displacement constrains. The Average power extracted is 3 times more than damping control.



Currents from linear generator can be controlled by making the instantaneous average voltage follow the reference voltage as shown below



Conclusion

- Machine loss is significant because of the machine is constantly working at full rate.
- A new type of linear generator is needed to provide more force.
- A high DC link voltage is required to achieve the control, which mean several power converters have to work together.