MASTS Small Grant Report

Attendance of the European Wave and Tidal Energy Conference 2019

Anna Garcia-Teruel, a.garcia-teruel@ed.ac.uk

1. Motivation and goal

The main objective of this Small Grant was to support me to attend the European Wave and Tidal Energy Conference (EWTEC) taking place in Naples (Italy) from the 1st to the 6th of September. This is the most renowned conference in the marine energy field. The Small Grant enabled me to attend this conference, during which I shared my research outcomes with the wider community through presentation of two conference papers.

2. Summary of presented work

A brief summary of the work presented at the conference is given below, as well as the references for the presented papers.

Many different Wave Energy Converter (WEC) concepts have been developed in the past years, with the goal of finding an economically competitive design, which at the same time enables maximal power extraction. One of the biggest cost reduction potentials has been associated with the device structure. This, combined with the existing lack of consensus in the preferred device design (such as three bladed vertical turbines for tidal energy applications), has revealed the need for inclusion of geometry optimisation studies to help determine the device's shape in the early stages of the design process. As a result, many geometry studies have been performed in the past years for different types of devices using various approaches. However, no methodology has been established for this process. A number of hull geometry optimisation studies have been performed to maximise power and reduce costs, where costs were mostly represented through the device size in terms of mass, volume or surface area. These studies were mostly based on simple geometrical shapes, such as spheres or cylinders.

In the first study presented at the conference, the suitability of different optimisation set ups is analysed, by investigating various objective functions. The goal is to find an optimal hull shape that considers relevant cost factors, such as manufacturability, reliability or installability, which will have an effect on the optimal geometry. This is done using a geometry definition free of designer bias (see Figure 1), instead of simple geometrical shapes, so that the analysis is device agnostic and can have a wide range of applications. The results are given for a particular location off the West Shetland shelf to the north of Scotland. The differences in shape and annual energy production are presented for optimal devices oscillating in surge only, and in surge, heave and pitch. Devices are optimised for maximal annual energy production, and its ratio to various size

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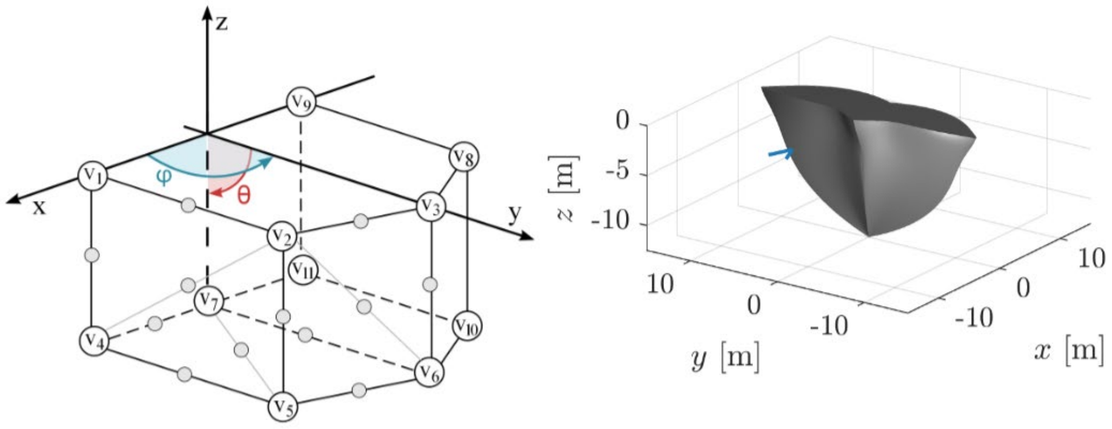
Modelling Forum through MASTS under the Small Grant Scheme system as NHMSG13.

characteristics based on volume and surface area. More information on this study can be found in [2].



(a) (b)

Figure 1: Geometry definition (a) Polyhedron with numbered vertices and example representations of the interpolated points in grey, adapted from [1] (b) Example submerged hull geometry approximated by bi-cubic B-spline surface seen from a point above the free surface. The blue arrow indicates flow direction.

The second study was performed in collaboration with Caity Clark, a PhD student at Oregon State University in USA, with the support of the INORE BEC scholarship for international collaboration. In this study, we seek to understand the relationship between wave energy converter (WEC) hull geometries and power take-off (PTO) reliability. To do this, we calculated the damage equivalent loads (DELs) for a PTO given three hull shapes (a cylinder, a sphere, and a barge), two sets of met-ocean conditions (from the centre of the North Sea and off the west coast of Norway), and two float motions (heave and surge). Results indicate that hull geometry has a primary influence on DELs experienced by the PTO, and also that certain geometries result in larger DELs based on whether the device is moving in heave or surge. These findings underline the importance of considering WEC hull geometry in early design processes to optimise cost, power production, and reliability. More importantly, this research emphasises the need to consider the relationship between the WEC geometry and the PTO reliability early in the design process. The method tested in this study will enable the inclusion of reliability considerations in geometry optimisation of WECs. More information on this study can be found in [3].

3. The conference

The conference took place near the port in Naples in the first week of September. During this time, I had the chance to share the above mentioned research with the wider marine energy community (see Figure 2), which was very well received by stakeholders in academia, industry and funding organisations. This enabled me to get very useful feedback, as well as, ideas for future research. The obtained feedback also pointed to the fact that the outcomes of this research are particularly interesting for technology developers aiming at improving efficiency of their devices, who were interested in

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applying the presented methods to their design. Last but not least, the attendance to the conference, allowed me to strengthen and expand my international network of marine energy enthusiasts.

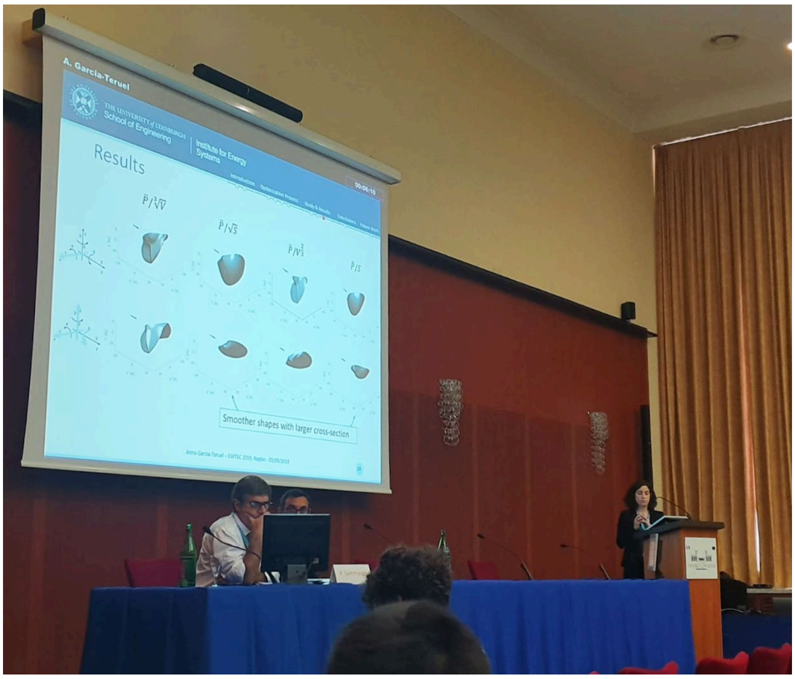

Figure 2: A moment during one of the conference presentations. The picture shows some of the results of the research described in [2].

References

[1] A.P. McCabe. Constrained optimization of the shape of a wave energy collector by genetic algorithm. *Renewable Energy*, 51:274–284, 2013.

[2] A. Garcia-Teruel, D.I.M. Forehand, H. Jeffrey. Metrics for Wave Energy Converter Hull Geometry Optimisation, *13th European Wave and Tidal Energy Conference*, 2019

[3] C.E. Clark, A. Garcia-Teruel, B. DuPont, D.I.M. Forehand. Towards Reliability-Based Geometry Optimization of a Point-Absorber with PTO Reliability Objectives, *13th European Wave and Tidal Energy Conference*, 2019

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