SIMULATING LARGE-SCALE ARRAYS OF INTERCONNECTED WAVE ENERGY DEVICES

Albatern is a wave energy technology company which develops novel offshore marine devices: buoyant “Squid” modules with three arms that are each capable of linking with up to three other such Squids. The linking of three Squid devices forms a hexagonal arrangement, and these can interlink to form arbitrarily large “Wavenet” installations.

The Squid modules and their link-arms contain mechanisms to generate power, capturing the heave and surge motion of the waves via hydraulics. This technology therefore offers a highly-scalable, modular wave power generator.

However, wave energy prototypes are large and expensive to produce, and are funded through risk capital. Under-design could result in a premature failure that is an unacceptable loss for the business, while over-design increases costs significantly. Computer simulation helps to reduce the risk of design flaws, and therefore forms a vital part of the device design process.

Simulations are also essential to help to demonstrate the potential cost and performance improvements of extremely large arrays of these devices. However, Albatern’s modelling was limited by the available software to individual Squid devices and Wavenet arrays of up to 6 devices. This was due to a hard limit on the number of free bodies that could be simulated and the computation time due to the serial nature of execution.

This research was financially supported by SHAPE, the SME HPC Adoption Programme in Europe, which aims to raise awareness of the innovation possibilities opened up to European SMEs by High Performance Computing (HPC) and equip them with the necessary expertise to take advantage of HPC to increase their competitiveness. SHAPE is part of the PRACE-3IP project funded by the EUs 7th Framework Programme (FP7/2007-2013) under grant agreement no. RI-312763.

The goal of this project was to begin the development of a computer code capable of simulating a large array (100 or more) of these devices on supercomputers such as ARCHER.

A new, modular code was proposed, and development of the code was split into two different tasks: algorithm development, and the HPC implementation.

A prototype multibody dynamics algorithm was developed, based on computational methods used in computer graphics and gaming. This allowed the detailed modelling of a small number of Squid devices. Albatern's first successful simulation using this solver was of a single Squid device interacting with an ocean roller. This has further been extended to small-scale arrays.

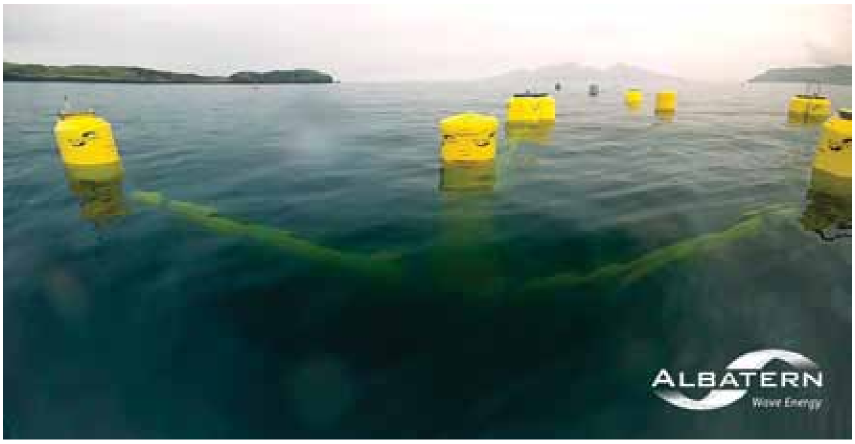
Meanwhile, EPCC developed the code to simulate a larger number of simplified devices attached to a mooring grid. The simulation is designed to be easily expandable to large arrays of Squid devices. It is also possible to incrementally increase the complexity of the model of the Squid so that eventually large arrays of complex Squids can be simulated.

The successful completion of both the algorithm and the HPC implementation has defined a clear development path for the implementation of a full multi-body dynamics code, which will be capable of carrying out the intended large-scale simulations.

The computer visualisations and power generation data produced from large-scale array simulations will greatly improve investor confidence, increasing the chances of securing the vital continued investment required to proceed to utility-scale generation projects, and to open to commercial exploitation a global market valued at between £60bn and £190bn. Success in securing further funding for large-scale array projects will also allow Albatern to grow as a business, with the opportunity to expand the scale of their projects and number of employees.

Since the start of this project, Albatern has deployed its first power-generating array off the Island of Muck, on the West Coast of Scotland. The array, comprised of three Squid devices, will supply a fish farm with electrical power to run lighting and feeding equipment.

A more detailed report on this project is available at:
http://www.prace-ri.eu/IMG/pdf/wp191_albatern.pdf



About ARCHER

ARCHER is the UK National Supercomputing Service. The service is provided to the UK research community by EPSRC, UoE HPCx Ltd and its subcontractors: EPCC and STFC's Daresbury Laboratory, and by Cray Inc. Laboratory.

The Computational Science and Engineering (CSE) partners provide expertise to support the UK research community in the use of ARCHER, and researchers can also apply for longer-term software development support through the Embedded CSE (eCSE) programme. The ARCHER CSE partners are EPSRC and EPCC at the University of Edinburgh.

The Case Study Series

The ARCHER service facilitates high quality science from a broad range of disciplines across EPSRC's and NERC's remits. The outcome is science that generates significant societal impact, improving health and overall quality of life in the UK and beyond. This science influences policy and impacts on the UK's economy.

This case study is one of a series designed to showcase this science. It has been produced as part of the ARCHER CSE service, supported by EPSRC research grant No EP/N006321/1.

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