Coupling between DualSPHysics and the Finite Element Module of Project Chrono: multiphysics modelling of waves-WEC interaction

Iván Martínez-Estévez[1], Joe El Rahi[2], José Domínguez[1], Bonaventura Tagliafierro[3], Vasiliki Stratigaki[2] Alejandro Crespo[1], Peter Troch[2], Tomohiro Suzuki[4], Moncho Gómez-Gesteira[1]

[1] EPHYSLAB, University of Vigo, Campus Sur, 32004, Ourense, Spain
[2] Department of Civil Engineering, Ghent University, Ghent, Belgium
[3] Department of Civil Engineering, University of Salerno, Via Giovanni Paolo II, 84084 Fisciano, Italy
[4] Flanders Hydraulics Research, 2140 Antwerp, Belgium
E-mails: ivan.martinez.estevez@uvigo.es; Joe.ElRahi@ugent.be; jmdominguez@uvigo.es; btagliafierro@unisa.it; Vicky.Stratigaki@ugent.be; alexbexe@uvigo.es; Peter.Troch@ugent.be; tomohiro.suzuki@mow.vlaanderen.be; mggesteira@uvigo.es

The DualSPHysics code is a widely used numerical tool to model wave energy converters (e.g., modelling a point absorber wave energy converter [1]) using the two-way coupling with Project Chrono. The current configuration includes a rigid body solver and elements such as hinges and springs [2] which can resolve motion and simulate linear damping elements. On this basis, the aim of this work is to extend the coupling to include the finite element (FEA) module of the Project Chrono with additional non-linear elements such as cables and beams. This is achieved through a two-way coupling where finite element objects are reproduced in the DualSPHysics environment and discretized according to a user-defined nodal resolution. The forces exerted by waves are then transferred accordingly and applied to the nodes, to be later resolved by Project Chrono. As a result, this implementation reproduces non-linear deformations and provides internal stress analysis. The development of this fluid-structure interaction model has direct implications on the numerical modelling techniques used to simulate floating and fixed wave energy converters. Material properties such as stiffness and elasticity can be now introduced; thus offering the capability of analyzing stress limits and deflections of energy devices. Furthermore, the common linear spring damper currently used to model point absorber wave energy converters would be replaced by the elastic cable elements. This new functionality will allow simulating not only flexible parts of the WECs but also to improve the survivability of the WEC devices being DualSPHysics a suitable tool for this purpose.

References

[1] Ropero-Giralda P, Crespo AJC, Tagliafierro B, Altomare C, Domínguez JM, Gómez-Gesteira M, Viccione G, 2020. Efficiency and survivability analysis of a point-absorber wave energy converter using DualSPHysics. Renew. Energy, 162: 1763-1776.
[2] Brito M, Canelas RB, García-Feal O, Domínguez JM, Crespo AJC, Ferreira RML, Neves MG, Teixeira L., 2020. A numerical tool for modelling oscillating wave surge converter with nonlinear mechanical constraints. Renew. Energy 146, 2024–2043.

Acknowledgements

This work was partially financed by the Ministry of Economy and Competitiveness of the Government of Spain under project "WELCOME ENE2016-75074-C2-1-R". Joe El Rahi, is Ph.D. fellow (fellowship 11I5821N) of the FWO (Fonds Wetenschappelijk Onderzoek - Research Foundation Flanders), Belgium. Vasiliki Stratigaki is a postdoctoral researcher (fellowship 1267321N) of the FWO (Fonds Wetenschappelijk Onderzoek - Research Foundation Flanders), Belgium.

COST is supported by the EU Framework Programme Horizon 2020. COST (European Cooperation in Science and Technology) is a funding agency for research and innovation networks. COST Actions help connect research initiatives across Europe and enable scientists to grow their ideas by sharing them with their peers.