INTERNATIONAL JOURNAL FOR NUMERICAL METHODS IN FLUIDS
Int. J. Numer. Meth. Fluids (in press)
Published online in Wiley InterScience (www.interscience.wiley.com). DOI: 10.1002/fld.1244

Simulation of flows with violent free surface motion and moving objects using unstructured grids

Rainald Löhner[1,*,†], Chi Yang[1,2,‡] and Eugenio Oñate[3,§]

[1]*School of Computational Science and Informatics, M.S. 4C7, George Mason University, Fairfax, VA, U.S.A.*
[2]*Chang Jiang Scholar, Shanghai Jiao Tong University, China*
[3]*International Center for Numerical Methods in Engineering (CIMNE), Universidad Politécnica de Cataluña, Barcelona, Spain*

SUMMARY

A volume of fluid (VOF) technique has been developed and coupled with an incompressible Euler/Navier–Stokes solver operating on adaptive, unstructured grids to simulate the interactions of extreme waves and three-dimensional structures. The present implementation follows the classic VOF implementation for the liquid–gas system, considering only the liquid phase. Extrapolation algorithms are used to obtain velocities and pressure in the gas region near the free surface. The VOF technique is validated against the classic dam-break problem, as well as series of 2D sloshing experiments and results from SPH calculations. These and a series of other examples demonstrate that the ability of the present approach to simulate violent free surface flows with strong nonlinear behaviour. Copyright © 2006 John Wiley & Sons, Ltd.

Received 3 October 2005; Revised 9 March 2006; Accepted 19 March 2006

KEY WORDS: marine engineering; computational techniques; incompressible flow; projection schemes; VOF; level set; FEM; CFD

1. INTRODUCTION

High sea states, waves breaking near shores and moving ships, the interaction of extreme waves with floating structures, green water on deck and sloshing (e.g. in liquid natural gas (LNG) tankers) are but a few examples of flows with violent free surface motion. Many of these flows have a profound impact on marine engineering.

*Correspondence to: Rainald Löhner, School of Computational Science and Informatics, M.S. 4C7, George Mason University, Fairfax, VA, U.S.A.
†E-mail: rlohner@science.gmu.edu
‡E-mail: cyang@gmu.edu
§E-mail: onate@cimne.upc.edu