

ACOMEN 2017

September 18-22, Ghent, Belgium



Book of Abstracts

Editors:

Marián Slodička, Ghent University
Karel van Bockstal, Ghent University

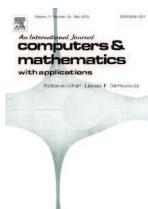
Organising committee:

C. Geuzaine (Univ. de Liège, Belgium)
S. Pop (UHasselt, Belgium)
K. Van Bockstal (Ghent Univ., Belgium)

Scientific committee:

J. Kačur (Comenius Univ., Bratislava, Slovakia)
G. S. Dulikravich (Florida Inte. Univ., USA)
P. Šolín (University of Nevada, Reno, USA)
S. Majid Hassanizadeh (Utrecht University, The Netherlands)
E. Zuazua (Universidad Autónoma de Madrid, Spain)
C. Geuzaine (Univ. de Liège, Belgium)
S. Pop (UHasselt, Belgium)

Sponsors and partners:



ISBN: xxxxxxxx

Contents

Plenary Talks	1
C^0 Interior Penalty Methods (<i>Susanne C. Brenner</i>)	3
Finite element method approximation of stochastic Landau-Lifshitz-Gilbert Equations. (<i>Zdzisław Brzeźniak</i>)	9
Undersampled Dynamic Tomography and Motion Estimation (<i>Martin Burger</i>)	13
Numerical solution of PDEs on surfaces and evolving domains (<i>C. M. Elliott</i>)	17
Operator Preconditioning: Theory and Applications (<i>Ralf Hiptmair</i>)	21
Phaseless Inverse Scattering and Global Convergence for Coefficient Inverse Problems (<i>Michael V. Klibanov</i>)	25
Micro-Macro Models for Reactive Flow and Transport Problems in Complex Media (<i>Peter Knabner</i>)	27
Mathematical and numerical modelling of multiphysics problems, with application to the cardiovascular system (<i>Alfio Quarteroni</i>)	31
 Minisymposia	 33
MS 1 Poromechanics: advances in numerical simulation and applications	35
Space-time finite element approximation of the Biot poroelasticity system with iterative coupling (<i>Markus Bause, Florin A. Radu , Uwe Köcher</i>)	37
Robust iterative schemes for unsaturated poromechanics (<i>Jakub W. Both, Kundan Kumar, Jan M. Nordbotten, Florin A. Radu</i>)	39
A new iterative algorithm based on the fixed-stress split scheme for solving the Biot's problem (<i>Francisco Gaspar, Kundan Kumar, Florin Adrian Radu, Carmen Rodrigo</i>)	41
Assessing solute macrodispersion in heterogeneous porous formations using random walk particle tracking (<i>Rinako Hamada, Kazuya Inoue, Yasutera Kobi, Tsutomu Tanaka</i>)	43
Finite element discretization Biot's consolidation model with strong mass conservation (<i>Guido Kanschat, Béatrice Rivière</i>)	47
A Globally Convergent Scheme for Non-equilibrium Models for Flow in Heterogeneous Porous Media (<i>K. Mitra, I.S. Pop, C.J. van Duijn, D. Seus, F.A. Radu</i>)	49

Numerical methods for porous media flow models Iterative schemes and domain decomposition approaches <i>(Jakub Both, Kundan Kumar, Koondanibha Mitra, Jan Martin Nordbotten, Iuliu Sorin Pop, Florin Adrian Radu, Christian Rohde, David Seus)</i>	51
Newton based iterative methods for non-linear poromechanics <i>(Florin Adrian Radu, Manuel Borregales, Carmen Rodrigo Cardiel, Francesco Gaspar, Kundan Kumar)</i>	53
MS 2 IMEX schemes for hyperbolic problems	55
A unified IMEX strategy for hyperbolic systems with multiscale relaxation <i>(Sebastiano Boscarino, Lorenzo Pareschi, Giovanni Russo)</i>	57
Multiderivative time integrators for a hybridized discontinuous Galerkin method <i>(Alexander Jaust, Jochen Schütz, David C. Seal)</i>	59
A new stable splitting for singularly perturbed equations <i>(Klaus Kaiser, Jochen Schütz)</i>	61
High-order accurate implicit time integration methods applied to semidiscrete Discontinuous Galerkin approximations for unsteady low Mach number flows <i>(Alessandra Nigro, Carmine De Bartolo, Andrea Crivellini, Matteo Franciolini, Alessandro Colombo, Francesco Bassi)</i>	63
On the stability of IMEX methods <i>(Jochen Schütz, Klaus Kaiser, Sebastian Noelle)</i>	65
Energy stable and high-order methods for gradient flows based on the Convex Splitting Runge–Kutta methods <i>(Jaemin Shin, Hyun Geun Lee, June-Yub Lee)</i>	67
Investigation of a novel splitting scheme for the weakly compressible Euler equations <i>(Jonas Zeifang, Andrea Beck, Klaus Kaiser, Jochen Schütz)</i>	69
MS 3 Numerical methods for evolving surfaces	71
Numerical modelling of forest fire propagation <i>(Martin Ambroz, Martin Balážovjech, Matej Medlá, Karol Mikula)</i>	73
Semi-implicit methods for numerical solution of level set advection equation <i>(Peter Frolkovič)</i>	75
Semi-implicit method with inflow-based gradient for the G-equation model on a polyhedron mesh <i>(Jooyoung Hahn, Karol Mikula, Peter Frolkovič, Branislav Basara)</i>	77
Atlas based image segmentation <i>(Jozef Urbán, Karol Mikula)</i>	79
MS 4 Recent advances on model order reduction techniques	81
Model Order Reduction on Control Problems of Navier-Stokes Equations <i>(Cansu Evcin, Ömür Uğur)</i>	83
Proper orthogonal decomposition-based model reduction of a synchronous machine <i>(Mehrnaz Farzam Far, Floran Martin, Anouar Belahcen)</i>	85
A reduced order accelerator for time-dependent reactor physics calculations <i>(Carlo Fiorina, Andreas Pautz)</i>	87
Off-line/On-line approach based on POD and (D)EIM for the Model Order Reduction of Low frequency Electromagnetic devices based <i>(T. Henneron, L. Montier, A. Pierquin, S. Clénet)</i>	89

Adaptive reduced-order modeling of thermo-mechanical systems (<i>David Sachs, Shobhit Jain, Paolo Tiso</i>)	91
Model Order Reduction for Pattern Formation in Reaction-Diffusion Systems (<i>Bülent Karasözen, Murat Uzunca, Tuğba Küçükseyhan, Gülden Müläyim</i>)	93
Approximation of Functions in Unbounded Domain by High Order Mapped Basis Sets using Double Exponential Transformation (<i>Faisal Mumtaz, Fahhad H. Alharbi</i>)	95
Multirate partial differential equations for the solution of field-circuit coupled problems (<i>Andreas Pels, Johan Gyselinck, Ruth V. Sabariego, Sebastian Schöps</i>)	97
Using the Proper Generalized Decomposition to solve Maxwell equations in thin laminated composites (<i>Hermine Tertrais, Ruben Ibanez, Anais Barasinski, Francisco Chinesta</i>)	99
MS 5 3rd Symposium on modelling of biological cells, fluid flow and microfluidics	101
Numerical Computation of the Immunotherapy Model Involving the Cervical Cancer Cells, Effector Cells, and IL-2 Compounds with Reaction-Diffusion (<i>Fajar Adi-Kusumo, Sulasri Suddin, Lina Aryati, Rara Sandhy Winanda</i>)	103
Relation between parameters of spring network model of red blood cell and membrane's bulk properties (<i>Ivan Cimrák</i>)	105
Force-free and torque-free elasticity in cell models (<i>Iveta Jančigová, Ivan Cimrák</i>)	107
Analytical Solution for a 3D model of the airflow in the human upper respiratory tract (<i>Supachara Kongnuan, Chatvarin Tasawang</i>)	109
Interior point method for the Stokes flow with stick-slip boundary conditions (<i>Kučera Radek, Šátek Václav</i>)	111
Magneto-Hydrodynamic Model for Simulation of Water Purification (<i>Serge Polyakov, Tatiana Kudryashova</i>)	113
Bicuspid aortic valve: A patient-specific modeling approach (<i>D. Oliveira, S. Aguiar Rosa, J. Tiago, A. Sequeira</i>)	115
MS 6 Novel trends and challenges in electromagnetic full-wave modelling	117
Calderon Preconditioners for the PMCHWT Integral Equation Based on the Quasi-Helmholtz Projectors (<i>Y. Beghein, R. Mitharwal, K. Cools, F. P. Andriulli</i>)	119
Coupling of FEM and Multiple Multipole Program for Computational Electromagnetics (<i>Daniele Casati</i>)	121
Local Preconditioner for the Maxwell BETI Method (<i>Kristof Cools, Francesco P. Andriulli</i>)	123
Determination of a time-dependent convolution kernel from a boundary measurement in non- linear Maxwell's equations (<i>Marián Slodička, Michal Galba</i>)	125
A Novel Calderón Preconditioner for the Simulation of Conductive and High-Dielectric Con- trast Media (<i>Michiel Gossye, Dries Vande Ginste, Hendrik Rogier</i>)	127
Stochastic Framework to Quantify Variability and Uncertainty in Wireless Links (<i>Marco Rossi, Dries Vande Ginste, Hendrik Rogier</i>)	129

A Leapfrog Alternating-Direction Hybrid Implicit-Explicit FDTD Method for Local Grid Refinement <i>(Arne Van Londersele, Daniël De Zutter, Dries Vande Ginste)</i>	131
MS 7 Electrokinetic and electrochemical flows for batteries and fuel cells: analysis, simulation, upscaling	133
Theoretical and Computational Investigation of Charge Transport in All-Solid-State Thin Film Cells <i>(Katharina Becker-Steinberger, Simon Schardt, Marie Preusse, Arnulf Latz)</i>	135
Adaptive finite element approaches for microscopic and macroscopic simulations of battery electrodes <i>(Thomas Carraro, Sven Wetterauer)</i>	137
An Elliptic Problem with Strongly Nonlinear Interface Condition <i>(Willy Dörfler)</i>	139
Numerical Simulation of Flowing Slurry Electrodes <i>(L. Feierabend, B. Oberschachtsiek, J. Wartmann, A. Kempf, A. Heinzel)</i>	141
Stress simulation of phase-separating cathode materials <i>(Tobias Hofmann, Ralf Müller, Heiko Andrä, Jochen Zausch)</i>	143
Spectral analysis and model reduction of Newman-type battery models for improved calibration and control <i>(Matteo Icardi, Florian Theil)</i>	145
A chemo-mechanical model of the response of electrode particles in Li-ion batteries <i>(Marco Magri, Alberto Salvadori, Robert McMeeking, Davide Grazioli)</i>	147
Consistent coupling of charge transport and fluid flow with application to nanopores <i>(Wolfgang Dreyer, Jürgen Fuhrmann, Clemens Guhlke, Rüdiger Müller)</i>	149
MULTIBAT – Reduced Order Modelling of Lithium-Ion Battery Models with Resolved Electrode Geometry <i>(Mario Ohlberger, Stephan Rave)</i>	151
Optimal Control of Ion Transport in Solid Electrolytes <i>(Simon Schardt, Katharina Becker-Steinberger, Marie Preusse, Arnulf Latz)</i>	153
MS 8 Inverse source problems : recent developments	155
Electroencephalography inverse source problem in neonates <i>(M. M. Diallo, M. Darbas, A. El Badia, S. Lohrengel)</i>	157
Full discretization of an inverse source problem <i>(M. Grimmonprez, M. Slodička)</i>	159
GPR data interpretation problem and Inverse Source Problem for wave equation <i>(Balgaisha Mukanova)</i>	161
Inverse Coefficient Problem for a Time Fractional Diffusion Equation <i>(Amir Hossein Salehi Shayegan)</i>	163
Recognition of a time-dependent source in a time-fractional wave equation <i>(Katarína Šišková, Marian Slodička)</i>	165
The identification of a space-dependent load source in isotropic thermoelastic systems: numerical experiments <i>(Karel Van Bockstal, Liviu Marin)</i>	167
The reconstruction of a time-dependent source from a surface measurement for full Maxwell's equations by means of the potential field method <i>(Ran Wang, Karel Van Bockstal, Tong Kang)</i>	169

MS 9 A priori and a posteriori error analysis for the time-harmonic Maxwell's systems	171
About the gauge conditions arising in finite element eddy current problems (<i>Emmanuel Creusé, Patrick Dular, Serge Nicaise</i>)	173
A method to take into account a short-circuit in lamination stack (<i>Ziani Smail, Thomas Henneron, Yvonnick Le Menach</i>)	175
Two guaranteed equilibrated error estimators for the eddy current problems solved by the finite element method (<i>Emmanuel Creusé, Serge Nicaise, Roberta Tittarelli</i>)	177
Optimal voltage control of non-stationary eddy current problems (<i>Fredi Tröltzsch, Alberto Valli</i>)	179
MS 10 Numerical methods in electromagnetism	181
Global solution of a mathematical model for the induction hardening with controlled Joule heat and nonlinear magnetic field: Potential formulation. (<i>Jaroslav Chovan, Christophe Geuzaine, Marián Slodička</i>)	183
Asymptotic Modelling for 3D Eddy Current Problems with a Conductive Thin Layer (<i>Mohammad Issa, Victor Péron, Ronan Perrussel</i>)	185
Gradient-based optimization of the multilayer diffraction grating profile (<i>A.A. Petukhov, D.A. Konyaev, A.V. Smirnov</i>)	187
Application of a hybrid numerical technique for solving direct and inverse problems of light diffraction on multilayer gratings (<i>A.V. Smirnov, A.A. Petukhov, D.A. Konyaev</i>)	189
Nonasymptotic and Nonlocal Homogenization of Electromagnetic Metamaterials (<i>Igor Tsukerman, Vadim A. Markel</i>)	191
MS 11 Fast Helmholtz solvers for acoustics, electromagnetics and elastodynamics	193
Recent advances in High-Order FEM for acoustics applications (<i>Hadrien Bériot, Alice Lieu, Gwenael Gabard</i>)	195
On the efficiency of an \mathcal{H} -matrix based direct solver for the Boundary Element Method in 3D elastodynamics (<i>Stéphanie Chaillat, Luca Desiderio, Patrick Ciarlet</i>)	197
Analytic preconditioners for 3D high-frequency elastic scattering problems (<i>Stéphanie Chaillat, Marion Darbas, Frédérique Le Louër</i>)	199
Considerations on the Magnitude of the Shift in the Shifted Laplace Preconditioner for the Helmholtz Equation Combined with Deflation (<i>D. Lahaye, C. Vuik</i>)	201
Performance study of the Beyn method for the solution of lossy electromagnetic cavity problems (<i>Nicolas Marsig, Felix Wolf, Sebastian Schöps, Herbert De Gersem</i>)	203
Transmission Conditions for Non-Overlapping Schwarz Domain Decomposition Methods Applied to Elastic Waves (<i>Christophe Geuzaine, Vanessa Mattesi</i>)	205
High-order absorbing boundary conditions with edge and corner compatibility for the Helmholtz equation (<i>Axel Modave, Vanessa Mattesi, Christophe Geuzaine</i>)	207

Optimized Schwarz Methods for Electromagnetic Time-Harmonic Wave Propagation Problems <i>(Bertrand Thierry, Xavier Antoine, Mohamed El Bouajaji, Christophe Geuzaine)</i>	209
MS 12 Computational methods in fractional PDEs	211
Analysis of L1-difference methods for time-fractional nonlinear parabolic problems with delay <i>(R. H. De Staelen, A. S. Hendy)</i>	213
Time fractional derivatives and maximal regularity results for evolution equations <i>(Davide Guidetti)</i>	215
Numerical methods for solving of the Dirichlet boundary value problem for the fractional Allers' equation <i>(Fatimat Karova)</i>	217
Structure-preserving methods to solve a nonlinear parabolic equation with fractional diffusion and advection <i>(Jorge E. Macías-Díaz)</i>	219
An explicit and dissipative method to solve a Riesz space-fractional wave equation with damping <i>(Adan J. Serna, Jorge E. Macías-Díaz)</i>	221
Open Session	223
Implementing adequate subsonic boundary conditions in the Spectral Difference Method for the compressible Navier-Stokes equations <i>(Takfarines Ait-Ali, Noureddine Hannoun, Fateh Boukria)</i>	225
Development of two dimensional Finite Surface Discretization for Fluid Flows <i>(Arpiruk Hokpunna)</i>	227
Multipoint flux mixed finite element methods for slightly compressible flow in porous media <i>(Andrés Arrarás, Laura Portero)</i>	229
Mixed finite element solution of radiative transfer equation <i>(M. A. Badri, Y. Favennec, H. Digonnet, S. Le Corre, B. Rousseau)</i>	231
Strong stability preserving transformed GLMs with RK stability <i>(Califano Giovanna, Izzo Giuseppe, Jackiewicz Zdzislaw)</i>	233
In Silico Modeling for the Risk Assessment of Toxicity in Cells <i>(Qasim Ali Chaudhry, Muqaddas Asif, Amna Abbas, Ayesha Noor)</i>	235
Data-driven discovery of the nonlinear dynamics in an electromechanical drivetrain using mixed norm inverse solver <i>(Guillaume Crevecoeur)</i>	237
Accurate Field Reconstruction by Kirchhoff Integrals on Unstructured Finite-Element Meshes <i>(Wolfgang Ackermann, Herbert De Gersem, Thomas Weiland)</i>	239
Accelerated numerical simulations of a heaving floating body by coupling a motion solver with a two-phase fluid solver <i>(Brecht Devolder, Peter Troch, Pieter Rauwoens)</i>	241
Water artificial circulation for eutrophication control <i>(Francisco J. Fernández, Aurea Martínez, Lino J. Álvarez Vázquez)</i>	243
Gmsh 3.0: Gmsh goes boolean! <i>(Christophe Geuzaine)</i>	245
A pyramid scheme for three-dimensional diffusion equations on general polyhedral meshes <i>(Xudeng Hang, Shuai Wang, Guangwei Yuan)</i>	247

Quality of the ruin probabilities approximation using the regenerative processes approach regarding to large claims <i>(S. Hocine, Z. Benouaret, D. Aïssani)</i>	249
Numerical modeling of heat exchange in unsaturated porous media <i>(J. Kačur, P. Mihala, M. Tóth)</i>	251
A Framework for the Generation and Descritization of Heterogeneous Polydisperse Material Microstructures <i>(Elizabeth R. Livingston, Peter J. Vonk, Masoud Safdari)</i>	253
Numerical methods of a mixed problem for a nonlinear Kirchhoff model with moving boundary <i>(Mohamed Mbehou)</i>	255
Adjoint sensitivity for ODE based statistical models <i>(Valdemar Melicher, Tom Haber, Wim Vanroose)</i>	257
Localization of polynomial eigenvalues <i>(Aaron Melman)</i>	259
The implementation of a new method for the approximation of integrals using Bernstein operators <i>(Dan Miclăus)</i>	261
Determination of transmission and matrix heat conduction coefficients at heat exchange in unsaturated porous media <i>(J. Kačur, P. Mihala, M. Tóth)</i>	263
Analysis of the semi-smooth Newton method for 3D contact problems with the Tresca friction <i>(Kučera Radek, Motyčková Kristina)</i>	265
TNL: Framework for numerical computing on modern parallel architectures <i>(T. Oberhuber, J. Klinkovský, V. Žabka, R. Fučík)</i>	267
A robust Riemann solver without artificial intervention <i>(Jian Ren, Zhijun Shen, Wei Yan, Guangwei Yuan)</i>	269
A fast solver for two-dimensional shallow water equations over erodible beds with multiple sediments <i>(Thomas Rowan, Mohammed Seaid)</i>	271
Accuracy enhancement for higher order non isoparametric finite-element simulations in curved domains <i>(Vitoriano Ruas)</i>	273
DRBEM Solution of MHD Flow in Pipes with Partly Insulated Partly Perfectly Conducting Slipping Walls <i>(P. Senel, M. Tezer-Sezgin)</i>	275
Use of QGD-based parallel program complex for hypersonic flows simulation <i>(Evgeny Shilnikov, Alexander Davydov, Tatiana Elizarova)</i>	277
Acceptance Tail Method for Sampling from Univariate and Multivariate Distributions <i>(Efraim Shmerling)</i>	279
p-adaptation strategies for a Flux Reconstruction based Compressible Navier Stokes solver <i>(Vikram Singh, Steven Frankel)</i>	281
Moving rigid body with perfect contact with surrounding area: Direct and Inverse source problem <i>(Marián Slodička, Karel Van Bockstal)</i>	283
MATSLISE, a Matlab package for solving Sturm-Liouville and Schrodinger equations <i>(Marnix Van Daele)</i>	285
Optimal management of an urban road network with an environmental perspective <i>(Miguel E. Vázquez-Méndez, L. J. Alvarez-Vázquez, N. García-Chan, A. Martínez)</i>	287

A $1/t$ Algorithm with the Density of Two States for Estimating Multidimensional Integrals <i>(Wanyok Atisattapong)</i>	289
Parallel iteration algorithms for 3T equations <i>(Yunlong Yu, Yanzhong Yao)</i>	291
Poster Session	293
The Numerical Simulation of a Microscale Model for Li-Ion Batteries <i>(Fabian Castelli, Willy Dörfler)</i>	295
Autocatalytic Reaction as a Building Block for Describing the Typical Dependencies of Chemical Kinetics <i>(Zoë Gromotka, Denis Constales, Gregory Yablonsky)</i>	297
POD based reduced order modelling of a non-linear eddy current problem <i>(MD Rokibul Hasan, Ruth V. Sabariego)</i>	299
Operator splitting Fourier spectral methods for the Swift–Hohenberg equation <i>(Hyun Geun Lee)</i>	301
Towards Accelerated Optimal Control with Black-Box System Simulators using an Adaptive Surrogate Model Refinement Trust Region Management Framework <i>(Tom Lefebvre, Frederik De Belie, Guillaume Crevecoeur)</i>	303
A new Steffensen-Homeier iterative method for solving nonlinear equations <i>(Laurian Ioan Pişcoran, Dan Miclăuş)</i>	305
A Sigmoidal Type Weight Function for Fourier Series Approximation to Discontinuous Functions <i>(Beong In Yun)</i>	307
List of participants	309

*Book of abstracts of the 7th International Conference
 on Advanced Computational Methods
 in Engineering, ACOMEN 2017
 18–22 September 2017.*

Accelerated numerical simulations of a heaving floating body by coupling a motion solver with a two-phase fluid solver

Brecht Devolder^{1,2,*}, Peter Troch¹ and Pieter Rauwoens²

¹ Department of Civil Engineering, Ghent University

² Department of Civil Engineering, Technology Cluster Construction, KU Leuven

e-mails: Brecht.Devolder@UGent.be, Peter.Troch@UGent.be,
 pieter.rauwoens@kuleuven.be

Abstract

Numerical simulations of floating bodies, heaving under wave loading, are performed by coupling a fluid solver and a motion solver. During each time step in the transient simulation, a converged solution is needed between the wave-induced fluid field around and the motion of the body. For some geometries in particular, a very slow converging or unstable solution is found. The mechanism for this non-physical instability is identified and an accelerated coupling scheme is derived for speeding up the simulations.

Key words: CFD, two-phase flow, rigid body motion, accelerated coupling scheme
MSC 2010: 65L20, 70E15, 76T10

1 Introduction

This paper presents a study on the coupling between a fluid solver and a motion solver by interchanging the total force F acting on a floating body. The two-phase fluid solver with dynamic mesh handling, interDyMFoam, is a part of the Computational Fluid Dynamics (CFD) toolbox OpenFOAM. The incompressible Navier-Stokes (NS) equations are solved together with a conservation equation for the Volume of Fluid (VoF). In this paper, that fluid solver is coupled to a rigid body motion solver, restricted to the heave motion only.

We were able to identify the mechanism for a numerical instability between the fluid and motion solver and to derive an accelerated coupling scheme, which are explained below.

2 Governing equations

The acceleration of the body a is derived from Newton's second law: $F = ma$ and subsequently integrated to the velocity v and position z respectively. In general, the fluid solver calculates the total force F by a discrete sum of the pressure forces p and the viscous forces τ over the faces of the body completed with body's total weight. In order to identify the source of the instability, the total force acting on the body is not calculated by solving the NS equations. Instead, a 1D simplified mass-spring-damper system is used in which the damping contribution is neglected ($b = 0$). Its equation of motion is explicitly formulated in terms of a by:

$$F^{n+1} = ma^{n+1} = -m_a a^n - bv^n - k(z^n - z^{eq}) \quad (1)$$

$$a^{n+1} = -\frac{m_a}{m} a^n - \frac{k}{m}(z^n - z^{eq}) \quad (2)$$

in which m_a is the added mass, b the damping coefficient, v the body's velocity, k the spring constant representing the hydrostatic restoring force and $z^n - z^{eq}$ the distance between the Centre of Mass (CoM) at the previous time step n and the CoM in equilibrium.

A linear stability analysis proves that (2) is only stable if $m_a < m$. Otherwise, an implicit formulation is needed for a (3a) using a relaxation method with relaxation factor α (3b).

$$a_{i+1}^{n+1} = -\frac{m_a}{m} a_i^{n+1} - \frac{k}{m}(z_i^{n+1} - z^{eq}) \quad (3a)$$

$$a_{i+1}^{n+1} = \alpha a_{i+1}^{n+1} + (1 - \alpha) a_i^{n+1} \quad (3b)$$

in which $i + 1$ and i are the current and previous iteration during the same time step $n + 1$.

3 Accelerated coupling scheme

The coupling between motion and fluid solver is accelerated by using an optimal value for α (4a). Consequently, only one sub-iteration is needed for (3b) if m_a is known. However, in general m_a is unknown and varies from time to time (e.g. a floating body in an irregular sea-state). Therefore Newton's second law $F = ma$ is linearised and m_a is estimated by (4b).

$$\alpha_{optimal} = \frac{1}{1 + m_a/m} \quad (4a)$$

$$m_a = -\frac{F_i^{n+1} - F_{i=1}^{n+1}}{a_i^{n+1} - a_{i=0}^{n+1}} \quad (4b)$$

As a result, the new acceleration is obtained by substituting (4b) in (4a) and apply (3b). As an example, the accelerated scheme is applied for a free decay test of a 2D floating block for which $m_a = 3m$ and compared to (3b) using α equal to 0.05 and 0.45. It is clearly shown in Fig. 1, that (4a) accelerates the convergence significantly between the fluid and motion solver.

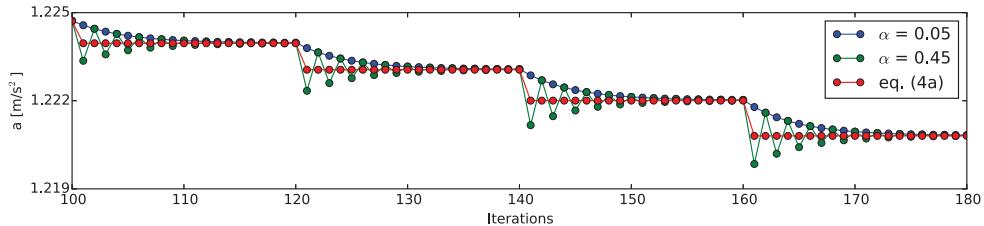


Figure 1: Acceleration as a function of the number of iterations for different values of α and eq. (4a). During each time step, 20 iterations are performed.

Acknowledgements

The first author is Ph.D. fellow of the Research Foundation-Flanders (FWO), Belgium (Ph.D. fellowship 1133815 N).