ADVANCES IN THE SIMULATION OF SHIP NAVIGATION IN ICE

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ABSTRACT

Navigation in the arctic regions is becoming more usual as new navigations routes are being opened due to the retreatment of the ice. This means that ships will be navigating in brash ice, which is the accumulation of floating ice made up of blocks no larger than two meters across, bringing up new concerns on the interaction of ice locks with the ship. In this work, we tackle these concerns and present the advances towards the development of a computational model for simulation of this navigation condition including the interaction among the ship and the ice blocks.

The computational tool developed in this work is based on the coupling of a Semi-Lagrangian Particle Finite Element Method (SL-PFEM) with a multi rigid-body dynamics tool. The Particle Finite Element Method [1] is a versatile framework for the analysis of fluid-structure interaction problems. The PFEM combines Lagrangian particle-based techniques with the advantage of the integral formulation of the Finite Element Method (FEM).

It has been shown [1][2] to successfully simulate a wide variety of complex engineering problems, e.g. free-surface/multi-fluid flows with violent interface motions, multi-fluid mixing and buoyancy-driven segregation problems etc.

The latest development within the framework of the PFEM is the X-IVAS (eXplicit Integration along the Velocity and Acceleration Streamlines) scheme [2][3]. It is a semi-implicit scheme built over a Semi-Lagrangian (SL) formulation of the PFEM.

In this work, the SL-PFEM model has been coupled with a multibody dynamics solver, able to handle the interactions between thousands of bodies, representing the different ice blocks. The interaction between the fluid flow and the ice blocks is taking into account by enriching the finite element space at the boundaries of the different blocks.

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