A THREE-DIMENSIONAL MODEL FOR THE DYNAMICS AND THE FREE-SURFACE HYDRODYNAMICS OF ROWING BOATS

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ABSTRACT

We present a model for the prediction of the performance of rowing boats that extends the one proposed in [1,2] to arbitrary boat motions in the six degrees of freedom. In this way, a more general class of problem can be faced, including non-symmetric boat configurations and stability analysis.

The hydrodynamic behavior of a rowing boat is strongly influenced by the motion of the rowers on board. Our model couples a detailed reconstruction of the complex rowers' kinematics (and their dynamical interaction with the boat) with a hydrodynamic model which accounts for the action of the water on the hull. Hydrodynamic models of different levels of complexity (ranging from semi-empirical relation to full Reynolds-Averaged Navier-Stokes models) have been considered, which can be fruitfully exploited in different phase of the design process and/or training activity.

A rowing boat is a physically unstable system (in particular around the roll axis) and needs to be actively balanced by the rowers during their action. A mathematical description of the rower control and its implementation into the numerical model is not an easy task. A first (simple) control model for the roll and yaw degrees of freedom is proposed, which emulates the main actions performed by the rowers to balance the boat. We show, through numerical examples, the fundamental role that the control plays in simulations of three-dimensional dynamics of rowing boats.

A comparison among the results obtained using different hydrodynamic models is also presented and discussed.

REFERENCES

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[2] L. Formaggia, E. Miglio, A. Mola, and N. Parolini, Fluid-structure interaction problems in free surface flows: application to boat dynamics, *Int. J. Num. Meth. Fluids* **56(8)**, pp. 965-978 (2008).