A NON-ITERATIVE IMMERSED BOUNDARY METHOD FOR THE FLUID-STRUCTURE INTERACTION OF SLENDER RODS

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This work presents a numerical approach for the interaction of highly flexible slender rods in turbulent flow, which bases on a previous method for rigid particles [1]. Here, the rod mass is substantially smaller than the added mass, so that the strong coupling of fluid and structure part requires special numerical techniques to reach numerical stability. Usually, an iterative procedure is applied to balance coupling forces at the interface, which increases the computational effort. In contrast to that practice, this work presents a simple non-iterative coupling of the Navier-Stokes equations to the equations of a Cosserat rod. The scheme is based on an immersed boundary method (IBM) and is unconditionally stable for arbitrary density ratios.

The method is well suited for simulations of scenarios with a large numbers of individual rods, e.g. to model aquatic canopy flows focused here. For validation, an experimental setup of [2] was simulated. This case was chosen as it exhibits the so-called *monami* phenomenon, i.e. a strong relation of coherent vortices and an organized plant deflection. Figure 1 shows a snapshot of the simulated configuration. With 800 individually computed flexible blades it is the largest simulation of an aquatic canopy flow so far.

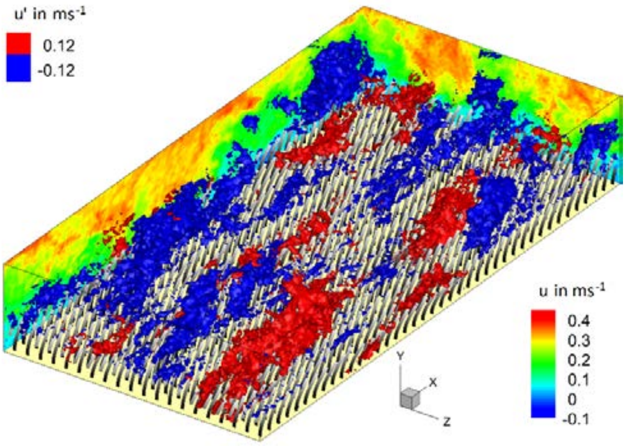

Figure 1. Large Eddy Simulation of a model canopy consisting of 800 equally distributed strip-shaped flexible rods in a turbulent channel flow, corresponding to an experimental setup of [2]. The Reynolds number, based on the channel height, is $Re_H = 42000$, the Cauchy number is Ca = 17. The visualization shows the instantaneous, streamwise velocity component u in the vertical planes as well as iso-surfaces of positive and negative velocity fluctuations $u' = u - \langle u \rangle = \pm 0.12$ m/s at an arbitrary instant in time.

REFERENCES

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