

Project Team INRIA: MC2

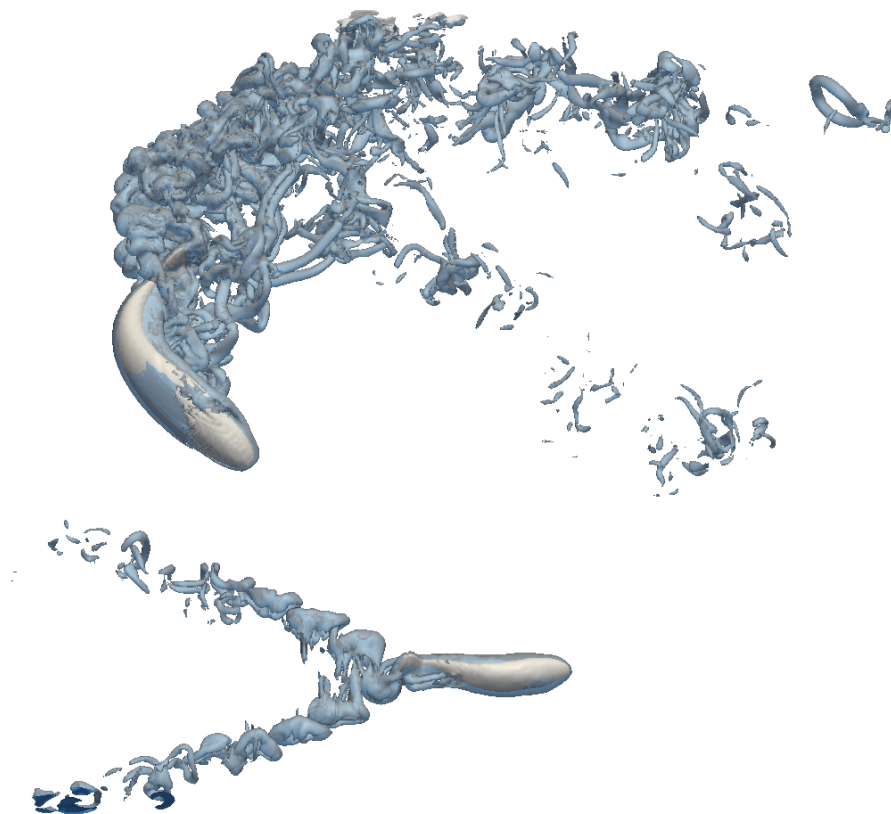
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Modeling and optimization of fish school motion.

Schooling in nature occurs in many biological systems: fish swimming, self-propelled particles, bacteria or bird flying. Each individual member only uses limited information related to their neighbourhood and its motion obeys simple control laws. However, flying or swimming schools can be organized into a global coherent motion to achieve some social objectives. Mathematical studies of these phenomena began with the works of Viscek et al [2], and both hydrodynamic [3] and kinetic [4] approaches have also been explored. Interactions between each school member are usually modelled with behaviours that take into account idealistic dynamic or kinetic motion for each individual member [5]. The aim of this proposal is to study the relationship between the propulsion mechanisms, the physical properties of the environment and the school motion. This study will be performed by means of numerical simulation (using an in house parallel code) of swimmers with parametric swimming laws. It can be thus possible to control or optimize the school motion to verify the hypothesis found in the literature. The following figure presents a numerical simulation of two fishes including control law for prey/predator purpose.



Required Knowledge and background:

Numerical simulation, Optimization, Fluid mechanics.

References:

[1] Bergmann, M. and Iollo A.: Modeling and simulation of fish-like swimming. *Journal of Computational Physics*, Volume 230, Issue 2, 20 (2011), Pages 329-348.

[2] Vicsek, T., Czirók, Ben-Jacob, E., Cohen, I. and Schochet, O.: Novel type of phase transition in a system of self-driven particles. *Phys. Rev. Lett.* 75, 1226-1229 (1995).

[3] Toner, J. and Tu, Y.: Flocks, herds, and Schools: A quantitative theory of flocking. *Physical Review E.* 58, 4828-4858 (1998).

[4] Degond P., Motsch S. Macroscopic limit of self-driven particles with orientation interaction. *Comptes Rendus Mathématique*, Volume 345, Issue 10, 15 November 2007, Pages 555-560.

[5] G. Grégoire and H. Chaté. Onset of collective and cohesive motion. *Phys. Rev. Lett.*, 92(2):025702, 2004.

Keywords: Numerical simulation, Optimization, Fluid mechanics, Fish like swimming, Group motion.

Duration : 1 year.