Flow simulations for optimal fish-like propulsion

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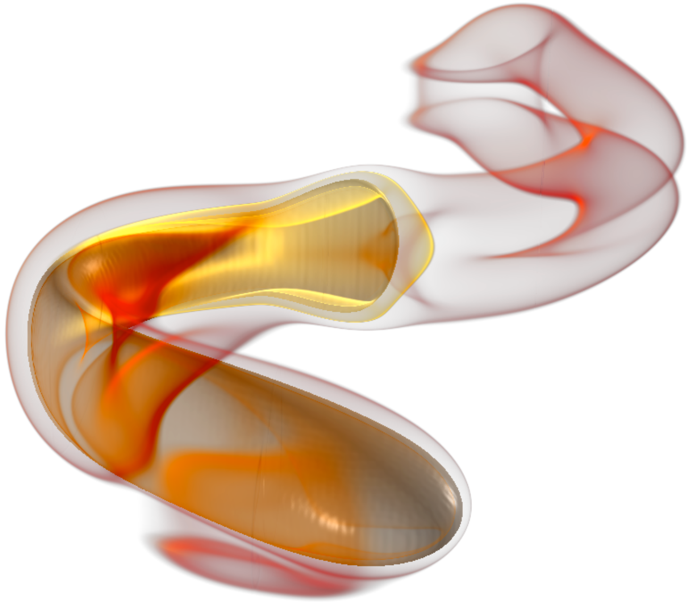
Abstract

In this talk we presented our work on numerical optimizations of 3D self-propelled swimmers and their propulsion techniques. We have coupled a stochastic optimization algorithm with a numerical flow solver to create a general framework that can find optimal solutions for self-propulsion [1, 2]. The flow solver is based on a remeshed vortex method with penalization technique for enforcing the boundary conditions, and can handle an arbitrary number of deforming geometries [1]. Current work is aimed at extending the flow solver to support multiresolution grids. The optimization algorithm wraps around the flow solver, providing the parameter sets to be tested and requiring only the resulting quantity of interesting in return.

The framework has been successfully applied to find optimal escape motion patterns for zebrafish larva [2], and to find optimal shapes for fast and efficient larval anguilliform swimmers [3]. The generality of the framework also allows for more specifically energy-related applications.



References

[1] Gazzola M., Chatelain P., van Rees W.M., Koumoutsakos P., Simulations of single and multiple swimmers with non-divergence free deforming geometries, **Journal of Computational Physics**, 230(19):7093–7114, 2011.

[2] Gazzola M., van Rees W.M., Koumoutsakos P., C-start: optimal start of larval fish. **Journal of Fluid Mechanics**, 698:5–18, 2012.

[3] van Rees W.M., Gazzola M., Koumoutsakos P., Optimal shapes for anguilliform swimmers at intermediate Reynolds numbers. **Journal of Fluid Mechanics**, 722, 2013.

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