A Deep Insight into the Applications of Computational Fluid Dynamics in Bio-Engineering Problems

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Study the self- propulsion of flexible filaments in viscous flows has seen considerable attention due to its promise for bioengineering applications. Motion of microorganisms by their flagella and cilia, reciprocal motion of scallops, semi-driven motion of sperms, bacterial flagellar swimming motion, fishing and heaving motion of aquatic creatures and development of artificial micro-swimmers are the most attractive research areas whose numerical simulations require a deep understanding on efficient and less-costly numerical methods in concept of computational fluid dynamics. Analysis the fluid dynamics of a flexible, swimming organism is namely Fluid Induces Vibration (FIV). When it comes to the accurate capturing of flags propulsion, the analysis becomes very difficult, even when an organism's waveform is assumed to be as a driver component (known in advance). It has been shown that simulation of microorganism motility is the easiest study as the low Reynolds number does simplify the mathematical analysis. In fact, the equations of fluid mechanics in this regime are linear. However, even at low Reynolds numbers, the unsteady wavy configuration of a microorganism body is a complex nonlinear system, comprising of the organism's force generation mechanisms, its passive highly flexible structure, and the unsteady external momentum. To the best of authors knowledge, the problems of FIV are not extensively studied when fluid is non-Newtonian. On the other hand, literature indicates that some real problems like ciliary motions in airways require study of the interaction between non-Newtonian fluid and structures. Nevertheless, a robust model for simulation of non-Newtonian fluid in the vicinity of the wavy shape is almost rare. Therefore, authors proposed a hybrid immersed boundary- non-Newtonian lattice Boltzmann method linked to the Lattice Spring Model to investigate Fluid-Induced Vibration (FIV) in non-Newtonian fluid flow. In this concept, complex partial differential equations of structure motion replaced by much more simple algebraic correlations.