Contribution ID: **49** Type: **not specified**

Three-dimensional modeling and experiment-driven numerical simulation of zebrafish escape swimming for biological applications

Thursday, December 3, 2020 11:00 AM (30 minutes)

Swimming simulations are performed to study the performance of an active immersed body according to its shape and deforming movements. The deformation velocity of the body is usually imposed using a proper analytic formulation to model simple deforming movements. In the literature, more complex motions can be derived to model food, and prey captures (Bergmann et al.2011). To our knowledge, only a few studies tried to extract the body deformations directly from actual data, using the optimal transport theory (Bergmann et al.2016) or experimental observations (Li et al.2012). Here, we aim to model a real-like three-dimensional (3D) eleuthero-embryo zebrafish shape and applying the actual deformation extracted from experimental images to simulate the very stereotyped escape response, the so-called C-start routine. In the biology field, only swimming kinematics were approximated to analyze the escape behavior and compare different zebrafish swimming altered by drugs or chemical compounds. Biologists use the zebrafish as an animal model to study the effects of neurotoxicants on locomotion and develop pharmacological treatments. However, the kinematic analysis may not be sufficient to describe accurately the locomotion. The computational fluid dynamics model provides the full computation of the flow and enlightens the amount of energy expended by the zebrafish during the different swimming stages. The solution of incompressible Navier-Stokes equations is approximated on a Cartesian mesh using a penalization method combined with a level-set method. After conducting a Procrustes Analysis on experimental data, we reconstructed and deformed a 3D zebrafish model by using optimal transportation and midline kinematics, to provide Lagrangian deformation velocities for 3D numerical simulations. We then used the fully-parallel computational model to give an insight into the energetic performance of challenged zebrafish escape swimming. As a result, the complex zebrafish escape swimming behavior has been successfully reproduced after computing experimental deformations.

Primary author: RAVEL, Guillaume (Université de Bordeaux)

Presenter: RAVEL, Guillaume (Université de Bordeaux)

Session Classification: Session parallèle 1