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Numerical simulation of exploring fish motion by a series of linked rigid bodies

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Results were obtained using ARCHIE-WeSt High Performance Computer (www.archie-west.ac.uk).

Present work is mainly based on numerical simulation of solving fish motion problem by using multi-body dynamics algorithm. The fluid solver employs the commercial software ANSYS Fluent 15.0. it is based on finite volume method. Basic theory used in Fluent is by discretising transport equation:

$$\frac{\partial}{\partial t} \int_{V} \rho \phi dV + \int_{S} \rho \phi \mathbf{v} \cdot dA = \int_{S} \Gamma \phi dA + \int_{V} \rho \phi \mathbf{v} \cdot \mathbf{v} dV$$

A first order implicit time marching scheme is used for time transient. Second-order upwind scheme is employed for diffusion term discretization. Pressure-velocity coupling can be achieved by the Fractional Step scheme. The first case two-element flapping wing was carried out to check the algorithm accuracy. The second one was about exploring fish motion by given prescribed angular motion.


Fig 1. shows the geometry of two elements, connecting with an given stiffness and damping ratio spring. Driven component and passive component is given. Prescribed translational and rotational motion is added on the driven component. Force and angle comparisons are shown in Fig 2 and 3. The results are comparable with previous results. Fig 4. is the contours presentation at t/T=0.2, 0.4, 0.6 and 1.

This eight-element model is shown in Fig 5. All the elements are identical and the gap between each element is equal as well. Two modes are simulated and Fig 6. gives the path lines for each mode. The angular motion on each hinge is prescribed. Fig 7 and 8 show the contours of two modes at different time. These two modes can stand for two different swimming conditions of fish.