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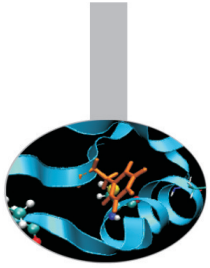
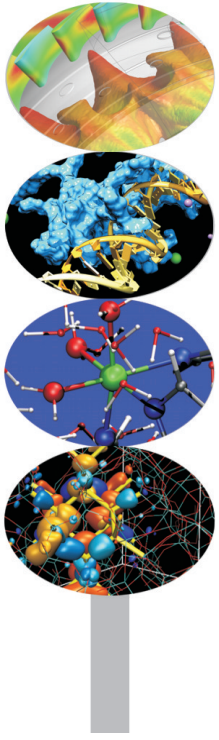


OpenFOAM selected solver



Roberto Pieri - SCS Italy

17 June 2014

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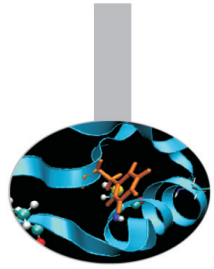

Introduction to multiphase solver

Volum of fluid method

VOF methocd in *OpenFOAM*

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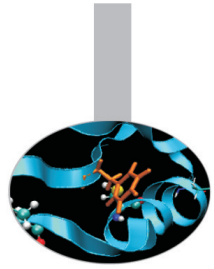

Interface capturing

Multiphase solvers

- Solvers for 2 (or more) different phases.
- Capture the interface between phases.

Lagrangian methods

- The grid moves to follow the interface.
- Interface is captured with precision.
- Possible problems are related to mesh morphing.

Eulerian methods

- Mesh is fixed.
- In every cell equations of motion are solved.
- Avoids problems related to mesh morphing.

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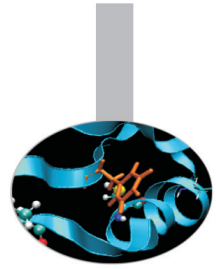
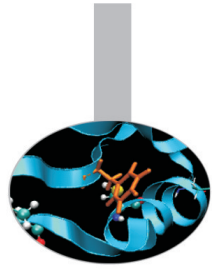
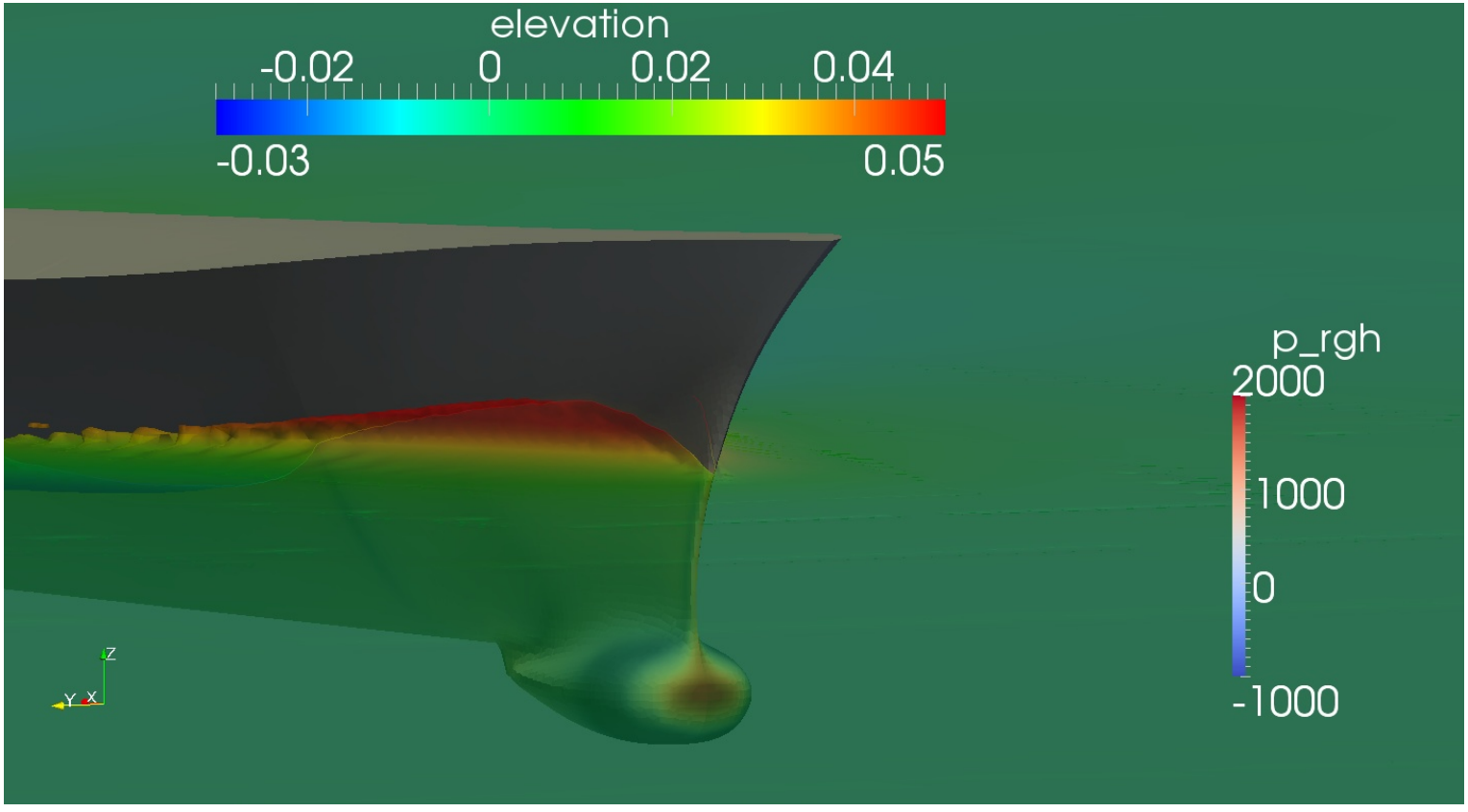
Volume of Fluid method

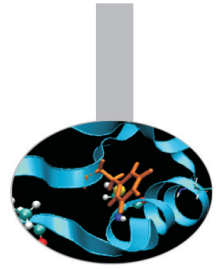


- In *OpenFOAM* , algorithm for interface capturing are based on the *Volume Of Fluid*
- It is an Eulerian fixed-grid technique.
- Used for simulation of immiscible fluids.
- Advantages: simple and flexible.
- Disadvantages: less effective as surface tension effects increase.



Volume of Fluid method

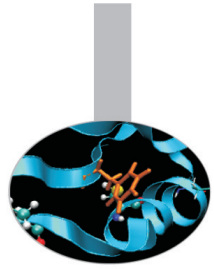




Volume of Fluid method

- Assumes that each cell contains just one phase or the interface between phases.
- A volume fraction function α_i is defined for each phase.
  - $\alpha_i = 0 \rightarrow$ *i-th* phase is not present in the cell.
  - $\alpha_i = 1 \rightarrow$ *i-th* phase fill the cell.
  - $0 < \alpha_i < 1 \rightarrow$ *i-th* the cell contains the interface.

Volume of Fluid equations (I)



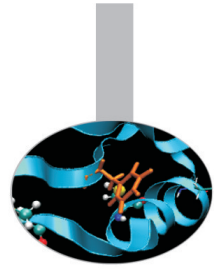
- Each phase is described by a fraction of α that occupies each cell of the computational domain.
- Navier-Stokes governing equations with the addition of a continuity equation for the phase fraction α_i.
- Volume fraction cotinuity equation (scalar):

$$\frac{\partial \alpha_i}{\partial t} + \nabla \cdot \mathbf{U}\alpha_i = 0.$$

- Density and viscosity are defined as:

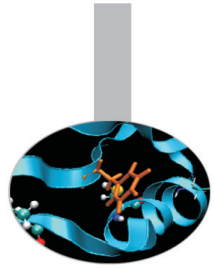
$$\rho = \sum_i \rho_i \alpha_i \qquad \mu = \sum_i \mu_i \alpha_i$$

Volume of Fluid equations (II)



- We need a sharp interface to have good resolution.
- A sharp interface cannot be maintained if the term $\nabla \cdot \mathbf{U}\alpha_i$ is diffusive.
- A counter-diffusive term is required in the phase fraction equation.
- In *OpenFOAM* a compressive convective term is added

$$\nabla \cdot \mathbf{U}_c \alpha_i \left(1 - \alpha_i\right)$$



Volume of Fluid equations (III)

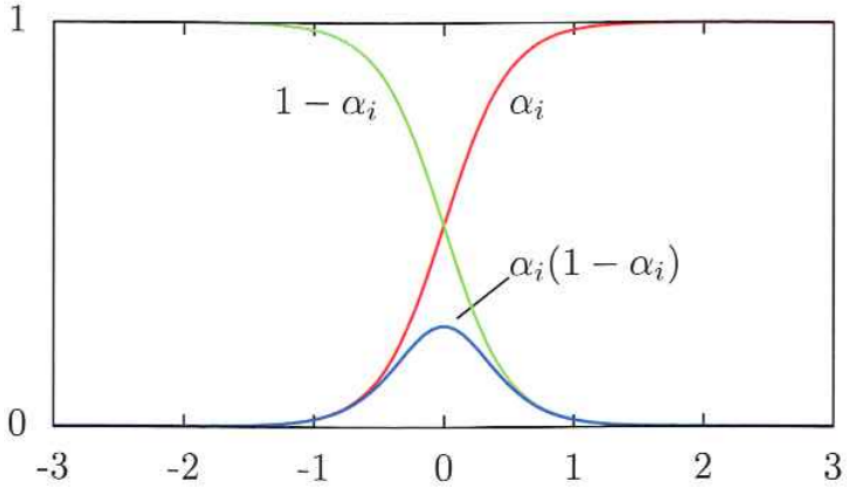
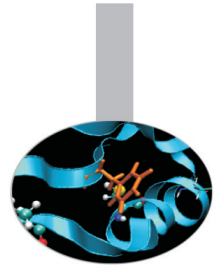


Figure : Distance from interface

- Conservative.
- Bounded.
- Non-zero only at interface.

Solver for multiphase



- *LTSInterFoam* is an example of implementation of a VOF method.
- It takes advantage of Local Time Step method to stabilize the solver.
- Time is fictious, only last (convergence) time has physical meaning.
- The object immersed in the fluid has 0 DOF.