CLSVOF Subroutine

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Outline

• User Defined Function (UDF)
• CLSVOF algorithm in FLUENT
• Initialization
CLSVOF algorithm in FLUENT

CLSVOF algorithm in FLUENT

- Initialization of Level Set Function (DEFINE_INIT)
- Computation of the Curvature and the Normal to the interface (DEFINE_ADJUST)
- Surface Tension Force (DEFINE_SOURCE)
- Advection of Level Set Function and Volume of Fluid Function
- Couple LS with VOF (DEFINE_EXECUTE_AT_END)
- Re-initialization (DEFINE_EXECUTE_AT_END)
Initialization

• Level Set Function $\Phi$
The level set function ($\Phi$) is set to be an approximate signed distance function, which is

$$x_{\text{normal}} \cdot (x - x_0) + y_{\text{normal}} \cdot (y - y_0) + z_{\text{normal}} \cdot (z - z_0) = 0$$

where

$x_{\text{normal}}, y_{\text{normal}}, z_{\text{normal}}$ are the components of the outside normal to the interface. And $x_0, y_0, z_0$ are the components of point on the interface.

Interface ($\Phi = 0$)

Nozzle outlet with end as the interface (normal = (-1, 0, 0) and point (0, 0, 0))
Initialization

- **Volume Fraction** $F$

  The initial $F$ is calculated by

  \[
  F_{ij} = \frac{1}{\Delta x \Delta y \Delta z} \int_{\Omega_j} H(\phi(x, y, z, 0)) \, dx \, dy \, dz
  \]

  Where $H(\Phi)$ is Heaviside function

  \[
  H(\phi) = \begin{cases} 
  0 & \text{if } \phi < -\varepsilon \\
  (\phi + \varepsilon)/(2\varepsilon) + \sin(\pi\phi/\varepsilon)/(2\pi) & \text{if } |\phi| < \varepsilon \\
  1 & \text{if } \phi > \varepsilon 
  \end{cases}
  \]

  $\varepsilon$ is usually taken as $\varepsilon = \sqrt{2\Delta x}$
Initialization

- `DEFINE_INIT (name, d)`
  
  Domain *d*

- Collocated grid (pressure and velocity are stored at cell-centers)

\[ (\Phi, F, V)_{i,j} \]
Initialization

1. Get domain pointer
2. Loop the cells in the domain
3. Get cell center coordinates
4. Signed distance calculation
5. Save cell center coordinates and $\phi$

Loop complete?

End

Initialization of $\Phi$
Initialization

- Get Stencil around a given cell
  - cellLimits (cell, cell_thread, face, face_thread)
    
    ```
    f=C_FACE(cell,cell_thread,n);
    f_t=C_FACE_THREAD(cell,cell_thread,n);
    F_CENTROID(xf,f,f_t);
    ```
  - Stencil (cell_t cell,Thread* cell_thread,cell_t* c,Thread** t)
    ```
    face_t face[4];   /*0 - xmin, 1 - xmax, 2 - ymin, 3 - ymax*/
    c0=F_C0(face[0],face_thread[0]);
    c1=F_C1(face[0],face_thread[0]);
    BOUNDARY_FACE_THREAD_P(face_thread[0])
    /*return 0 for boundary */
    ```
Next

- Initialization of Volume of Fluid (DEFINE_INIT)
- Computation of the Curvature and the Normal to the interface (DEFINE_ADJUST)