CLSVOF Subroutine

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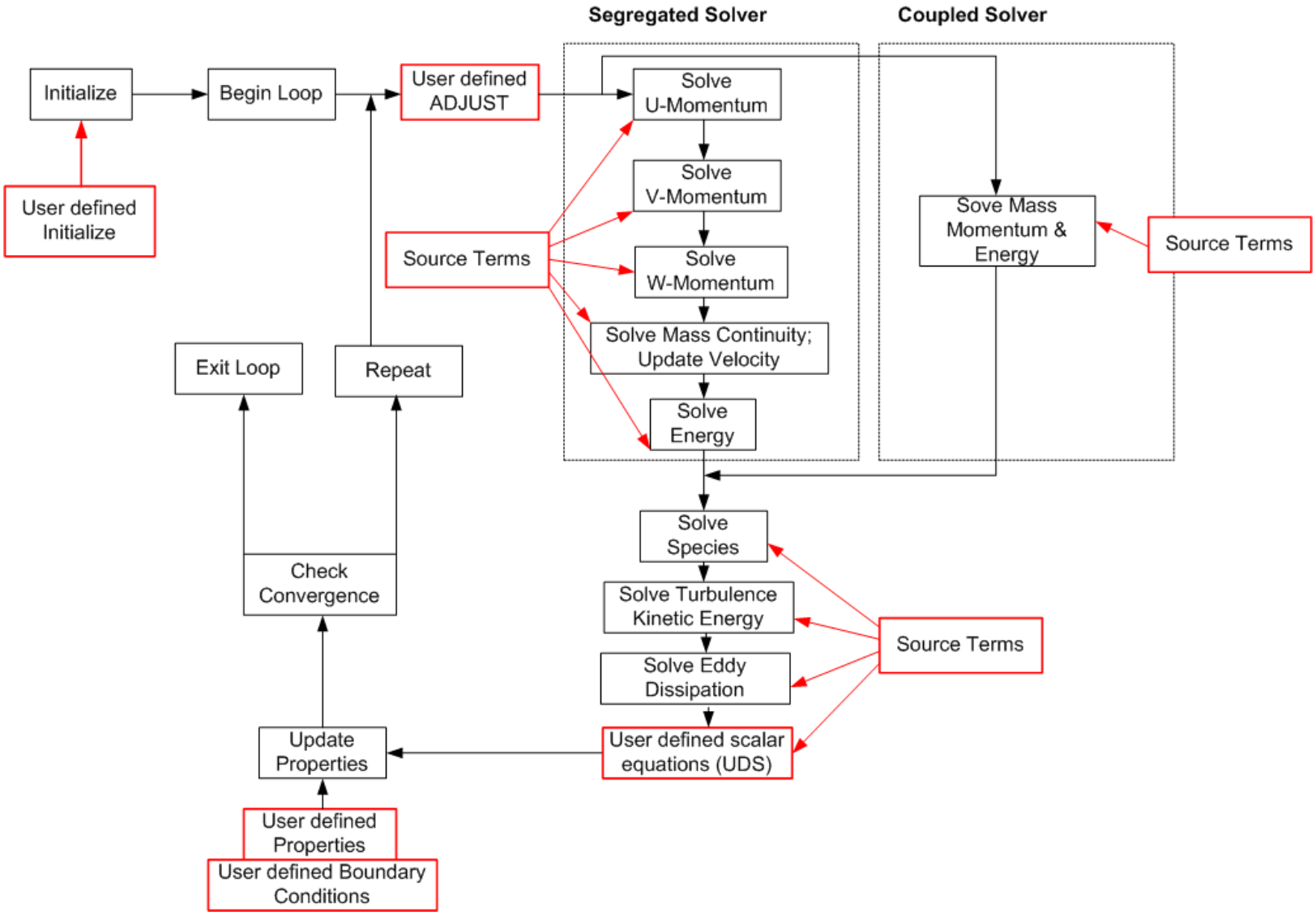
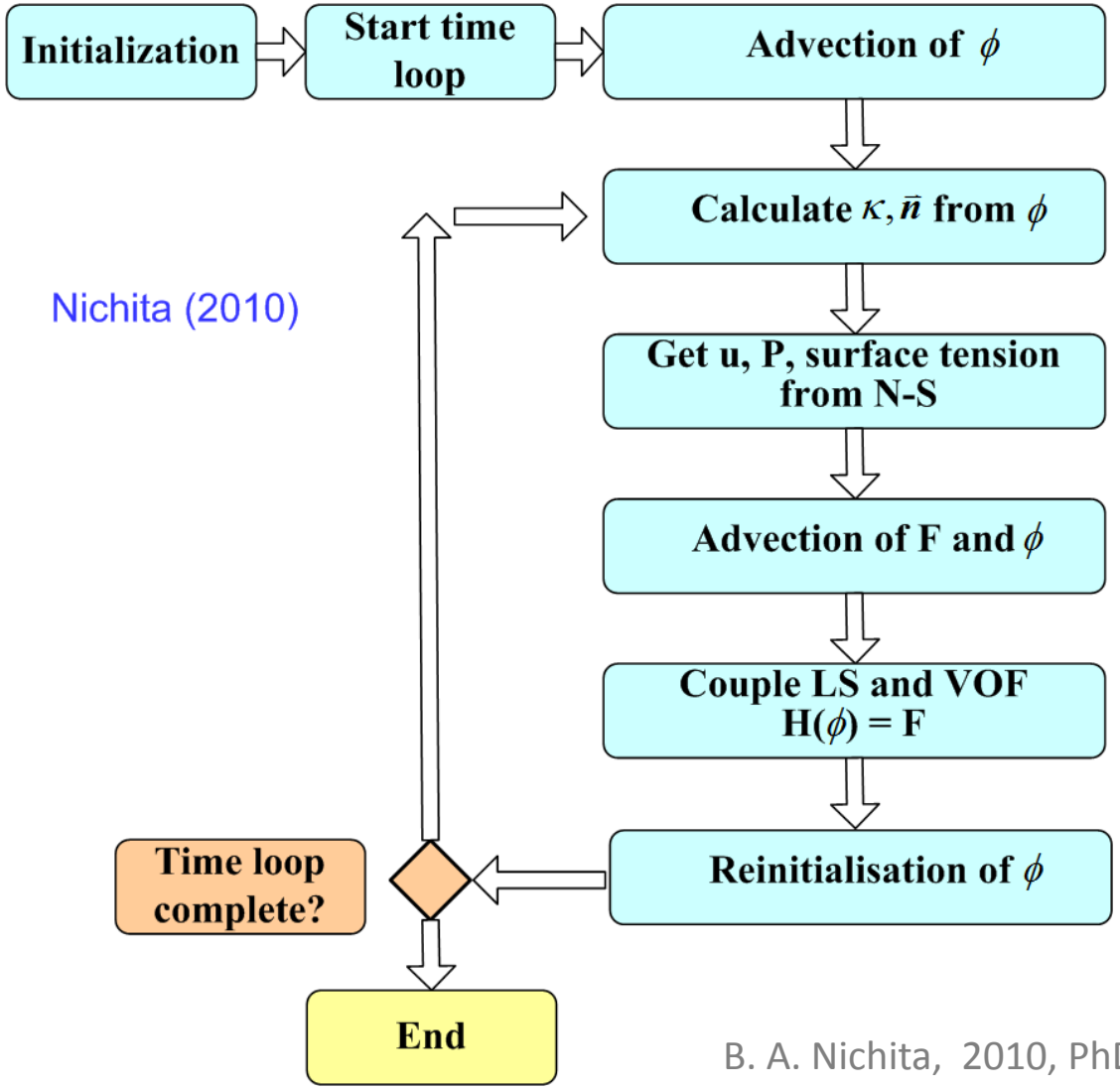
Outline

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

UDF


Segregated Solver
Coupled Solver
Initialize
Begin Loop
User defined ADJUST
User defined Initialize
Solve U-Momentum
Solve V-Momentum
Solve W-Momentum
Solve Mass Continuity; Update Velocity
Solve Energy
Source Terms
Sove Mass Momentum & Energy
Source Terms
Exit Loop
Repeat
Solve Species
Solve Turbulence Kinetic Energy
Solve Eddy Dissipation
User defined scalar equations (UDS)
Source Terms
Check Convergence
Update Properties
User defined Properties
User defined Boundary Conditions

CLSVOF algorithm in FLUENT



Nichita (2010)

B. A. Nichita, 2010, PhD thesis, An improved CFD tool to simulate adiabatic and diabatic two-phase flows

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

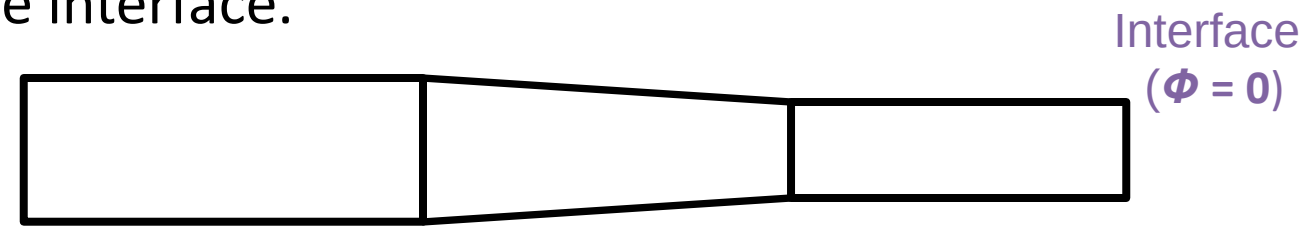
- Level Set Function Φ

The level set function(Φ) is set to be an approximate signed distance function, which is

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

where

x_{normal}, y_{normal}, z_{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.



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

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

Where H(Φ) is Heaviside function

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

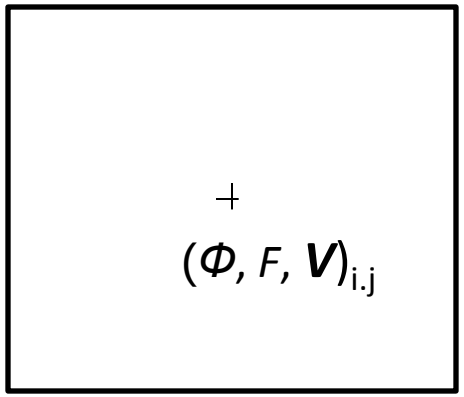
ε is usually taken as $\varepsilon = \sqrt{2}\Delta x$

Initialization

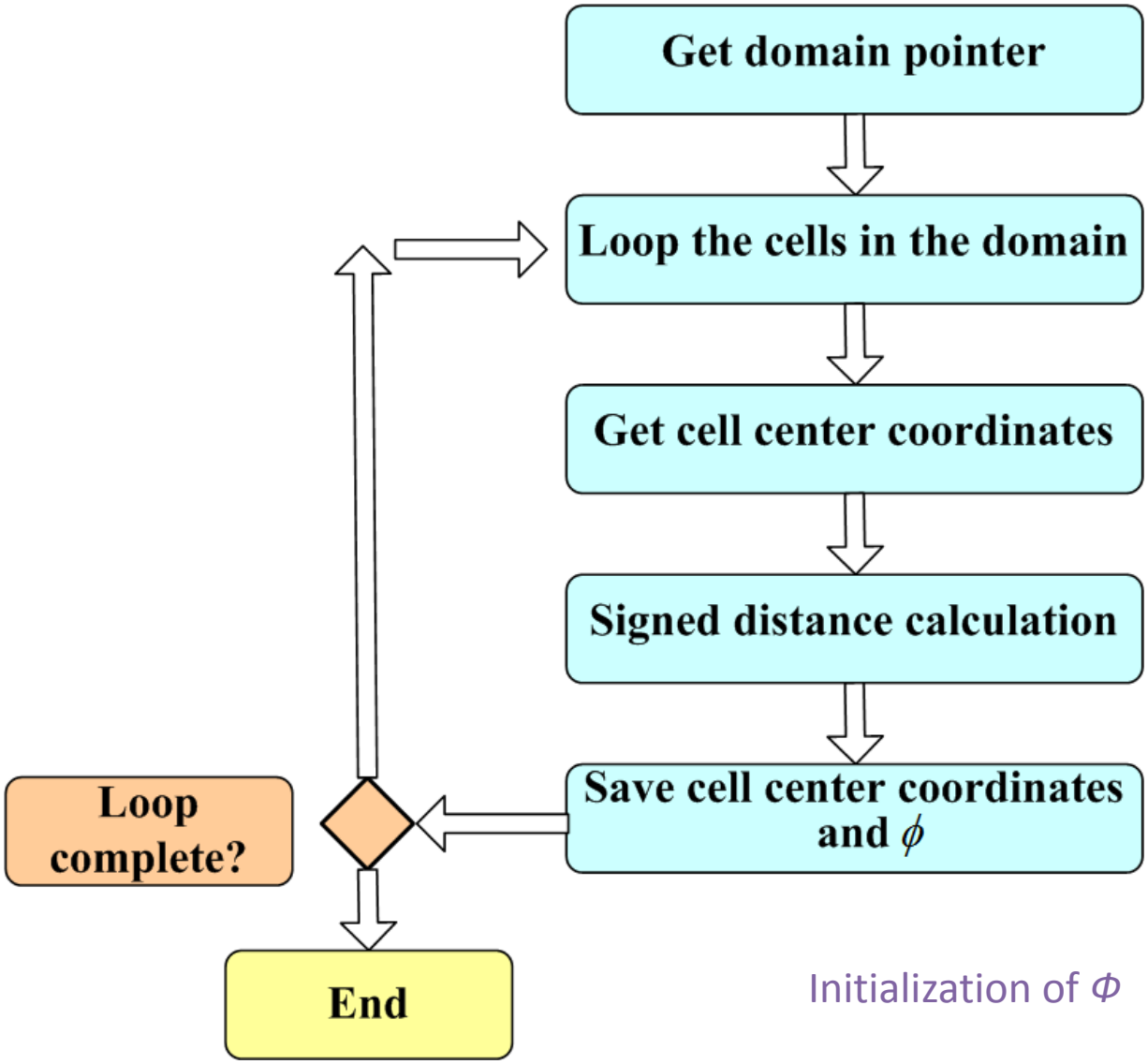
- DEFINE_INIT (name, d)

  Domain *d

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



Initialization



Initialization of Φ

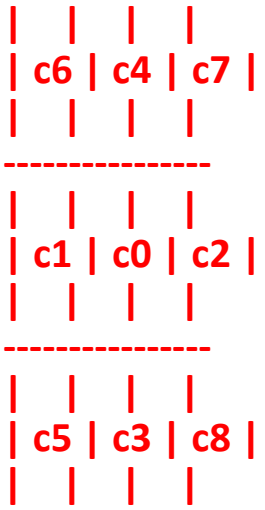
Initialization

- 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)