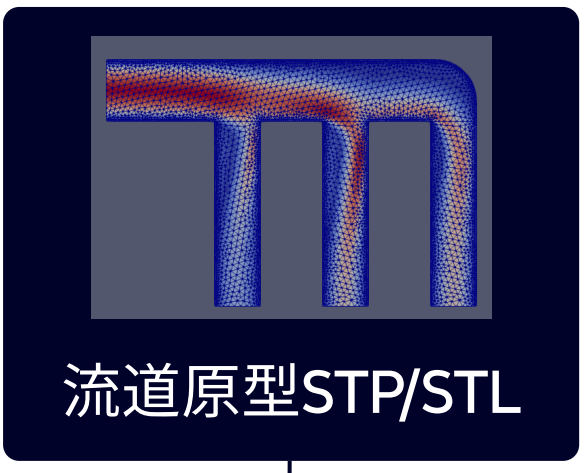


设置目标函数:
1. 能量耗散目标: T1=integral[grad(u) * grad(u) * dx]
2.体积目标: T2=(Integral[dx] - target_vol)**2

选择CFD控制方程(Navier Stoke):
C1: v*grad(v) + grad(p) + laplace(v) = 0
C2: divergence(v) = 0

组建拉格朗日方程:
J = T1 + T2 + adjoint_1 * C1 + adjoint_2 * C2
定义控制变量(control_variable): position即是x，y，z坐标
定义状态变量(state_variable): v(velocity)速度，p(pressure)压力
adjoint为拉格朗日乘子也作为TestFunction用于有限元求解

OpenFoam基于有限体积法(FVM)求解state_variable

对J进行变分:
variation_J = variation(J, state_variable) + variation(J, control_variable)
使variation(J, state_variable)==0，求取adjoint

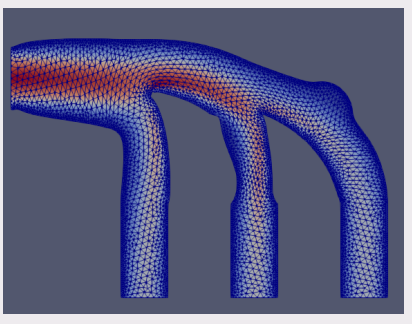
根据Riesz Representation(Laplace smoothing) of shape gradient:
-laplace(grad_position) = dJ(position),求得形状梯度shape_gradient

更新geometry:
new_shape = old_shape - stepSize * shape_gradient

如果变形量很小

否

是



Exit