Numerical Simulation of Hydrogen Jet / Freestream Interaction Mechanisms on Rocket Flight termination system

July 10 2018 International HPC Summer School

Toshihiro Iwasa Department of Mechanical Engineering Kyushu Institute of Technology

Background -rocket safety assessment-

Flight termination system ⇒as a way to destroy safely the rocket, propellant is ejected from the tank



Interaction between Freestream and hydrogen jet may cause auto-ignition/explosion

⇒Clarification conditions igniting/flame holding

(auto-ignition ⇔ non-ignition)
(flame holding ⇔ blow off)

- > Temperature
- Mixing
- Velocity magnitude



Governing equation

3D Compressible Navier-Stokes

```
Mass conservation of 9 chemical species (H_2, O_2, H, O, OH, HO_2, H_2O_2, H_2O, N_2)
```

Ideal equation of state

Numerical scheme

Time integration	LU-ADI (implicit method)
Convection	AUSMDV + MUSCL + minmod limiter
Viscous	2 nd order central difference

Physical model

Turbulence RANS, Spalart-Allmaras(Time-averaged model)

Visualization -3D view-



Color & Contour line: Velocity magnitude

Iso-surface : Q value

Color & Contour line : H_2 mole fraction

Future work

 Parallel computing are performed(8 node 8 thread) by using MPI/OpenMP hybrid method. MPI is used only in one direction(wall-normal direction). I employ MPI in other direction that computational cost is large.

 My in-house code are written by Fortran 77. The lack of the static memory may occur. I rewrite the code by Fortran90 to allocate the memory to dynamic memory