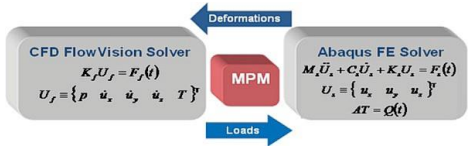
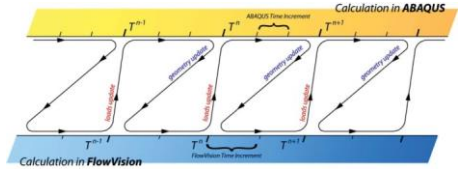
Fluid-Structure-Interaction SIMULIA/Abaqus FEA- FlowVision

FlowVision combined with SIMULIA/ABAQUS offers unique co-simulation capabilities for solving heavily coupled fluid-structure-interaction problems. The SGGR based grid generation provides natural link between the fluid and FEA domains. The "wetted interface" is automatically established and can involve moving object with arbitrary complexity. The MPM (Multi-Physics-Manager) controls both FlowVision and ABAQUS during the simulation process. The data is exchanged through ABAQUS Direct Coupling Interface providing optimal and accurate data transfer rates and support of parallel processing, which significantly speeds up the simulations. The most complex FSI problem can be solved now in realistic time (hours vs. weeks and days).

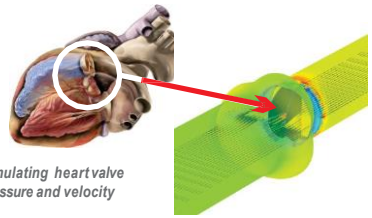
- Simple set-up, control and monitoring with MPM
- Automatic coupling of not matched meshes (fluid-structure)
- Inclusion of highly deformable and moving structures
- Free surface tracking
- Socket based communication
- Full parallel processing with ABAQUS(explicit/implicit)
- Distributed computing (Abaqus, FlowVision on different computers, locations)



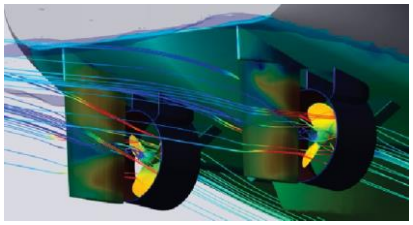
Co-simulation Abaqus-FlowVision



Data exchange Abaqus-FlowVision



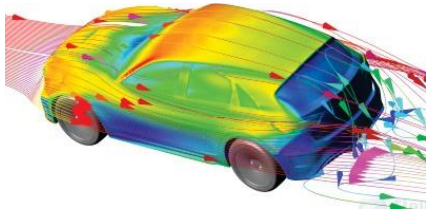
Simulating heart valve Pressure and velocity



Fluid flow generated by propellers and free surface simulation

Parallel supper computing

The FlowVision operates on Microsoft Windows or Linux operating systems. FlowVision supports novel heterogeneous computers with simultaneously distributed and shared memory. FlowVision offers high level of scalability speeding up the most complex simulations from weeks to days. Results: realistic simulations without simplifications, more accurate results through use of automated multi-parameter and multi-criteria optimization procedures.



Aerodynamic simulation

Supported platforms

- Windows 7/ 10/ Compute Cluster Server
- Unix and Linux clusters: SUSE, RedHat
- Windows, Linux: 32/64-bit
- Intel Cluster Ready Program

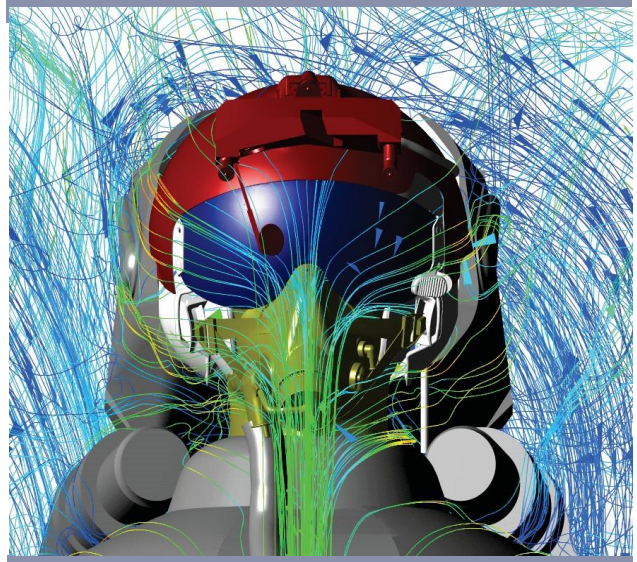
㈜솔루션랩

대전광역시 서구 둔산중로 20, 1203호
(탄방동, 나비가 아르누보팰리스)

Phone: 042-628-0789
Fax: 042-623-0780
E-mail: info@solution-lab.co.kr

FlowVision

Computational Fluid Dynamics and Multi-Physics



FlowVision is general purpose Computational Fluid Dynamics simulation software for modeling complex 3D laminar and turbulent gas/fluid flows. The FlowVision solver uses the Finite-Volume formulation and robust physical models implemented on the parallel architecture using high accuracy and high efficiency numerical schemes. FlowVision is easy to use all-in-one CFD software (pre/post-processor, solver) with intuitive and straightforward user interface. Automatic grid generation operates directly on 3D CAD models with arbitrary complexity supporting both single parts as assemblies. The original boundary curvature is fully maintained even on the coarse grids thanks to Sub-Grid-Geometry-Resolution method of mesh generation. The integrated on-line post processing provides graphical monitoring of simulation results starting from the first iteration. The FlowVision solver can run on remote multi-processor clusters and serves multiple users. The modern object oriented implementation (C++) provides modularity, flexibility and robustness.

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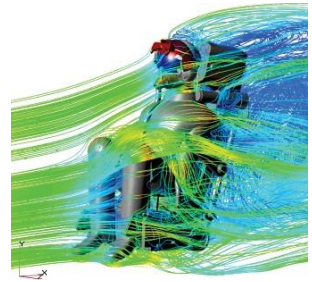

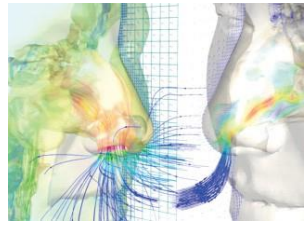

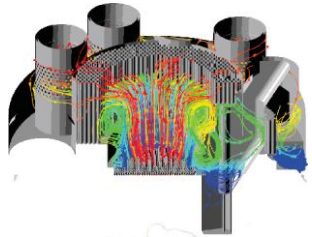

Simulation capabilities

Mesh generation

- Import of CAD/FEM geometry: VRML, STL, INP Abaqus FEA, NASTRAN, ANSYS, IGES, STEP, VDAFS, PARASOLID, ACIS, CATIA V4/V5, Pro/E, UGS, SolidWorks
- Sub-Grid Geometry Resolution (SGGR) method of mesh generation: resolution of curve-linear boundaries with arbitrary complexity (natural truncation of hexahedral cells by triangulated geometry)
- Easy grid definition and fast automatic mesh generation
- Automated local dynamic grid adaptation to geometry and solution peculiarities

Pre-processor

- Definition of substances, phases, and phase interactions
- Selecting physical processes and models
- Definition of initial and boundary conditions
- Definition of initial grid and adaptation criteria

One Navier-Stokes solver for all Mach numbers

- Simultaneous presence of regions with M<<1 (incompressible flow) and M>>1 (supersonic or hypersonic flow) in the computational domain
- Single numerical algorithm applied throughout the entire computation domain

Stationary and non-stationary flows

- Single time marching procedure for obtaining steady and unsteady solutions

Moving bodies

- Easy import of bodies into the computation domain
- 6 degrees of freedom motion
- Accurate and fast Euler method for computing body kinematics: user-defined motion laws
- Body dynamics: gravity, hydrodynamic, or user-defined forces
- Calculator for complex math expressions
- Coupled simulation of the body motion and evolution of free surfaces

High-accuracy VOF for free surface tracking

- Advanced VOF method is used for solving one-, two-, and three-phase problems with contact surfaces. A contact surface is reconstructed using SGGR method. Mass, momentum and energy fluxes are accurately balanced in the neighbor cells.

Fluid-structure interaction (FSI)

- Two-way coupling with FEA systems,
- Automatic data exchange
- Fast explicit coupling procedure
- MPM Manger controlling co-simulation

Turbulence models

- "Standard" k-ε
- Low Reynolds k-ε, AKN (Abe, Kondoh, Nagano)
- Quadratic k-ε
- SST k-omega (Shear Stress Transport)
- SA (Spalart-Allmares)
- Wall functions: Equilibrium; Non-equilibrium

Heat transfer models

- Free and forced convection
- Conjugate heat transfer
- Heat generation due to viscous dissipation
- Radiation heat transfer (P1)
- Anisotropic heat transfer
- Turbulent heat transfer:
  - AKN (Abe, Kondoh, Nagano)
  - S&S (Sommer, So)

Mass transfer models

- Mixing + chemistry
- Combustion

Non-Newtonian fluid models

- Power law
- Hershel-Bulkley

Porous medium models

- Isotropic or Anisotropic resistance

Numerical algorithms

- Unstructured mesh with arbitrarily shaped cells
- Finite Volume approach
- Velocity-pressure split algorithm for integration of the Navier-Stokes equations
- High-accuracy skew schemes
- Implicit time integration
- SofGMRES method for solving algebraic equations

Post-processor

- Color contours, Vectors and Isolines on a plane or surface
- Integral volumetric or surface characteristics
- Integral cross-section characteristics

Application Areas

Aerospace

- Air flows around airplanes, rockets, wings, intakes, etc.
- Gas flows in compressors, turbines, and jet engines

Automotive

- Car body aerodynamics
- Engine cooling
- Oil flow in lubrication systems (seals, bearings, differential gears, etc.)
- Ventilation and conditioning of the car compartment
- Water flow near a moving wiper

Power Production

- Heat exchange in the nuclear reactor cooling system

Medical applications

- Blood flow in arteries
- Blood flow in a heart valve
- Air flow in the respiratory tract

Oil &gas Industry

- Oil or gas flows in ducts, reservoirs, and pumps

Electronics

- Thermal analysis of electronics
- Ventilation of electronic devices

Shipbuilding

- Water flow around the hull of a high speed boat
- Ship resistance calculation
- Putting a ship afloat
- Ship screw propeller hydrodynamic analysis
- Ship propeller and hull interaction

Turbomachinery

- Definition of the head-flow characteristic of a pump, compressor, or turbine
- Estimation of thermal and flow loads on turbine blades
- Air flow around a wind machine

Civil Engineering

- Water dam breaking followed by flooding a landscape

Features

- Ease of use -all-in-one environment: pre-processing, solver, post-processing
- Automatic mesh generation based on SGGR (Sub-Grid Geometry-Resolution)
- Exact CAD model boundaries representation
- Moving bodies: hydrodynamics determined or user defined 6DOF motion
- One solver for all Mach numbers operating on grid with arbitrary cell shape
- Unique approach for simulating fluid flows in computational domain with very small clearances (sub-grid gap model)
- Advanced VOF method for solving multiphase problems free surface tracking
- 2-way coupling with Abaqus for complex fluid structure-interaction problems
- Parallel postprocessing
- Extensive substance and materials database
- High level of customization with templates and plug-ins
- Client-server architecture and C++ implementation

Simulation of landing on Mars