CAD INTERFACE, STRAND GRID TECHNOLOGY AND OTHER NEW DEVELOPMENTS IN CHIMERA GRID TOOLS 2.0

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OVERVIEW

Chimera Grid Tools (CGT) is a collection of software tools for performing grid generation, flow solver input preparation, and solution analysis using overset grid methods

Version 2.0 Highlights

- CAD Interface Using CAPRI Library
- Strand Grid Technology
- OVERGRID Main Development
- CGT Main Development

CAPRI OVERVIEW

- Single interface to native solid model CAD parts from different vendors
- Solid model concept: volumes, faces, edges, points
- Generic functions to interface with solid model
- Easy to implement into existing grid generators and GUI
- Require native CAD license and CAPRI license to run (http://www.cadnexus.com)

GRID POINT DISTRIBUTION ON CAD2SRF TRIANGULATION

Appropriate for geometry description and flow solvers based on cut-cells at the surface but not appropriate as a computational grid

FROM SURFACE TRIANGULATION TO GRIDS

Surface triangulation and edge curves

Cut-cell Flow Solver
**SRF2CAD MODULE IN CHIMERA GRID TOOLS**

- First generate structured grid onto triangulation (surfgrid)
- Triangulation stencil contains CAD volume tags and face tags
- surfgrid calls srf2cad with CAD volume and face tags at each grid point
- srf2cad projects all grid points onto CAD model using inverse evaluation function from CAPRI
- Can be used for grid generation and adaptation

**GRID GENERATION SCRIPT FOR AXISYMMETRIC BODIES**

- A special case of prismatic volume grid with straight lines (strands) in the body-normal direction
- Each strand defined by a direction vector and a grid point distribution function
- All strands share same length and grid point distribution
- Each strand may be clipped at a cut-off index from negative volume trimming and hole cuts
- Viscous spacing at wall stretched to larger spacing at outer boundary

**SURFACE TRIANGULATION GRID POINT CLUSTERING REQUIREMENTS FOR STRAND GRID**

The quality of the strand grid is highly dependent on the quality of the given initial surface triangulation

- Near-body viscous flow resolved by strand grid
- Off-body space covered by AMR Cartesian grids
**STRAND GRID DEVELOPMENT TASKS**

- Develop methods to provide better volume coverage
- Clip strands that are adjacent to negative volume prisms
- Develop visualization tool for strand grid and off-body Cartesian grids

**BETTER VOLUME COVERAGE BY STRAND VECTOR ADJUSTMENTS**

- Direction vector initially given by local surface normal
- Adjust/smooth to bend towards convex corner regions for volume coverage
- Remove small negative cell volumes
- Smooth out cell volumes at interface to off-body Cartesian grids (not yet implemented)

**STRAND CLIPPING DUE TO NEGATIVE VOLUMES**

Crossing of strands can result in negative prism cell volumes

**STRAND PROTRUSION INSIDE SOLID BOUNDARIES**

- Task: For each strand, find intersection(s) with all triangles (from same body, or neighboring bodies)

**STRUCTURED AUXILIARY MESH (SAM) SEARCH ALGORITHM FOR STRAND CLIPPING**

- Determine bounding box around surface geometry
- Determine number of Cartesian cells (buckets) in each direction
- For each bucket, build list of triangles that fall inside or intersect cell
- Can be faster than Alternating Digital Tree searches

**LINE SEGMENT - TRIANGLE INTERSECTION SEARCH USING SAM ALGORITHM**

- Number of line segment tests = Number of surface verts
- Line-box intersection -> line-triangle intersection -> Trim line segment from first grid point below intersection point to outer boundary -> minimum hole cut

RECENT DEVELOPMENTS IN OVERGRID GUI

Solution viewer - cut plane on Cartesian grids, log of scalars, velocity vectors
Dynamics animation - show snap shots of CG track, component orientation, force/moment vectors

CAD interface - hook to cad2srft to ‘read’ CAD part and display as triangulation
Triangulations - display open and bad normal edges, operate by comp. ID, separate faces by sharp edge and disjointedness criteria
Calculators - 6-dof parameters unit conversion and non-dimensionalization
Hybrid grid - strand and AMR Cartesian grids visualizer

STRAND CLIPPING BETWEEN COMPONENTS

Dynamics animation - showsnap shots of CG track, component orientation, force/moment vectors

STRAND GRID VISUALIZATION USING OVERGRID

Strand bundles
Prism stack
Surface shell
Off-surface shell
Constant plane cut

STRAND AND AMR CARTESIAN GRID CUT-PLANE VISUALIZATION USING OVERGRID

AMR grids - filled
iblanked prism cells with overlaid un-cut Cartesian grid
Surface triangle index on iblanked prism cells

CGT 2.0 MAIN ENHANCEMENTS, FUTURE WORK AND RECENT APPLICATIONS

CAD Interface - via CAPRI calls, cad2srft and srftcad modules, callable from overgrid and surgrid, respectively
Strand grid - near-body grid generation module (W. Chan), used with AMR off-body Cartesian grid module (from A. Wissink, Loret/Army)
USURP - automated force/moment computation using weighted surface quads (code by D. Boger, Penn State)
OVERPLOT/OVERHIST - compatibility with new FOMOCO history file format from OVERFLOW 2.02+ (pressure/viscous moment breakdown)
SCRIPTLIB - cap over singular axis, create analytic curve, create cylinder grids, create hyperbolic surface grids, create X-ray hole cut, create full-body grid system from half-body system
Version 2.0 - anticipated release date: late fall 2006
Future work - CAD to abut. structured patches (quilts by J. Dannenhoffer)
Space Shuttle Attach Hardware
Apollo Abort Simulation
Crew Launch/Exploration Vehicles

STRAND GRID GENERATION AND SAM SEARCH PERFORMANCE

Single processor AMD Opteron 244, 1.8 GHz, 1Mb cache

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