CGS

CSG (constructive solid geometry) represents geometry using primitives combined by boolean operations. The surfaces of the primitives are described implicitly by nonlinear equations.

Supported primitives: Hallspace, cylinder, sphere, cone

solid cube =
  plane (0, 0, 0; 0, 0, -1)
  and plane (0, 0, 0; 0, 0, -1, 0)
  and plane (0, 0, 0; -1, 0, 0)
  and plane (100, 100, 100; 0, 0, 0)
  and plane (100, 100, 100; 0, 1, 0)
  and plane (100, 100, 100; 1, 0, 0)

solid all =
  cube
  and sphere (50, 50, 50; 70)
  and not sphere (50, 50, 50; 60)

STL

STL (stereolithography) files are the de-facto standard CAD representation for rapid prototyping. They use faceted surface representation, i.e. a list of triangular surface patches with no adjacency information.

solid Solidname
  facet normal 9.836565a-01 3.236734e-02 1.760037e-01
  outer loop
  vertex -1.070000e+02 0.000000e+00 1.816800e+02
  vertex -1.065000e+02 0.000000e+00 1.790100e+02
  vertex -1.070000e+02 1.200000e+00 1.813800e+02
  endloop
  endfacet
  facet normal 9.824255e-01 9.205644e-02 1.623756e-01
  outer loop
  vertex -1.070000e+02 1.200000e+00 1.813800e+02
  vertex -1.065000e+02 1.200000e+00 1.790100e+02
  vertex [...]
  endloop
  endfacet
  [...]
  endsolid

STEP AP 203

STEP (Standard for the Exchange of Product model data) is an ISO standard. It was designed as a successor of IGES and VDAFS. AP 203 (Application protocol) uses a boundary representation, i.e. a list of surface patches defining the boundary of the solid. These are bounded by edges with well-defined starting and ending points. Additional topological information (how the faces are joined together) is included.

Supported surface types: Plane, cylinder, sphere, cone, torus, sweep and rotational surfaces, b-spline and rational b-spline surfaces

Supported curve types: Line, circle, ellipse, parabola, hyperbola, b-spline and rational b-spline curve

Mesh generation features

- Different elements supported: Triangles, quadrilaterals; tetrahedra, prisms, pyramids
- Rule based advancing front mesh generator: The rules can be specified in form of data structures
- Surface mesh generation using advancing front methods: In a trust region around the current segment whose radius is controlled by the geometry, the front is transformed into local 2D-coordinates and the 2D rules are applied.
- Volume mesh generation using a combination of Delaunay's algorithm and advancing front methods: We use Delaunay's algorithm for large parts of the volume and advancing front methods for generating a conforming closure to the boundary mesh.
- Local mesh size control: The mesh size is controlled by the local curvature of the geometry.

- Anisotropic mesh generation for thin layers
- Mesh optimization of surface and volume mesh using
  1. free point relaxation,
  2. point relaxation on edges and surfaces,
  3. edge swapping,
  4. point collapsing,
  5. edge splitting.

Examples