UNIT-3

3DObjectRepresentations

Methods:

- PolygonandQuadricsurfaces: ForsimpleEuclideanobjects
- Splinesurfacesandconstruction:Forcurvedsurfaces
- Proceduralmethods:Eg.Fractals,Particlesystems
- Physicallybased modelingmethods
- OctreeEncoding
- Isosurfacedisplays,Volumerendering,etc.

Classification:
BoundaryRepresentations(B-reps) eg.PolygonfacetsandsplinepatchesSpace-partitioningrepresentations eg.OctreeRepresentation

Objectsmayalsoassociate withotherpropertiessuch asmass, volume, so as todeterminetheirresponse to stressand temperatureetc.

PolygonSurfaces

Thismethodsimplifies andspeeds upthesurface renderinganddisplayofobjects.

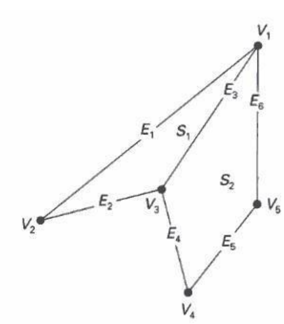
Forother3D objection representations,theyareoften convertedinto polygonsurfacesbeforerendering.

PolygonMesh
- Usingasetofconnectedpolygonallyboundedplanarsurfacestorepresentanobject,whichmayhav ecurved surfaces or curved edges.
- Thewireframedisplayofsuchobjectcanbedisplayedquicklytogivegeneralindicationofthe surfacestructure.
- Realisticrenderingscanbeproducedbyinterpolatingshadingpatternsacrossthepolygonsu rfaces toeliminate orreducethepresenceof polygonedgeboundaries.

PolygonTables

This is the specification of polygonsurfacesusingvertexcoordinatesa ndotherattributes:

1. Geometricdatatable:vertices,edges,andpo lygon surfaces.
2. Attribute table: eg. Degree oftransparency and surface reflectivityetc.



VERTEX TABLE
V_1: x_1, y_1, z_1
V_2: x_2, y_2, z_2
V_3: x_3, y_3, z_3
V_4: x_4, y_4, z_4
V_5: x_5, y_5, z_5

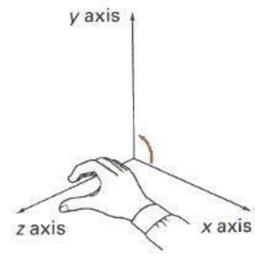
EDGE TABLE
E_1: V_1, V_2
E_2: V_2, V_3
E_3: V_3, V_1
E_4: V_3, V_4
E_5: V_4, V_5
[illegible]

POLYGON-SURFACE TABLE
S_1: E_1, E_2, E_3
S_2: E_3, E_4, E_5, E_6

Someconsistencychecksofthegeom etricdata table:

- Everyvertexislistedasanendpointforat least 2 edges
- Everyedgeis part of at least one polygon
- Everypolygonis closed

Planeequationandvisiblepoints



Consider a cube, each of the 6 planes has 2 sides: insideface and outside face.

For each plane (in a right-handed coordinate system), if welook at its surface and take 3 points in counter-clockwisedirection:(x_1,y_1),(x_2,y_2),and(x_3,y_3),wecancompute4values:A,B,C,Das

$$A=\begin{vmatrix}1 & y_1 & z_1\\ 1 & y_2 & z_2\\ 1 & y_3 & z_3\end{vmatrix}\qquad B=\begin{vmatrix}x_1 & 1 & z_1\\ x_2 & 1 & z_2\\ x_3 & 1 & z_3\end{vmatrix}\qquad C=\begin{vmatrix}x_1 & y_1 & 1\\ x_2 & y_2 & 1\\ x_3 & y_3 & 1\end{vmatrix}\qquad D=-\begin{vmatrix}x_1 & y_1 & z_1\\ x_2 & y_2 & z_2\\ x_3 & y_3 & z_3\end{vmatrix}$$

Then, the plane equation at the form: Ax+By+Cz+D=0 has the property that:If

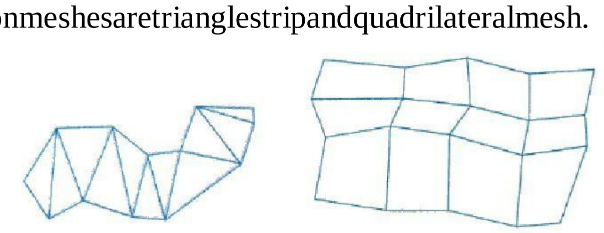
wesubstitute anyarbitrarypoint (x,y) intothis equation, then,

Ax + By + Cz + D < 0 implies that the point (x,y) is inside the surface, andAx

+By+Cz+D <1 implies thatthepoint (x,y) is outsidethesurface.

PolygonMeshes

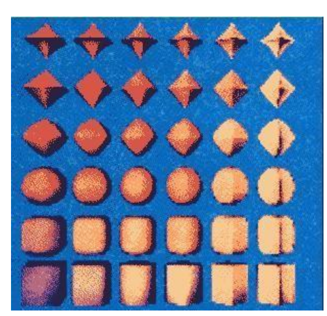
Commontypesofpolygonmeshesaretrianglestripandquadrilateralmesh.



Fasthardware-implementedpolygon renderersarecapableofdisplayingupto1,000,000ormore shaded triangles per second, including the application of surface texture and speciallightingeffects.

CurvedSurfaces

1. Regularcurvedsurfacescanbe generatedas
- QuadricSurfaces, eg.Sphere,Ellipsoid,or
- Superquadrics,eg.Superellipsoids



Thesesurfacescanberepresentedbysomesimpleparametric equations,eg,forellipsoid:

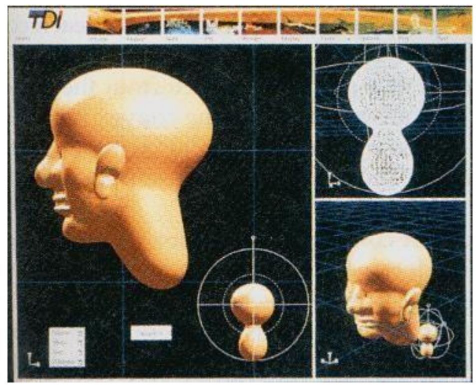
$x = r_x \cos^{s1}\phi \cos^{s2}\theta, \quad -\pi/2 <= \phi <= \pi/2$

$y = r_y \cos^{s1}\phi \sin^{s2}\theta, \quad -\pi <= \theta <= \pi$

$z = r_z \sin^{s1}\phi$

Wheres1, r_x, r_y, and $r_x$areconstants. Byvaryingthe values of ϕ and θ, points onthe surfacecan becomputed.

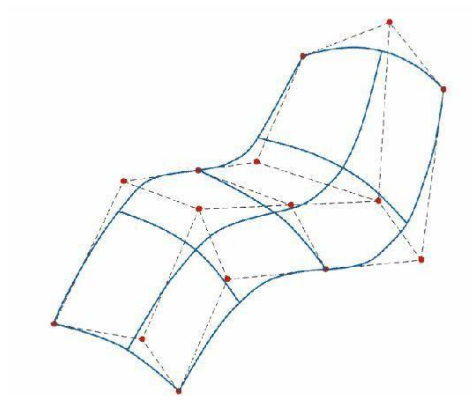
2. Irregularsurfacescanalsobegenerated using some specialformulating approach, to form a kind of**blobby objects** -- The shapes showing acertaindegreeof fluidity.



SplineRepresentations

Spline means a flexible strip used to produce a smooth curve through a designated set ofpoints. Several small weights are distributed along the length of the strip to hold it in positiononthe draftingtableas the curveis drawn.

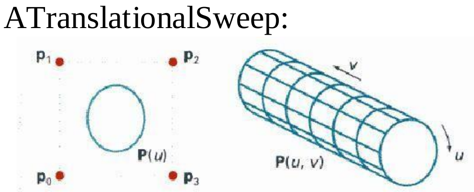
We can mathematically describe such a curve with a piecewise cubic polynomial function =>splinecurves. Thenasplinesurfacecanbedescribedwith 2sets oforthogonal splinecurves.



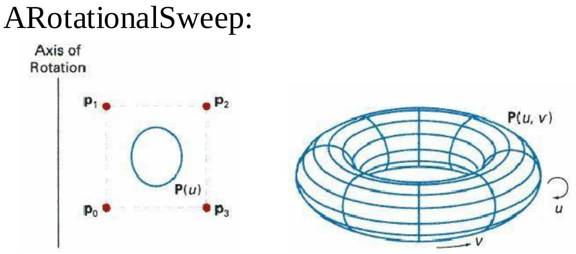
SweepRepresentations

Sweeprepresentationsmeansweepinga2Dsurfacein3Dspacetocreateanobject.However, the objects created by this method are usually converted into polygon meshesand/orparametricsurfaces before storing.

ATranslationalSweep:



ARotationalSweep:



Othervariations:

- Wecan specifyspecial path forthe sweep as somecurve function.
- Wecan varythe shapeorsizeof thecrosssectionalongthe sweeppath.

- Wecan also varytheorientation of thecross section relative to the sweep path.