Unit-6
Solid Modeling

⊛. Solids and solid modeling:-

A solid is a state of matter characterized by particles arranged such that their shape and volume are relatively stable. Soled modeling is the representation of the solid parts of the object on our computer. It is the most advanced method of geometric modeling in three dimensions. It is a complete geometric data representation of an object that enables points in space to be classified relative to the object, if it is inside, outside or on the object. Solid modeling is the foundation of 3D-computer-aided design (CAD) and in general support the creation, exchange, visualization, animation etc. The solid modeling CAD software helps the designer to see the designed object as if it were the real manufactured product. This helps the designer to be sure that the object looks exactly as they wanted it to be.

To make the solid models we have to fist make the wire frame model of the object and convert it into 3D view. After that, surfaces are added to the 3D wire model to convert it into 3D solid model. For creating the solid models we need to have special CAD software that can create solid models. One of the most popular CAD Software for solid modeling is SolidWorks. Solid modeling software are being used in engineering; medical industry, entertainment industry etc.

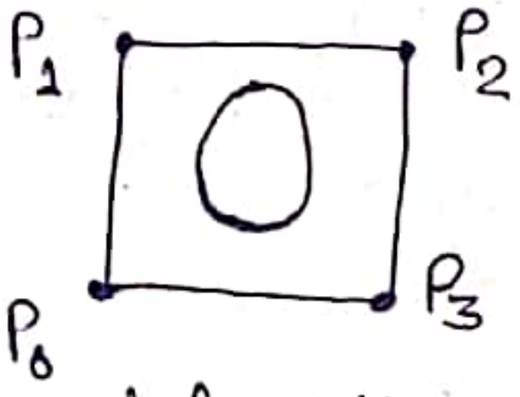
Boundry points → Points where distance to the object and the objects complement is zero.

Interior points → All the other points than boundry points in the object.

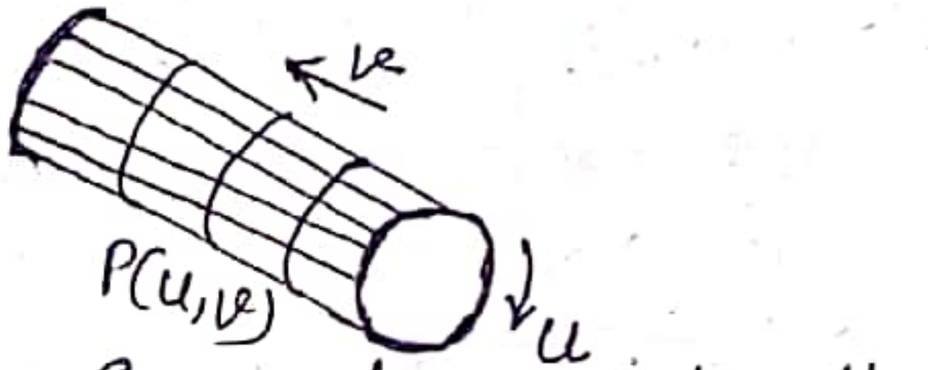
Closure → Union of interior points and boundry points.

⊛. Sweep Representation:-

Sweep representations are used to construct 3D object from 2D shape that have some kind of symmetry. Sweep representations are useful for constructing 3D objects that possess translational, rotational and other symmetries.

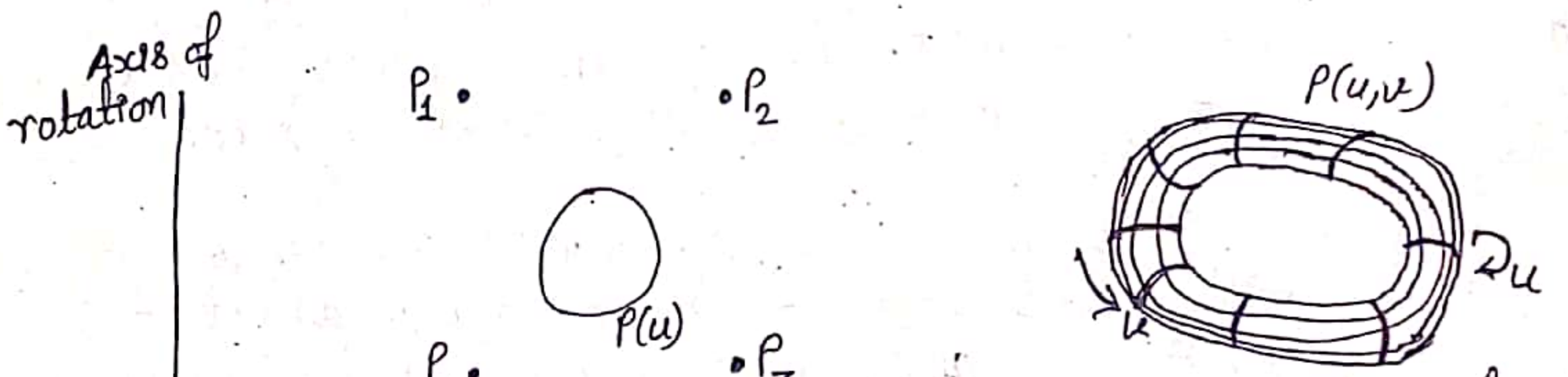


Translating the control points of the periodic spline curve.



Generating solid with point function P(u,v).

fig. Illustration of a translational sweep.



Rotating the control points of the periodic spline curve.

Generating solid about given rotation axis.

fig. Constructing a solid with rotational sweep.

In general we can specify sweep constructions using any path. For rotational sweeps, we can move along a circular path through any angular distance from 0 to 360°. For noncircular paths we can specify the curve function describing the path and the distance of travel along the path. In addition we can vary the shape or size of the cross section along the sweep path. Sweeping is based on the notation of moving a point, curve or a surface along a given path.

⊛. Boundry Representation (B-rep):-

A boundry representation (B-rep) of an object is a geometric and topological description of its boundry. The object boundry is segmented into a finite number of bounded subsets, called faces. A face is represented in a B-rep by its bounding edges and vertices. Thus a B-rep consists of three primitive topological entities: faces (2-D entitites), edges (1-D entities) and vertices (0-D entities). Geometric information consist of the shape and location in space of each of the primitive topological entities.

Advantages and Disadvantages of B-rep:

The main advantage of B-rep is that it is very appropriate to construct solid models of unusual shapes that are difficult to build using primitives. Another major advantage is that it is relatively simple to convert a B-rep model into a wireframe model.

The disadvantage of the boundry model is that it requires large amounts of storage. The model is defined by its faces, edges and vertices which tend to grow fairly fast for complex models. If B-rep systems do not have a CSG-compatible user interface then it becomes slow and ~~inve~~ inconvinent to use Euler operations in a design and production environment.

⊛. Spatial-Partitioning Representation:-

It describes the objects as collections of adjoining non-intersecting solids. It creates collections of solids that may or may not be the same type as the original object. It creates collection of solids that are like building blocks and can vary in type, size, position and orientation. Solid objects can be formed with spatial-partioning using cell decomposition, octrees, quadtrees etc.

It is used in computer graphics in ray tracing where it is frequently used to organize the objects in virtual scene. Recursively partitioning space using planes in this way produces a BSP tree, which is one of the most common forms of space partitioning.

⊛. Binary Space Partition Trees (BSP):-

In this representation scheme, we subdivide a scene into two sections at each step with a plane that can be at any position and orientation. Many 3D modeling and rendering programs utilize a Binary Space Partition tree (BSP tree) to make rendering go faster. It is a generic process of dividing a scene into two until the partitioning satifies one or more requirements. It is a way of grouping data so it can be processed faster.

BSP trees provide more efficient partitioning since we can position and orient the cutting planes to suit the spatial distribution of objects. This reduces the depth of the tree representation for a scene compared to octree and thus reduce the time to search the tree. BSP trees are useful for identifying visible surfaces and for space partioning in ray-tracing algorithms.

⊛. Octree Representation:-

Hierarchical tree structures are called octrees. Octrees are used to represent solid objects in some graphics systems. Medical imaging and other applications that require displays of object commonly use octree representations.

Octree is 3D quadtrees, its three dimensions are recursively subdivided into octants and have quadrants. The octree encoding procedure for a 3D space is an extension scheme for a 2D space called quadtree encoding. Quadtrees are generated by successively dividing a 2D region into quadrants An algorithm for generating a quadtree tests pixel-intensity values and sets up the quadtree nodes accordingly.

Octrees are typically used when the interior of object is important. Octrees are usually applied in raycasting and shadow casting.

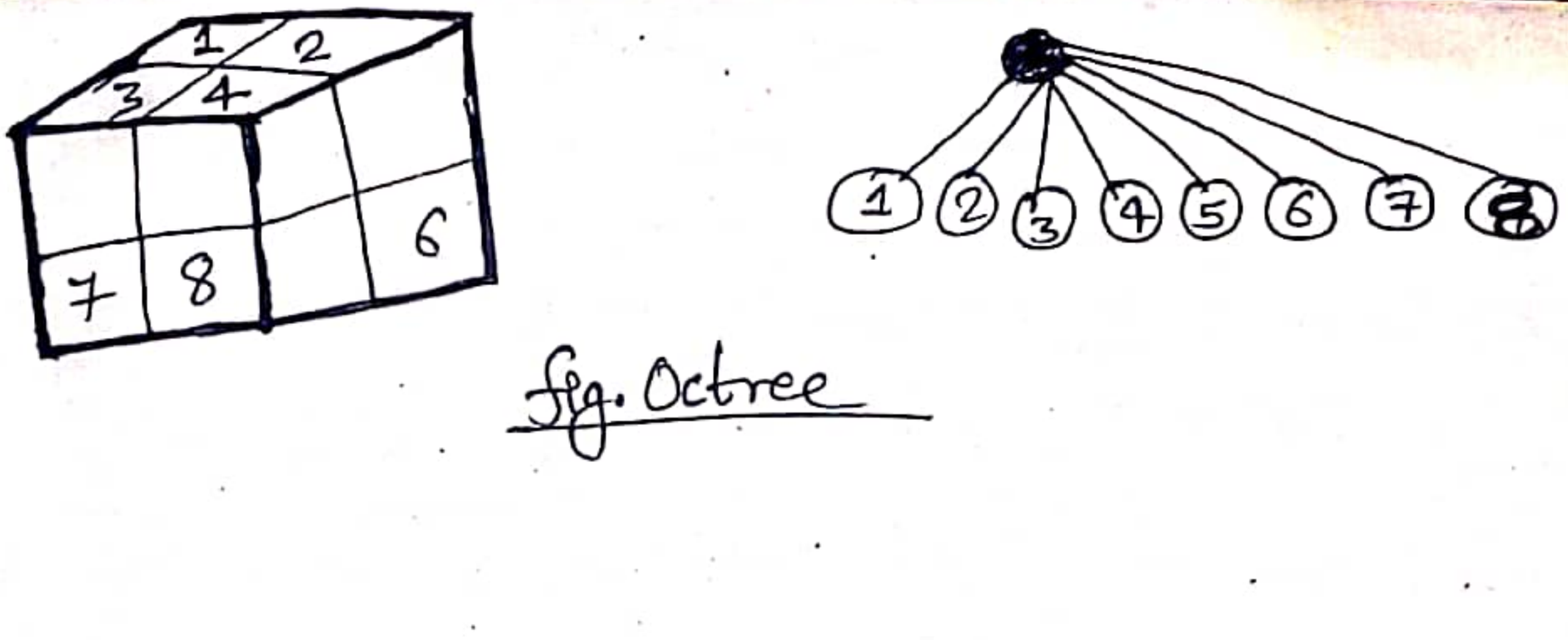


fig. Octree

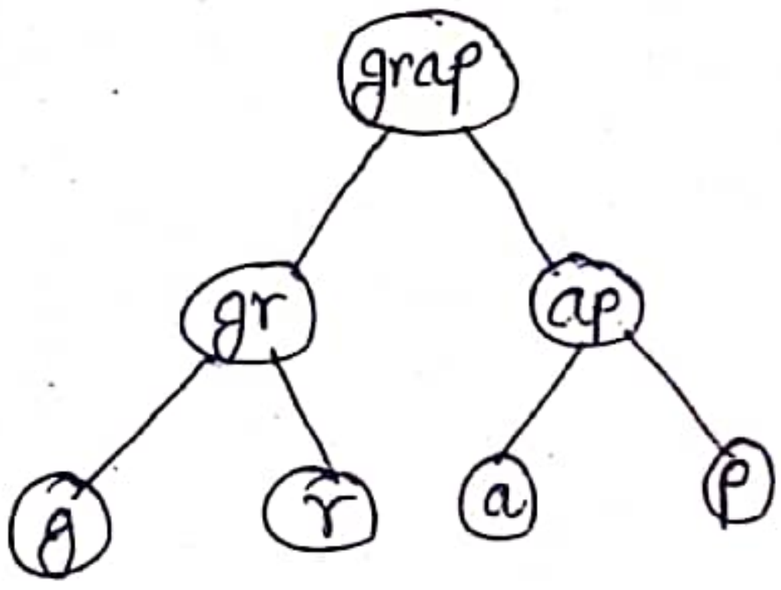


fig. Simple Binary Space Partition Tree (Simple BSP)