CZ2003 COMPUTER GRAPHICS & VISUALIZATION

EXPERIMENT 3: PARAMETRIC SURFACES AND SOLIDS

LAB REPORT

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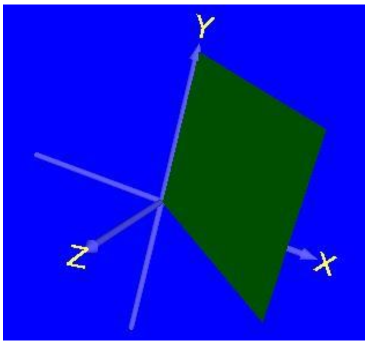
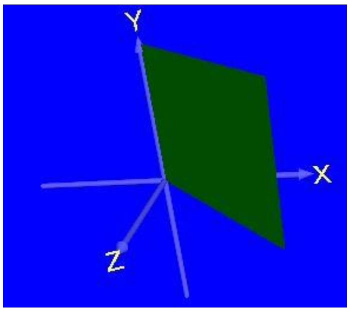
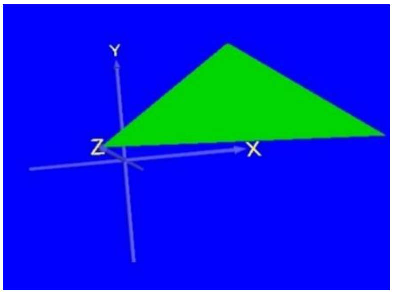
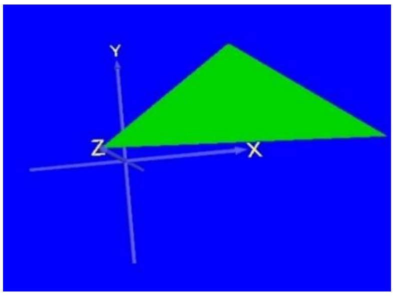
LAB GROUP: SS2

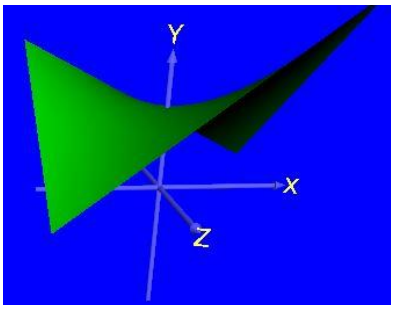
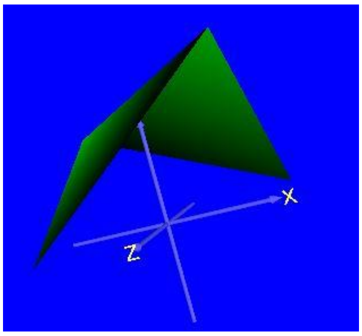
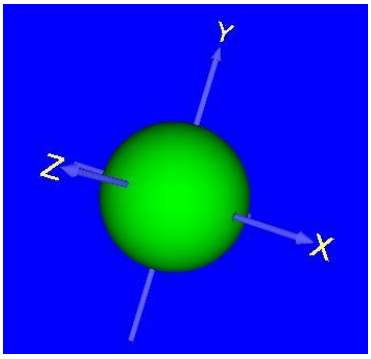
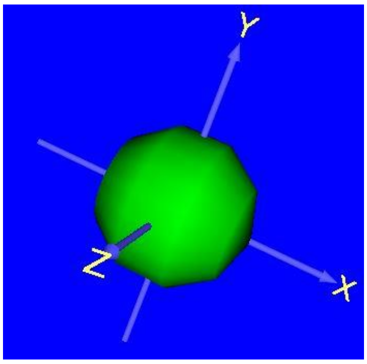
<table>
<tr><th>Surface 1</th><th>Surface 2</th><th>Note</th></tr>
<tr><td>

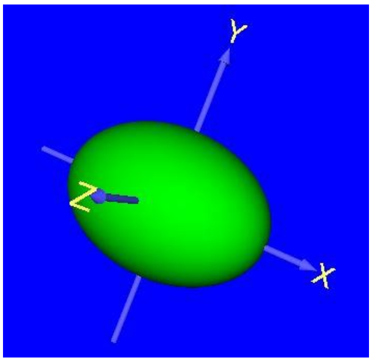
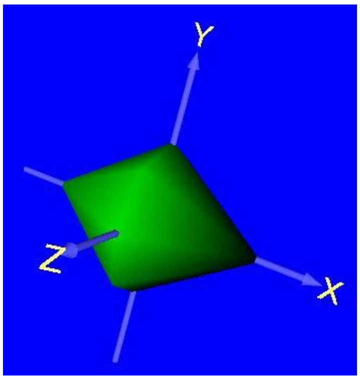
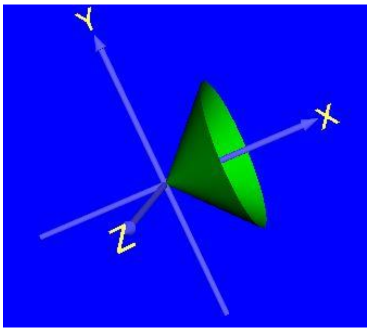
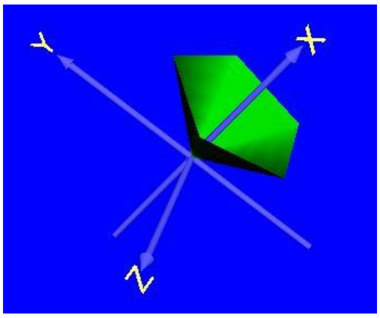
Above is the snapshot of “3D plane.wrl” which defines a plane by parametric equations x=u, y=v, and z=u with parameter domain [0,1 0,1]. The sampling resolution is [75 75].</td><td>

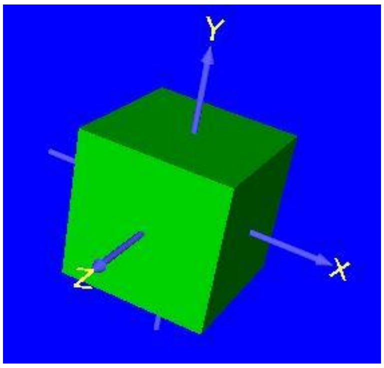
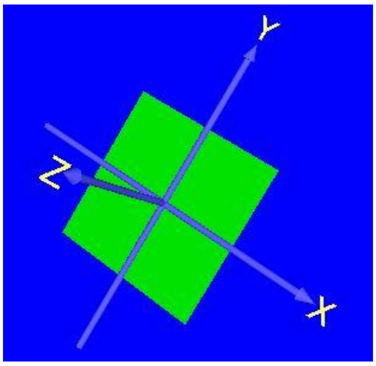
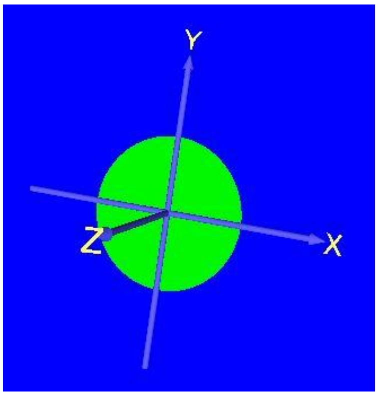
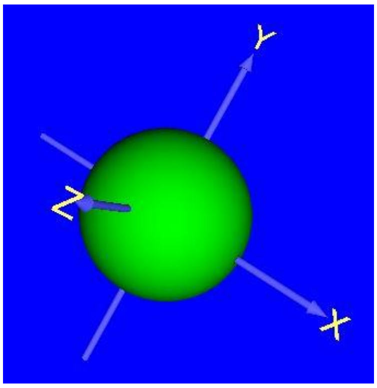
Above is the snapshot of “3D plane2.wrl” which defines a plane by parametric equations x=u, y=v, and z=u with parameter domain [0,1 0,1]. The sampling resolution is [1 1].</td><td>Note 1:
The sampling resolution for a plane can be set to as low as a minimum of 1 and the plane will have no observable difference because a the plane only contains straight lines.</td></tr>
<tr><td>

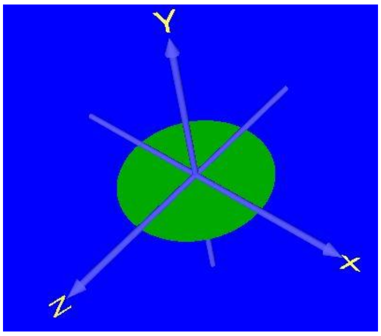
Above is the snapshot of “3D triangle.wrl” which define a triangle by parametric equations x= u*(2) +v*(1+u*(-2)),
y=v,
z=1+u*(-1) +v*(-1+u) with parameter domain [0 1 0 1]. The sampling resolution is [75 75].</td><td>

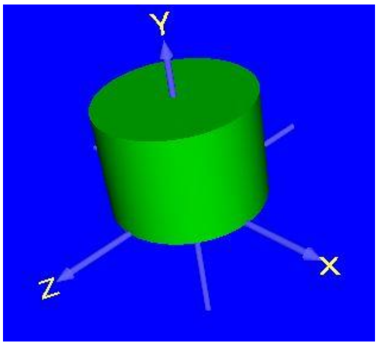
Above is the snapshot of “3D triangle2.wrl” which define a triangle by parametric equations x= u*(2) +v*(1+u*(-2)),
y=v,
z=1+u*(-1) +v*(-1+u) with parameter domain [0 1 0 1]. The sampling resolution is changed to [1 1].</td><td>Note 2:
The sampling resolution does not affect the object, because this is a surface, and the surface is constructed by straight lines.</td></tr>
</table>

 Above is the snapshot of “bilinear surface.wrl” which define a bilinear surface by parametric equations x= -1+2*u, y= 1-u-v+u*v*2.5, and z= -1+2*v with parameter domain [0 1 0 1]. The sampling resolution is [75 75].	 Above is the snapshot of “bilinear surface2.wrl” which define a bilinear surface by parametric equations x= -1+2*u, y= 1-u-v+u*v*2.5, and z= -1+2*v with parameter domain [0 1 0 1]. The sampling resolution is changed to [1 1].	**Note 3:** For a 3D “twisted” surface that is supposed to have a smooth, curved surface like in “bilinear surface.wrl”, if we change the sampling resolution to [1 1], the surface changes to a surface with sharp edges and no curved surfaces. Therefore, to display a 3D “twisted” surface with a smooth, curved surface, we must make the sampling resolution higher to allow more points to be sampled for the surface.
Solid 1	**Solid 2**	
 Above is the snapshot of “sphere.wrl” which define a sphere by parametric equations x= 0.5*cos(2*pi*u), y= 0.5*sin(2*pi*u) *cos(pi*v), z= 0.5*sin(2*pi*u) *sin(pi*v), with parameter domain [0 1 0 1]. The sampling resolution is [75 75].	 Above is the snapshot of “sphere.wrl” which define a sphere by parametric equations x= 0.5*cos(2*pi*u), y= 0.5*sin(2*pi*u) *cos(pi*v), z= 0.5*sin(2*pi*u) *sin(pi*v), with parameter domain [0 1 0 1]. The sampling resolution is [10 10].	**Note 4:** The more the number of samples used, the more accurate and smooth the object will be. This is because the object is created by joining multiple straight line together between points defined in the formula. Object is formed by rotational sweeping of a circle by 180 degrees.

 Above is the snapshot of “ellipsoid.wrl” which define an ellipsoid by parametric equations x= 0.7*cos(2*pi*u), y= 0.5*sin(2*pi*u) *cos(pi*v), z= 0.5*sin(2*pi*u) *sin(pi*v), with parameter domain [0 1 0 1]. The sampling resolution is [75 75].	 Above is the snapshot of “ellipsoid2.wrl” which define an ellipsoid by parametric equations x= 0.7*cos(2*pi*u), y= 0.5*sin(2*pi*u) *cos(pi*v), z= 0.5*sin(2*pi*u) *sin(pi*v), with parameter domain [0 1 0 1]. The sampling resolution is [4 4].	**Note 5:** The more the number of samples used, the more accurate and smooth the object will be. This is because the object is created by joining multiple straight line together between points defined in the formula. Object is formed by rotational sweeping of an ellipse by 180 degrees.
 Above is the snapshot of “cone.wrl” which define a conical surface by parametric equations x= 0.5*u, y= 0.5*u*cos(2*pi*v), z= 0.5*u*sin(2*pi*v), with parameter domain [0 1 0 1]. The sampling resolution is [75 75].	 Above is the snapshot of “cone2.wrl” which define a conical surface by parametric equations x= 0.5*u, y= 0.5*u*cos(2*pi*v), z= 0.5*u*sin(2*pi*v), with parameter domain [0,1 0,1]. The sampling resolution is [5 5].	**Note 6:** The more the number of samples used, the more accurate and smooth the object will be. This is because the object is created by joining multiple straight line together between points defined in the formula. Using lesser sampling resolution will allow sharp edges to be visible on the cone. Object is formed by rotational sweeping a straight line by 2*pi degrees.

 Above is the snapshot of "box.wrl" which define a 3D solid box by parametric equations x=-0.5+u, y=-0.5+v, z=-0.5+w, with parameter domain [0 1 0 1 0 1]. The sampling resolution is [75 75 75].	 Above is the snapshot of "box2.wrl" which define a 3D plane by parametric equations x=-0.5+u, y=-0.5+v, z=0, with parameter domain [0 1 0 1]. The sampling resolution is [75 75]	**Note 7:** **Translational Sweeping:** By introducing another parameter, w, in the additional dimension along the z-axis, it will translate the surface along the z-axis through the domain w [0 1] causing it to form a solid object.
 Above is the snapshot of "solid circle.wrl" which defines a 3D circular disk by parametric equations x=0.5*cos(2*pi*u) *v, y=0.5*sin(2*pi*u) *v, z=0, with parameter domain [0 1 0 1,0 1]. The sampling resolution is [75 75 75].	 Above is the snapshot of "solid sphere.wrl" which define a solid sphere by parametric equations x=0.5*cos(2*pi*u)*v, y=(0.5*sin(2*pi*u)*v)*cos(pi*w), z=(0.5*sin(2*pi*u)*v)*sin(pi*w), with parameter domain [0 1 0 1 0 1]. The sampling resolution is [75 75 75].	**Note 8:** As can be seen in this example, we can obtain a solid sphere from a circular surface by rotating the circular surface about any of the axis using rotational sweeping by pi degrees and implementing another parameter w.

<table>
<tr>
<td>

Above is the snapshot of “disk.wrl” which defines a 3D circular disk by parametric equations x= 0.5*sin(2*pi*u) *v,
y=0,
z=0.5*cos(2*pi*u) *v, with parameter domain [0 1 0 1 0 1]. The sampling resolution is [75 75 75].</td>
<td>

Above is the snapshot of “solid cylinder.wrl” which defines a 3D solid cylinder by parametric equations x= 0.5*sin(2*pi*u) *v,
y=0.7*w,
z=0.5*cos(2*pi*u) *v, with parameter domain [0 1 0 1 0 1]. The sampling resolution is [75 75 75].</td>
<td>Note 9:
By using translational sweeping as can be seen in this example, we can transform a circular surface into a cylinder by introducing a new parameter w and let the surface grow in the direction of one of the axis. In this example, we defined a cylinder with radius 0.5 and a height of 0.7.</td>
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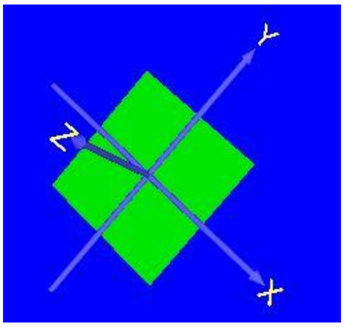
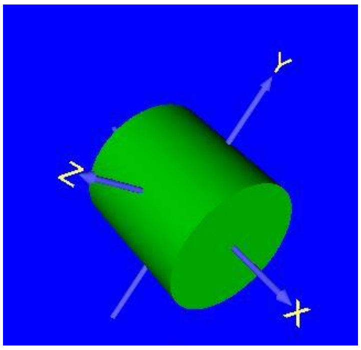
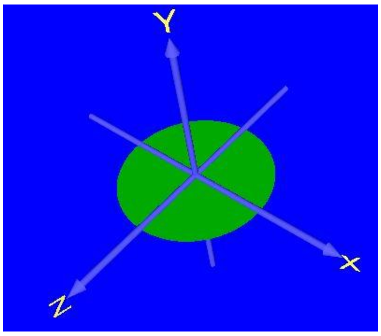
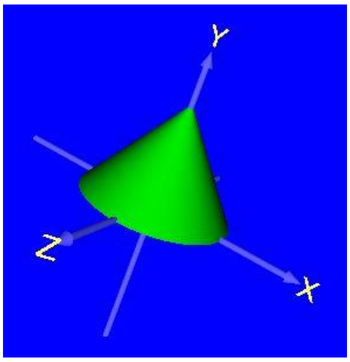
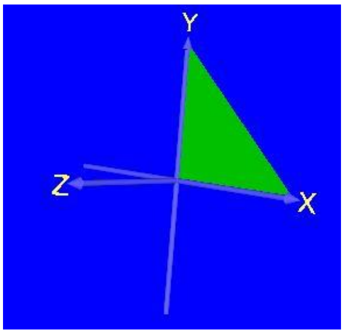
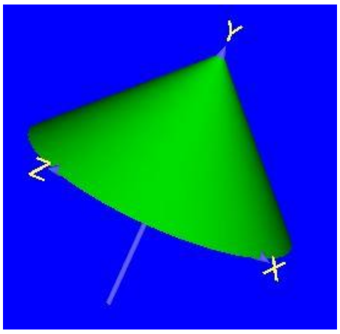
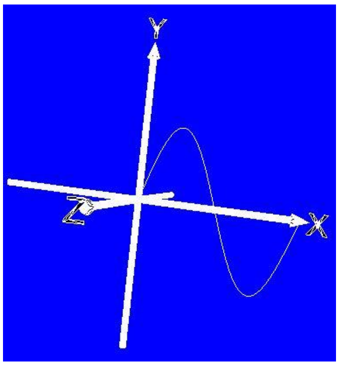
<tr>
<td>

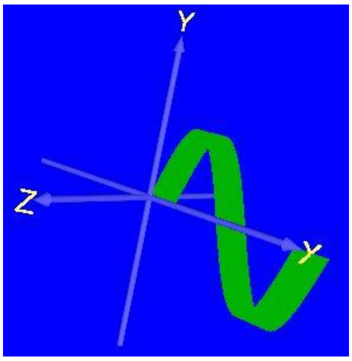
Above is the snapshot of “square.wrl” which defines a square plane by parametric equations x=-0.5+u,
y=-0.5+v,
z=0, with parameter domain [0 1 0 1 0 1]. The sampling resolution is [75 75 75].</td>
<td>

Above is the snapshot of “cylinder2.wrl” which defines a solid cylinder by x=-0.5+u,
y=(-0.5+v) *cos(pi*w),
z=(-0.5+v) *sin(pi*w), with parameter domain [0 1 0 1 0 1]. The sampling resolution is [75 75 75].</td>
<td>Note 10:
By using rotational sweeping as can be seen in this example, we can transform a square surface into a solid cylinder by introducing a new parameter w and let the surface rotate about the x axis by pi degrees.</td>
</tr>
</table>

 Above is the snapshot of “disk.wrl” which defines a 3D circular disk by parametric equations x= 0.5*sin(2*pi*u) *v, y=0, z=0.5*cos(2*pi*u) *v, with parameter domain [0,1 0,1,0,1]. The sampling resolution is [75 75 75].	 Above is the snapshot of “solid cone.wrl” which defines a 3D solid cone by parametric equations x= 0.5*sin(2*pi*u) *v*(w-1), y=0.7*w, z=0.5*cos(2*pi*u) *v*(w-1), with parameter domain [0,1 0,1,0,1]. The sampling resolution is [75 75 75].	**Note 11:** By using translational sweeping, we can transform a circular surface into a cylinder by introducing a new parameter w and let the surface grow in the direction of one of the axes. In order to change the cylinder into a solid cone, we must shrink the radius of the circular surface as parameter w grows from 0 to 1. Therefore, (1-w) is multiplied to x and z which defines the circular surface in order to shrink the radius as w grows.
 Above is the snapshot of “triangle.wrl” which defines a triangular plane by parametric equations x= 0.5*sin(2*pi*u) *v, y=0, z=0.5*cos(2*pi*u) *v, with parameter domain [0,1 0,1,0,1]. The sampling resolution is [75 75 75].	 Above is the snapshot of “cone3.wrl” which defines a 3D solid cone by parametric equations x = u*(1-v) *sin(2*pi*w+pi/2), y = v, z=u*(1-v) *cos(2*pi*w+pi/2), with parameter domain [0,1 0,1,0,1]. The sampling resolution is [75 75 75].	**Note 12:** By using rotational sweeping, we can transform a 2D triangular plane into a solid cone by rotating it 2*pi degrees about the y axis.

Use curve y=sin(x) for making a solid by applying rotational and translational sweepings together

<table>
<tr>
<td>

Above is the snapshot of "sine wave.wrl" which defines a sine wave with the parametric equations x = u, y=0.5*sin(2*pi*u), z=0, and the parameter domain [0,1,0,1,0,1]. The sampling resolution is [75 75 75].</td>
<td>

Above is the snapshot of "sine wave2.wrl" which defines a sine wave with the parametric equations x=u+0.2*v, y=0.5*sin(2*pi*u), z=0, and the parameter domain [0,1,0,1,0,1]. The sampling resolution is [75 75 75].</td>
<td>Note 13:
The sine wave gains a "thickness" of 0.2 when we introduce a new parameter v and do a translational sweeping along the x axis.</td>
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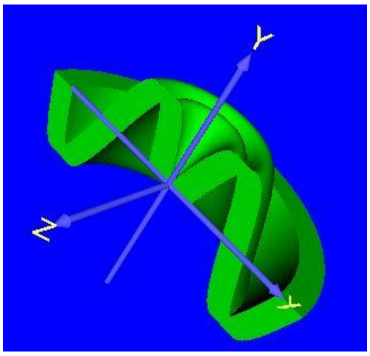
<td></td>
<td>

Above is the snapshot of "sine wave3.wrl" which defines a sine wave with the parametric equations x=(u+0.2*v)*sin(pi*w+pi/2), y=0.5*sin(2*pi*u), z=(u+0.2*v)*cos(pi*w+pi/2), and the parameter domain [0,1,0,1,0,1]. The sampling resolution is [75 75 75].</td>
<td>Note 14:
Next, by rotating the surface obtained in "sine wave2.wrl" by pi degrees, we get the solid figure as seen in "sine wave3.wrl".</td>
</tr>
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