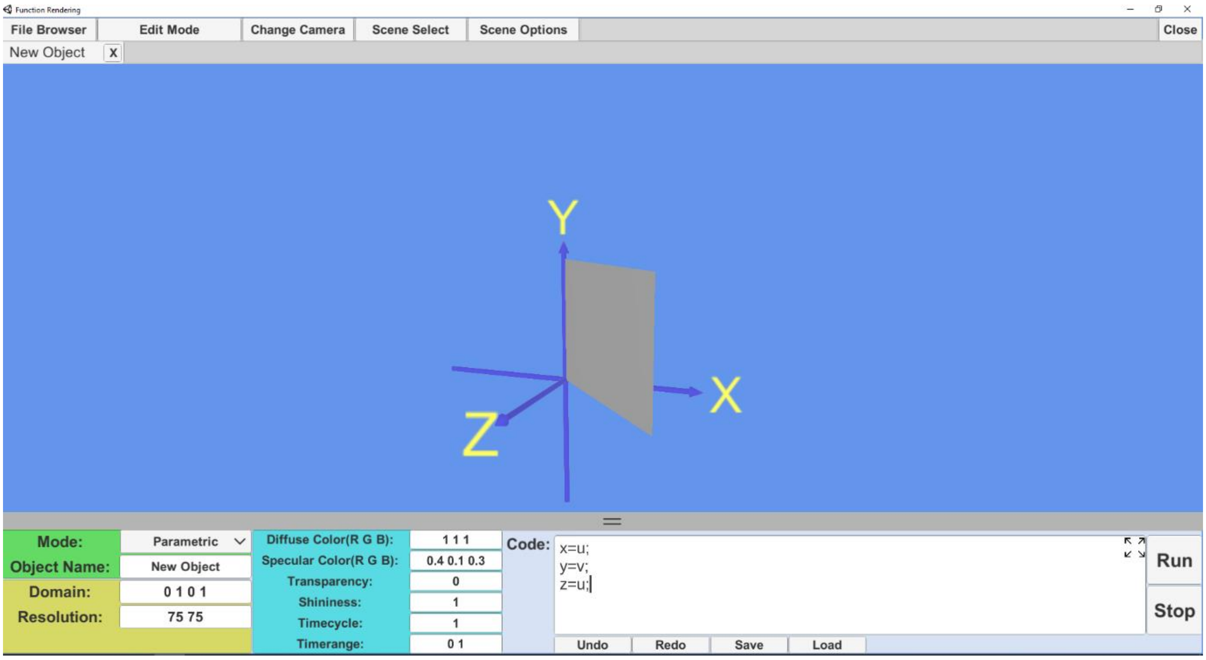
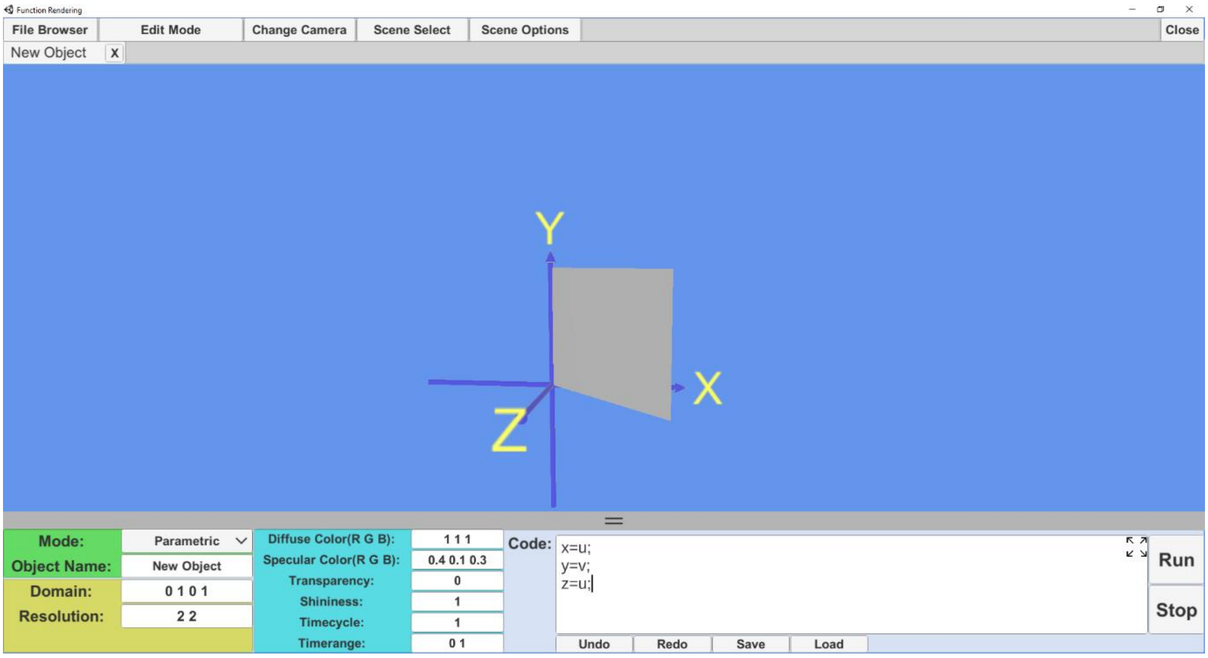
1. Surfaces

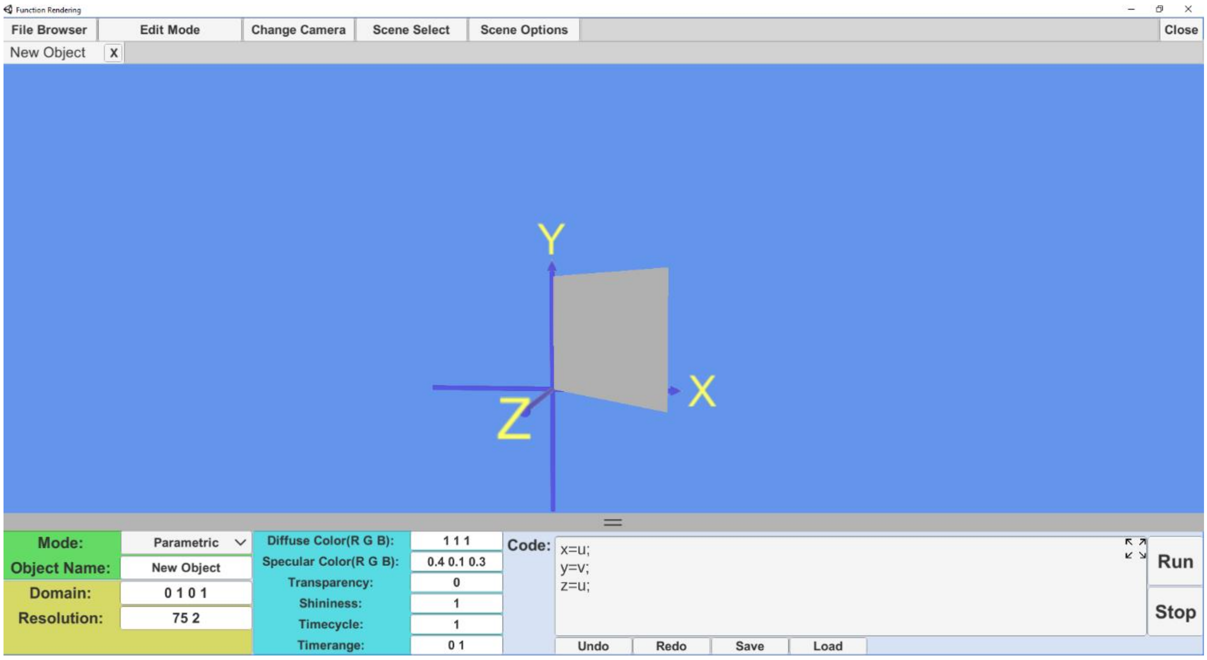
3D Plane



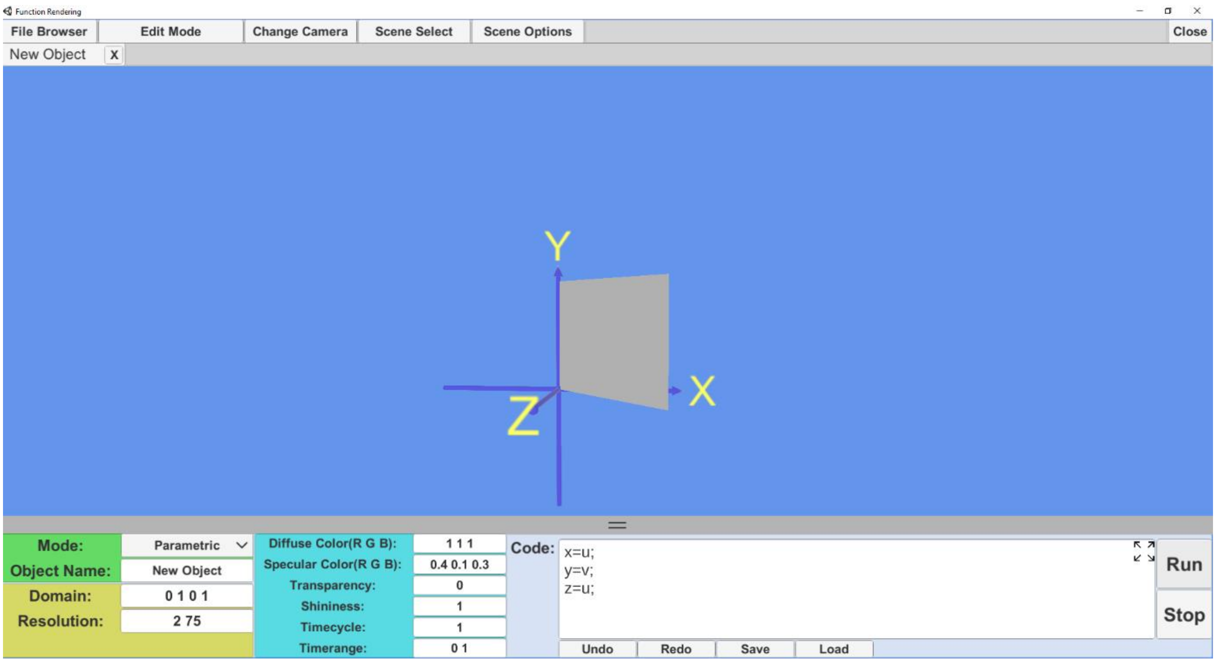
Surface 1



Surface 2



Surface 3



Surface 4

Curve No.	Notes

Surface 1	In 3DPlane1.Func,
	x = u;
	y = v;
	z = u;
	
	The parameter domain is [0 1 0 1].
	The sampling resolution is 75 75.

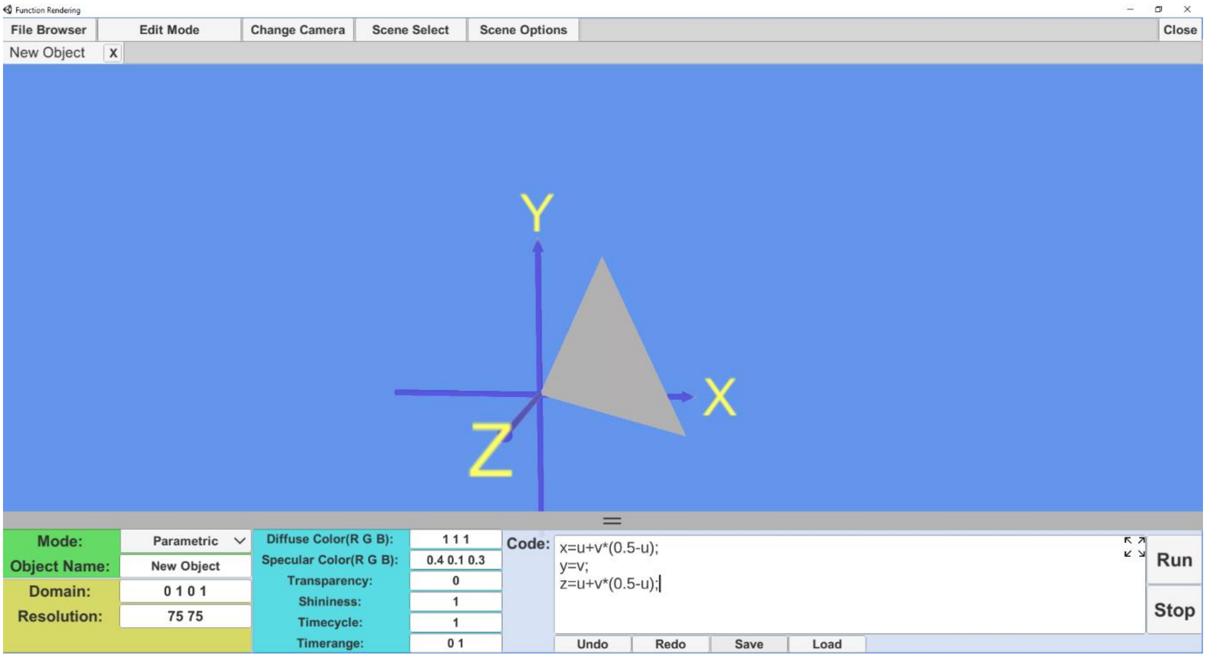
Surface 2	In 3DPlane2.Func,
	x = u;
	y = v;
	z = u;
	
	The u parameter domain is [0 1 0 1].
	The sampling resolution is 2 2.

Surface 3	In 3DPlane3.Func,
	x = u;
	y = v;
	z = u;
	
	The u parameter domain is [0 1 0 1].
	The sampling resolution is 75 2.

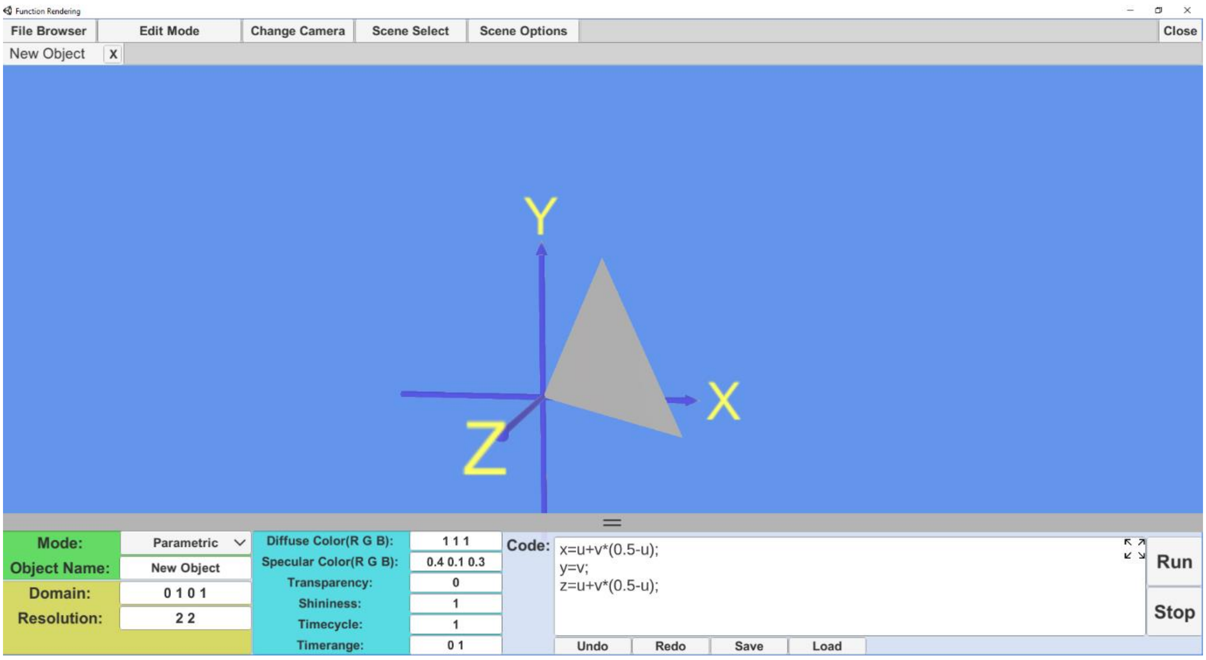
Surface 4	In 3DPlane4.Func,
	x = u;
	y = v;
	z = u;
	
	The u parameter domain is [0 1 0 1].
	The sampling resolution is 2 75.

Comparing the difference between all the surfaces, the results look the same. This is because the change of resolution will not affect the output and the resolution can even go as low as 1 as only one sampling point is needed to form a 3D plane.

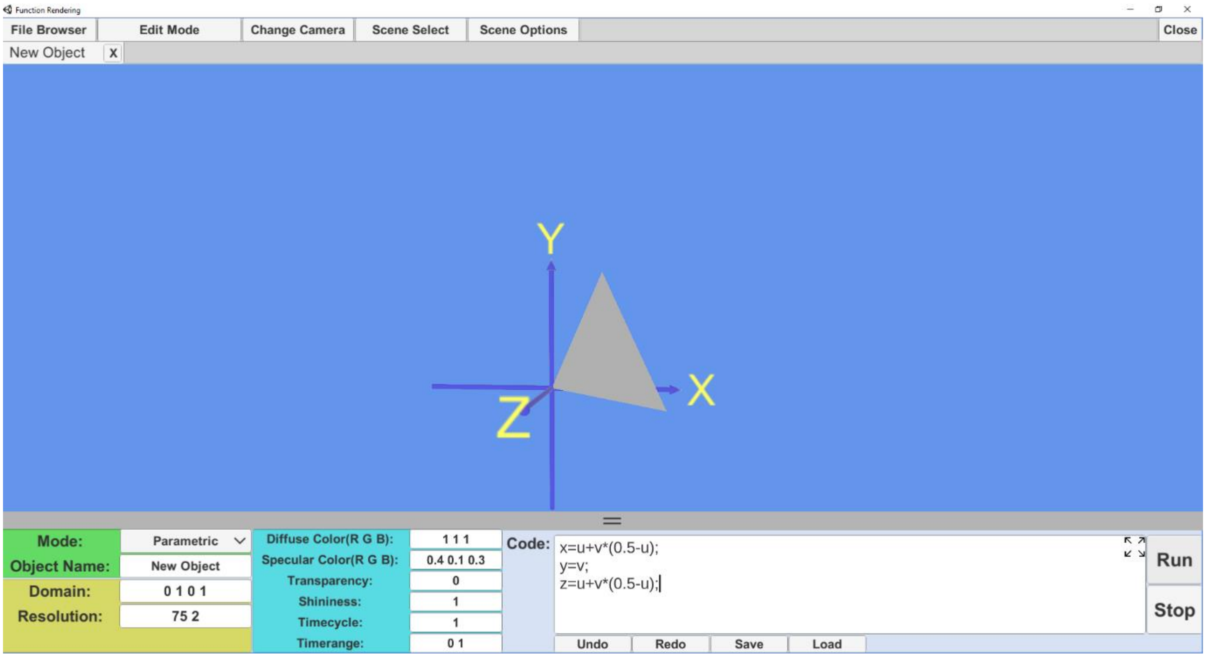
3D Triangle



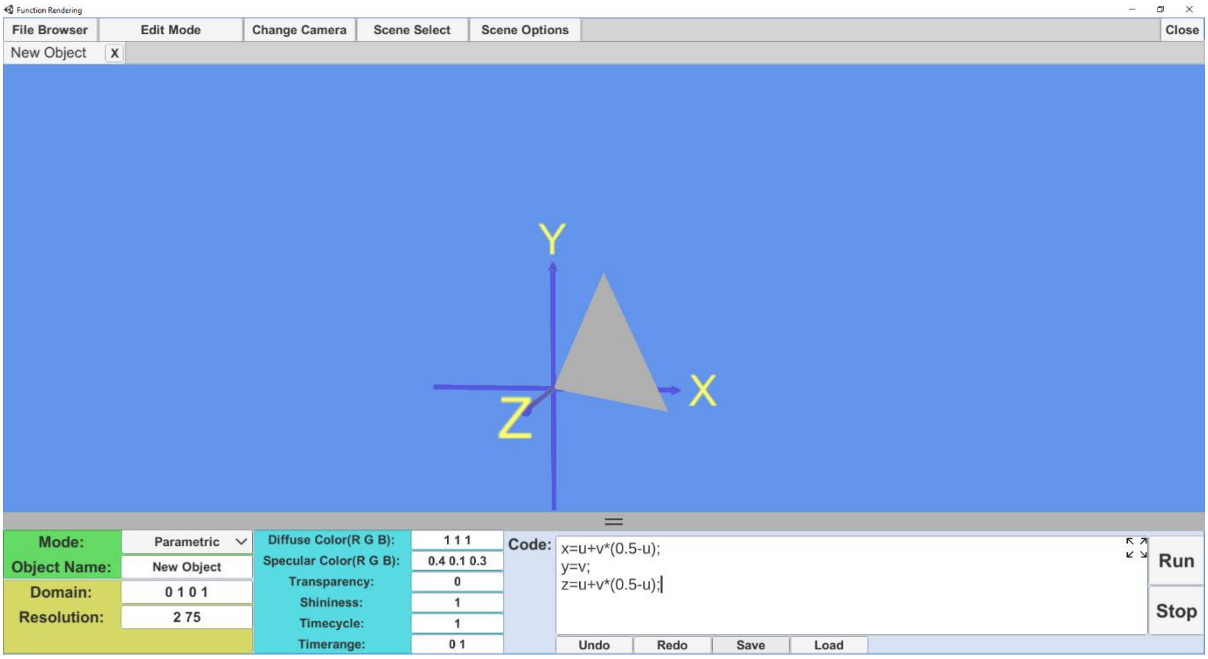
Surface 1



Surface 2



Surface 3



Surface

Curve No.	Notes

Surface 1	In 3DTriangle1.Func,
	x = u+v*(0.5-u);
	y = v;
	z = u+v*(0.5-u);
	
	The parameter domain is [0 1 0 1].
	The sampling resolution is 75 75.

Surface 2	In 3DTriangle2.Func,
	x = u+v*(0.5-u);
	y = v;
	z = u+v*(0.5-u);
	
	The u parameter domain is [0 1 0 1].
	The sampling resolution is 2 2.

Surface 3	In 3DTriangle3.Func,
	x = u+v*(0.5-u);
	y = v;
	z = u+v*(0.5-u);
	
	The u parameter domain is [0 1 0 1].
	The sampling resolution is 75 2.

Surface 4	In 3DTriangle4.Func,
	x = u+v*(0.5-u);
	y = v;
	z = u+v*(0.5-u);
	
	The u parameter domain is [0 1 0 1].
	The sampling resolution is 2 75.

The equation for x, y, and z axis can be obtained by using the Bilinear surface parametric representation equation, P = P1 + u*(P2 - P1) + v*(P3 - P1 + u*(P4 - P3 - (P2 - P1))), where P1(0, 0, 0), P2(1, 0, 1), P3(0.5, 1, 0.5), P4(0.5, 1, 0.5).

Thus,

x-axis or z-axis:

P = 0 + u*(1 - 0) + v*(0.5 - 0 + u*(0.5 - 0.5 - (1 - 0)))

= u + v*(0.5 - u)

y-axis:

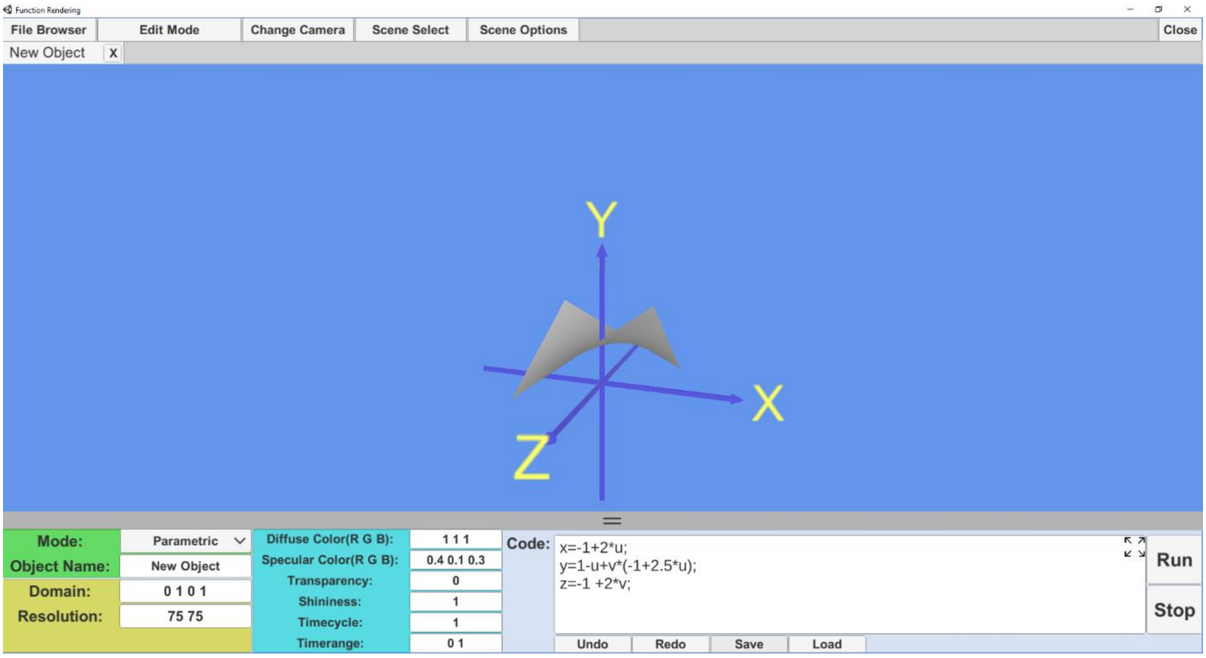
P = 0 + u*(0 - 0) + v*(1 - 0 + u*(1 - 1 - (0 - 0)))

= v*(1 + 0)

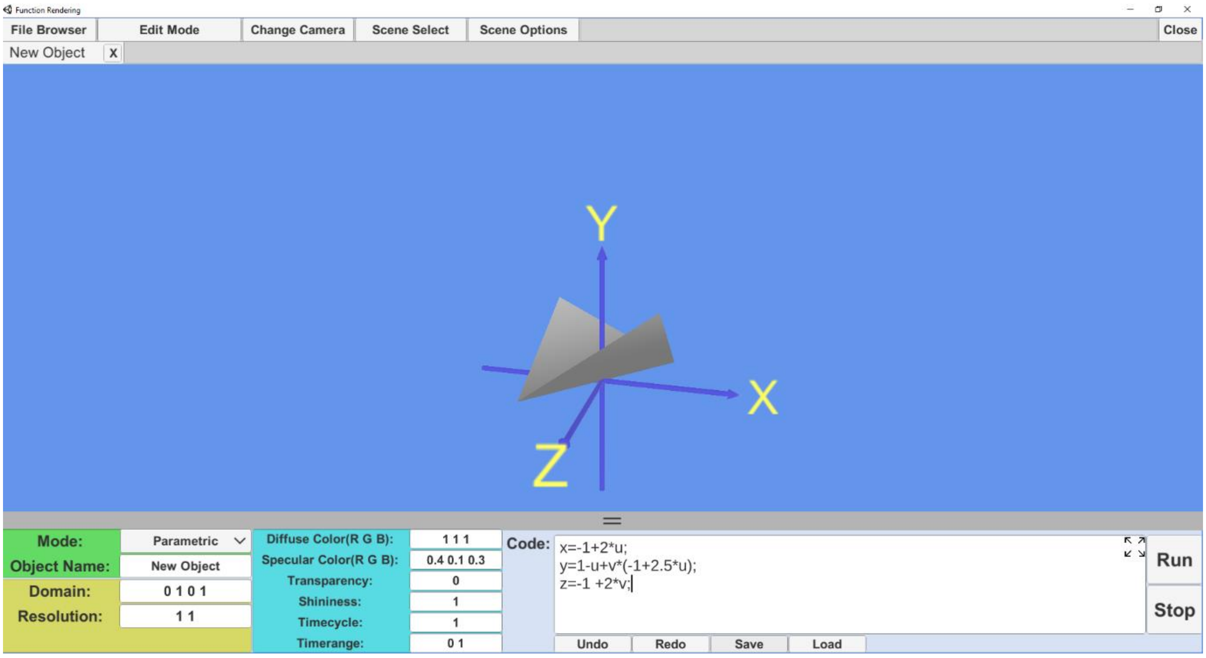
= v

Comparing the difference between all the surfaces, the results looks the same. The reason for this is similar to 3D plane because the change of resolution will not affect the output as only one sampling point is needed to form a 3D triangle.

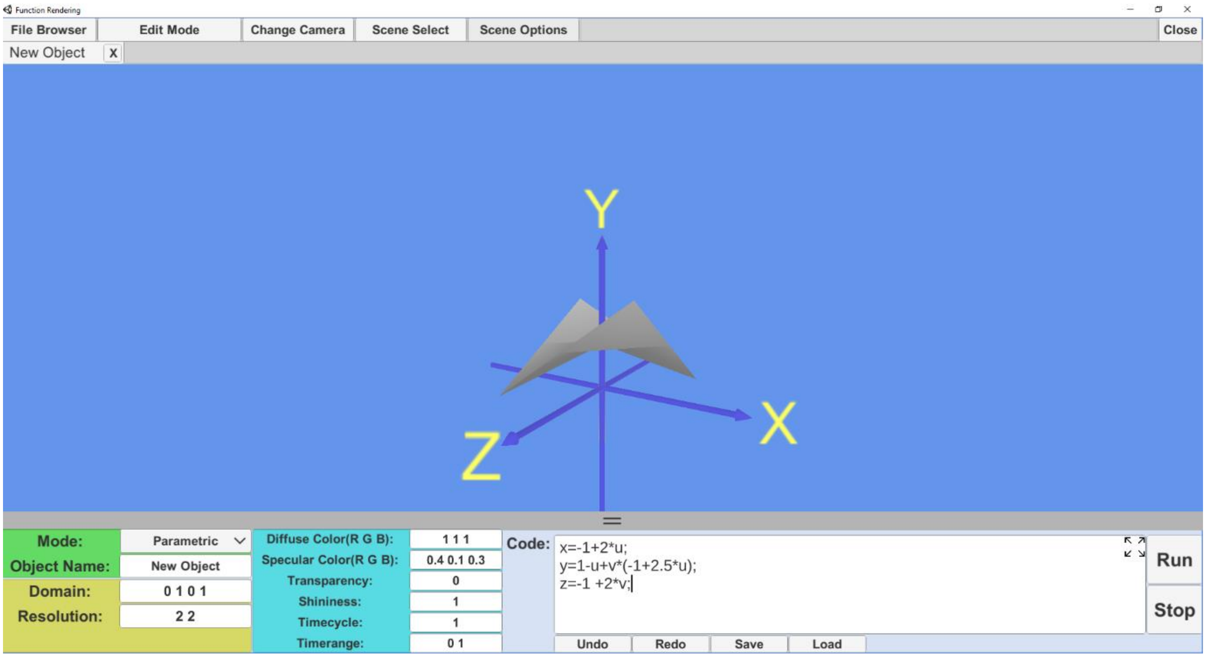
Bilinear Surface



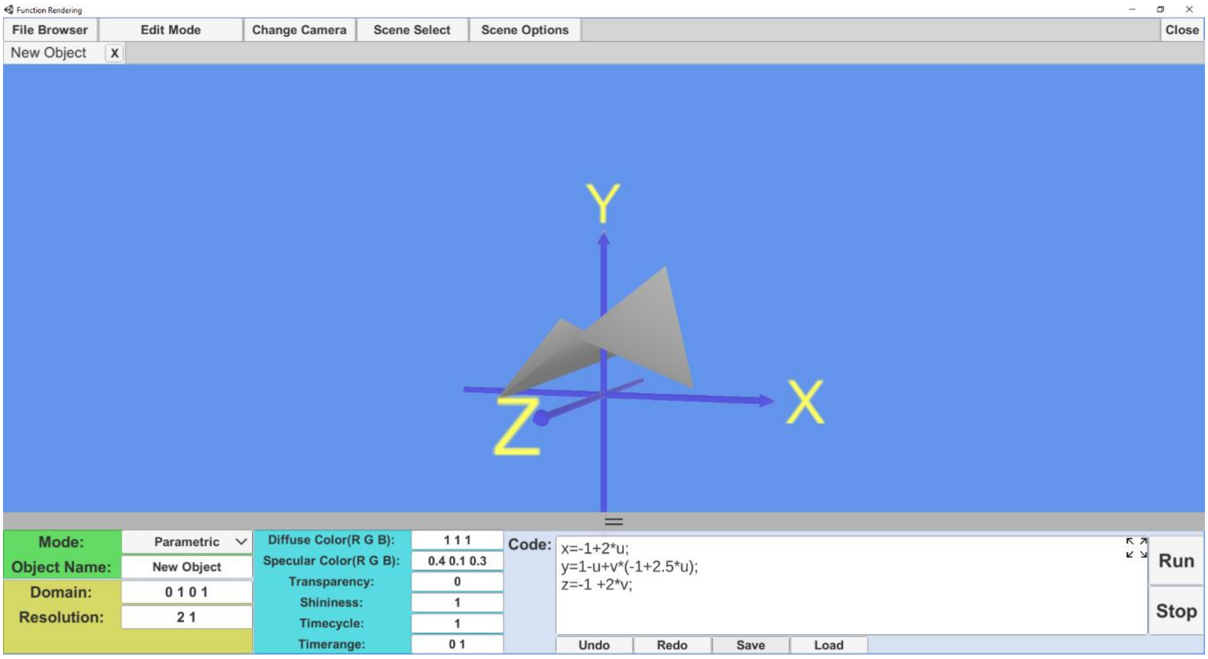
Surface 1



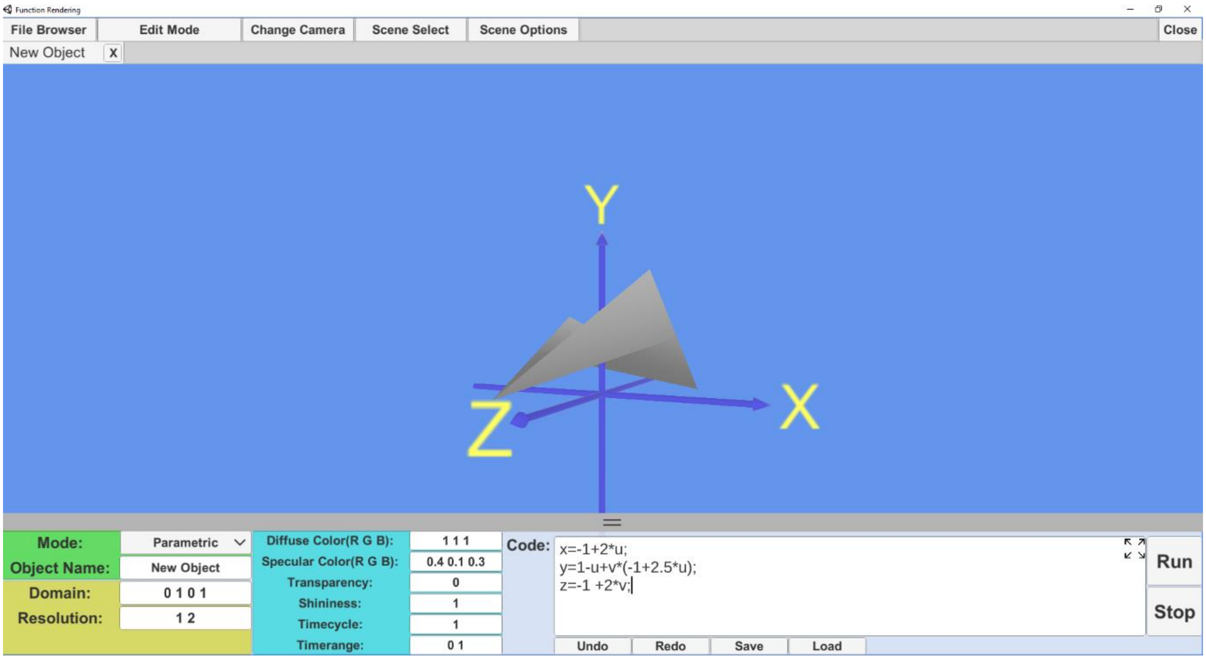
Surface 2



Surface 3



Surface 4



Surface 5

Curve No.	Notes

Surface 1	In BilinearSurface1.Func,
	x = -1+2*u;
	y = 1-u+v*(-1+2.5*u);
	z = -1 +2*v;
	
	The parameter domain is [0 1 0 1].
	The sampling resolution is 75 75.

Surface 2	In BilinearSurface2.Func,
	x = -1+2*u;
	y = 1-u+v*(-1+2.5*u);
	z = -1 +2*v;
	
	The parameter domain is [0 1 0 1].
	The sampling resolution is 1 1.

Surface 3	In BilinearSurface3.Func,
	x = -1+2*u;
	y = 1-u+v*(-1+2.5*u);
	z = -1 +2*v;
	
	The parameter domain is [0 1 0 1].
	The sampling resolution is 2 2.

Surface 4	In BilinearSurface4.Func,
	x = -1+2*u;
	y = 1-u+v*(-1+2.5*u);
	z = -1 +2*v;

	The parameter domain is [0 1 0 1]. The sampling resolution is 2 1.

Surface 5	In BilinearSurface5.Func,
	x = -1+2*u;
	y = 1-u+v*(-1+2.5*u);
	z = -1 +2*v;
	
	The parameter domain is [0 1 0 1].
	The sampling resolution is 1 2.

The equation for x, y, and z axis can be obtained by using the Bilinear surface parametric representation equation, P = P1 + u*(P2 - P1) + v*(P3 - P1 + u*(P4 - P3 - (P2 - P1))), where P1(1, 1, -1), P2(1, 0, -1), P3(-1, 0, 1), P4(1, 1.5,1).

Thus,

x-axis:

P = -1 + u*(1 - (-1)) + v*(-1 - (-1) + u*(1 - (-1) - (1 - (-1))))

= -1 + 2*u + v*(0 + u*(2 - 2))

= -1 + 2*u

y-axis:

P = 1 + u*(0 - 1) + v*(0 - 1 + u*(1.5 - 0 - (0 - 1)))

= 1 - u + v*(-1 + u*(1.5 - (-1)))

= 1 - u + v*(-1 + 2.5*u)

z-axis:

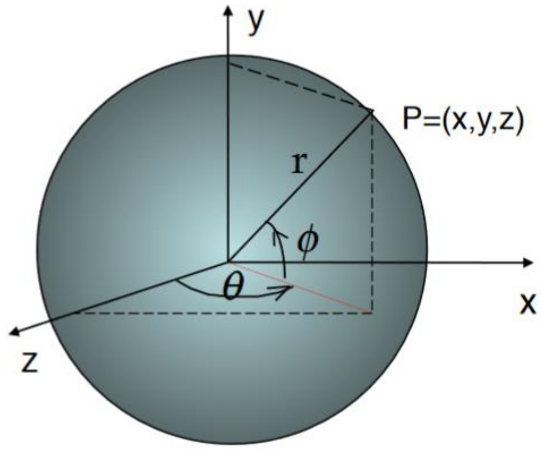
P = -1 + u*(-1 - (-1)) + v*(1 - (-1) + u*(1 - 1 - (-1 - (-1))))

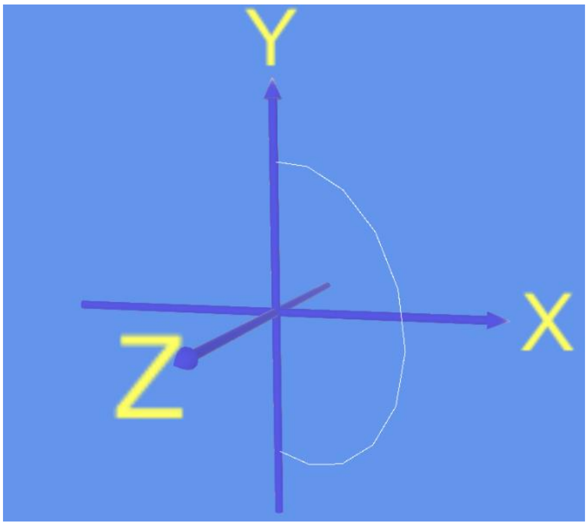
= -1 + 0 + v*(2 + u*0)

= -1 + 2*v

While changing the sampling resolution, the surface of the bilinear surface that is bended, do not have a smooth curved surface when the sampling resolution is low as shown from surface 2 to surface 5. In surface 2, the bended surface is sharp while the bended surface became smoother in surface 3. Therefore, as the sampling resolution increases, the bilinear surface becomes smoother.

Sphere





The equation of the sphere is created by the use of Cartesian coordinates, and rotational sweep around the y-axis. The figure above shows the circle formed before rotational sweeping is applied. 2*pi is used to created circle around the point of origin.

x = 1*cos(-pi/2+u*pi);

y = 1*sin(-pi/2+u*pi);

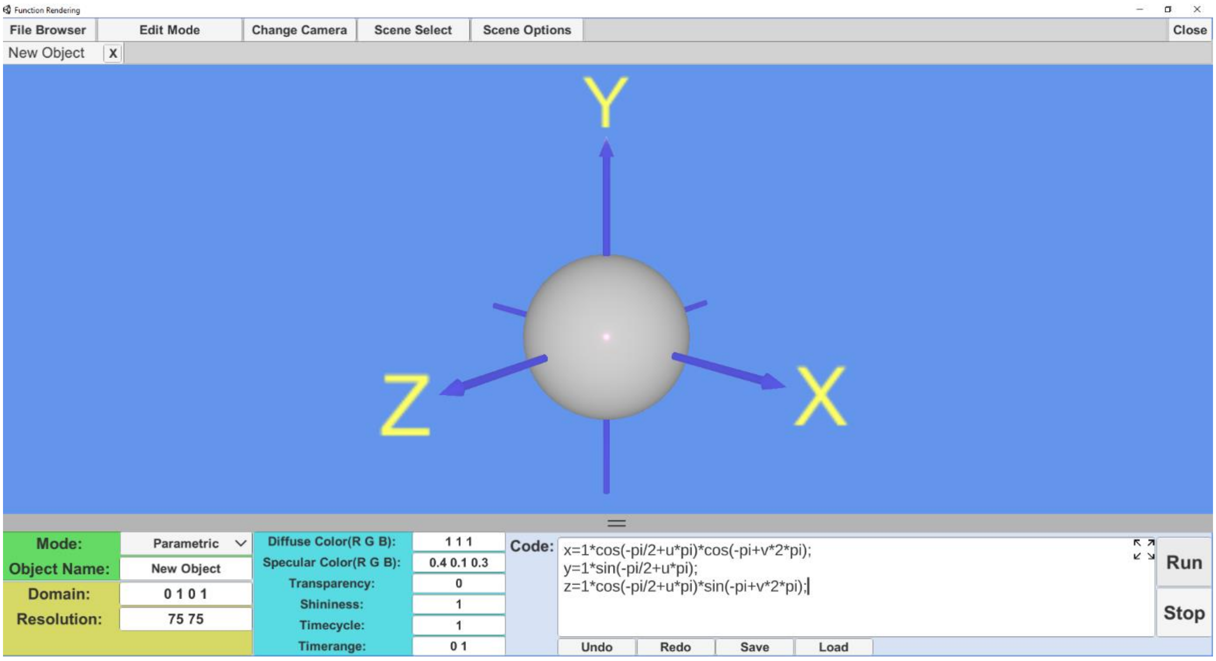
z = 1*cos(-pi/2+u*pi);

Next, rotational sweeping is applied around the y-axis up to 2*pi to form a sphere.

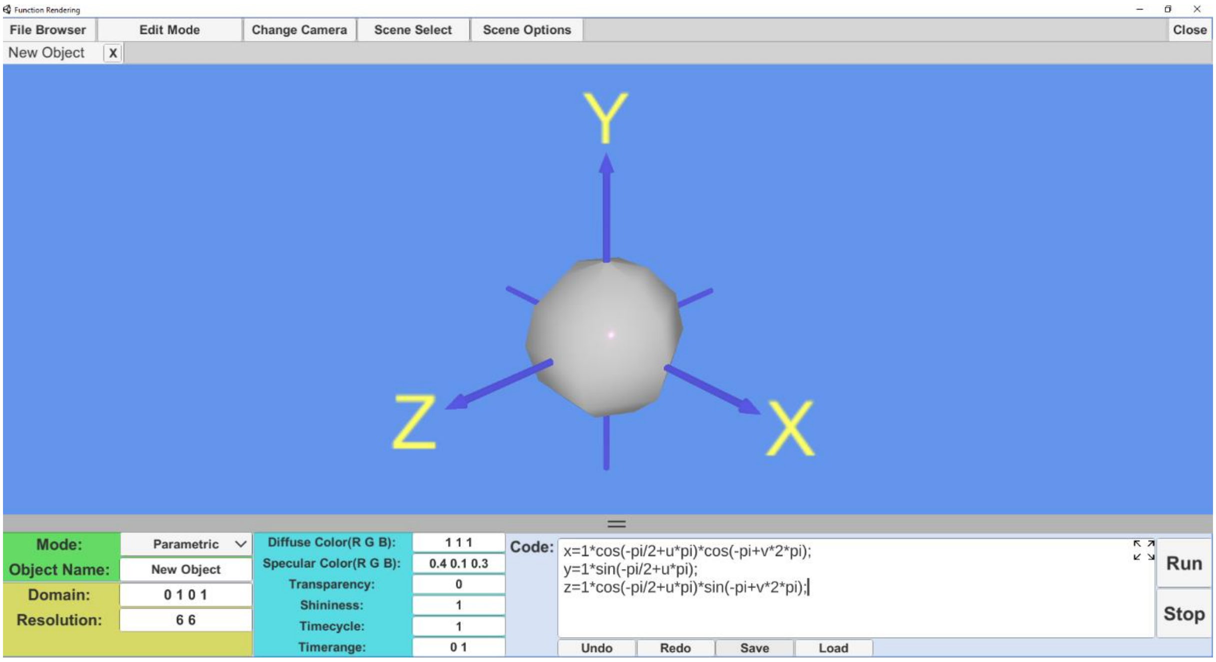
x = 1*cos(-pi/2+u*pi)*cos(-pi+v*2*pi);

y = 1*sin(-pi/2+u*pi);

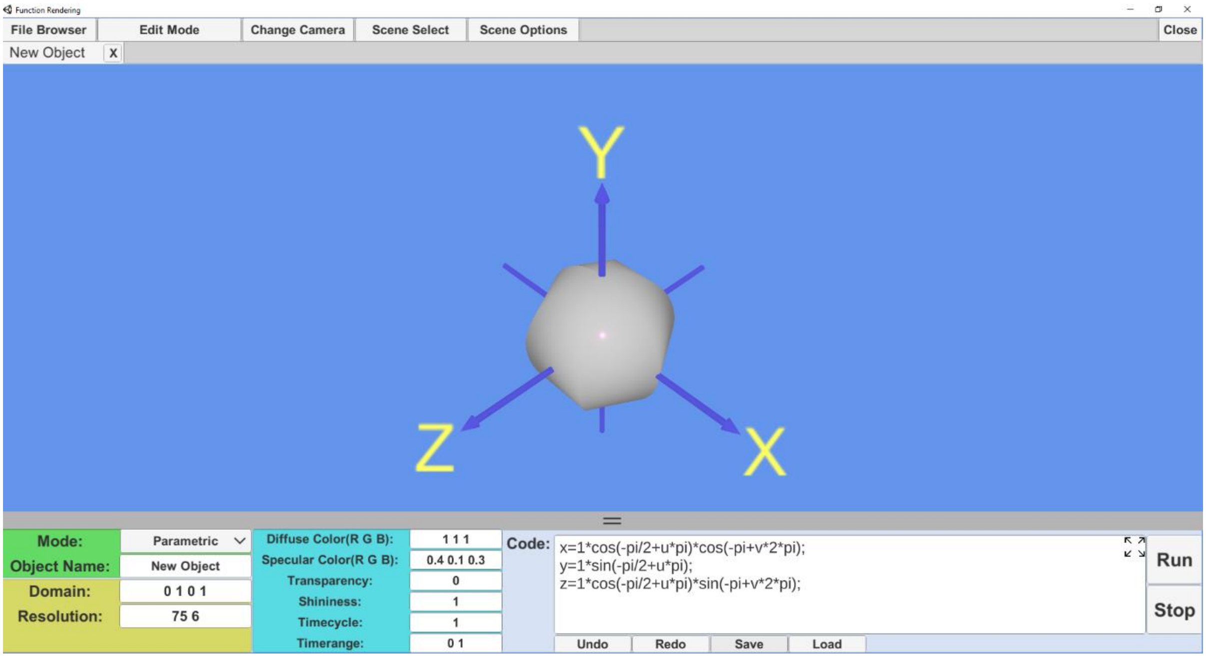
z = 1*cos(-pi/2+u*pi)*sin(-pi+v*2*pi);



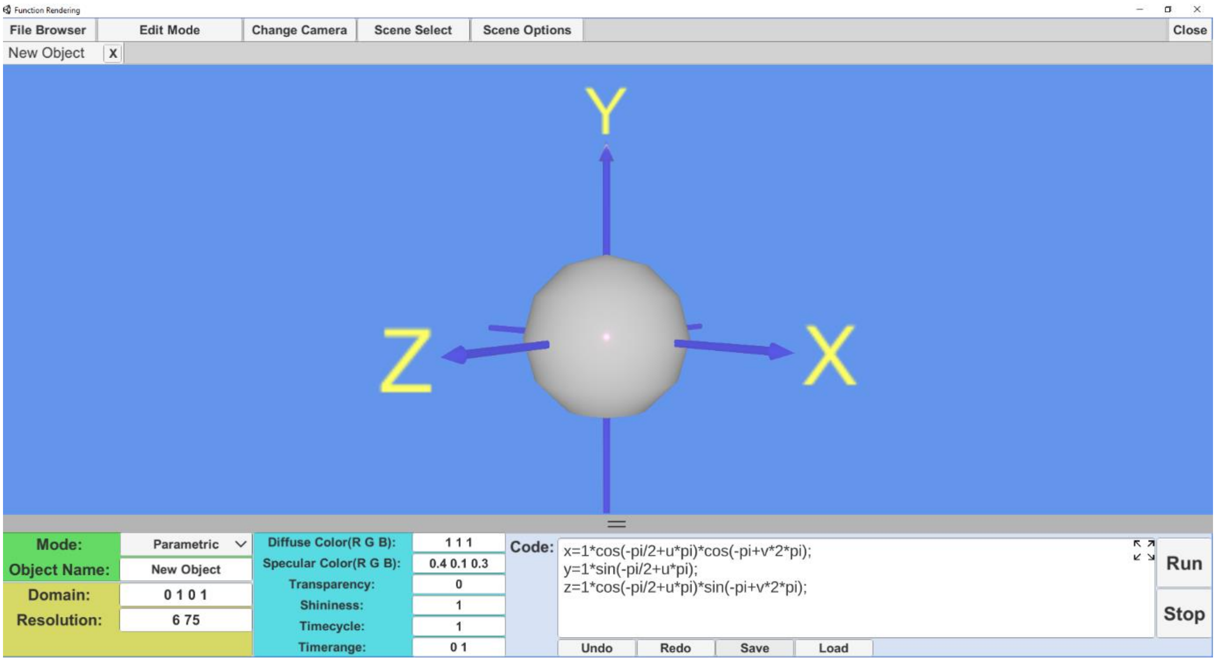
Surface 1



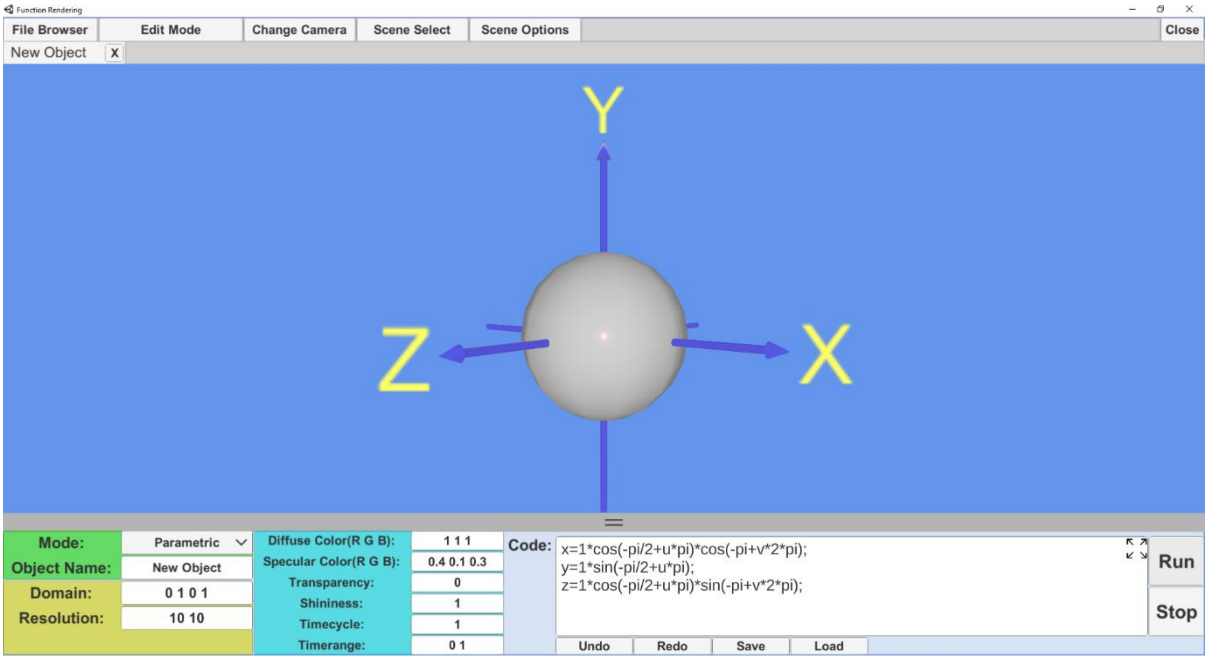
Surface 2



Surface 3



Surface 4



Surface 5

Curve No.	Notes

Surface 1	In Sphere1.Func,
	x = 1*cos(-pi/2+u*pi)*cos(-pi+v*2*pi);
	y = 1*sin(-pi/2+u*pi);
	z = 1*cos(-pi/2+u*pi)*sin(-pi+v*2*pi);
	
	The parameter domain is [0 1 0 1].
	The sampling resolution is 75 75.

Surface 2	In Sphere2.Func,
	x = 1*cos(-pi/2+u*pi)*cos(-pi+v*2*pi);
	y = 1*sin(-pi/2+u*pi);
	z = 1*cos(-pi/2+u*pi)*sin(-pi+v*2*pi);
	
	The parameter domain is [0 1 0 1].
	The sampling resolution is 6 6.

Surface 3	In Sphere3.Func,
	x = 1*cos(-pi/2+u*pi)*cos(-pi+v*2*pi);
	y = 1*sin(-pi/2+u*pi);
	z = 1*cos(-pi/2+u*pi)*sin(-pi+v*2*pi);
	
	The parameter domain is [0 1 0 1].
	The sampling resolution is 75 6.

Surface 4	In Sphere4.Func,
	x = 1*cos(-pi/2+u*pi)*cos(-pi+v*2*pi);
	y = 1*sin(-pi/2+u*pi);
	z = 1*cos(-pi/2+u*pi)*sin(-pi+v*2*pi);

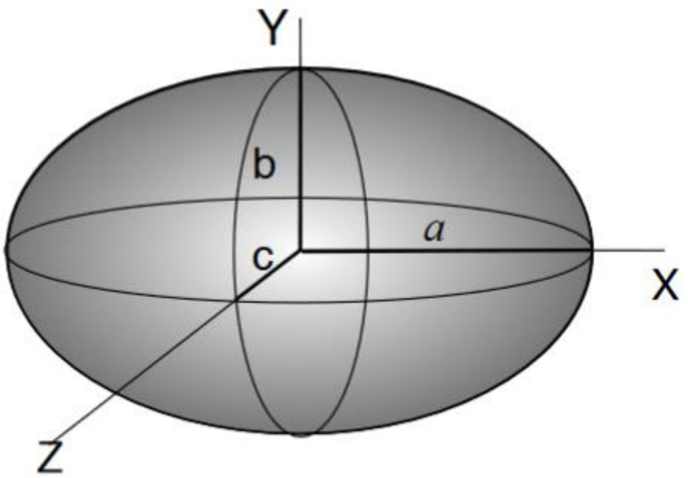
	The parameter domain is [0 1 0 1]. The sampling resolution is 6 75.

Surface 5	In Sphere5.Func,
	x = 1*cos(-pi/2+u*pi)*cos(-pi+v*2*pi);
	y = 1*sin(-pi/2+u*pi);
	z = 1*cos(-pi/2+u*pi)*sin(-pi+v*2*pi);
	
	The parameter domain is [0 1 0 1].
	The sampling resolution is 10 10.

Based on surface 1, surface 2, and surface 5, it is observed that the higher the sampling resolution, the smoother is the sphere. When the sampling resolution is 10 10, it is smoother than sampling resolution of 6 6. When the sampling resolution is 75 75 in surface 1, the sphere is completely smooth.

Between surface 3 and 4, sampling resolution of 75 6 and 6 75 respectively produces different result. Surface 3 produces a sphere smoother than surface 4 around the x-axis or z-axis. This is because surface 3 have higher sampling resolution for forming the arc of circle. An arc of circle is formed by joining multiple lines together around the point of origin. Therefore, if the sampling resolution has a value of 7 when forming the circle in surface 4, a less smooth circle is resulted as compared to surface 3 who has a sampling resolution of 75 when forming the circle. However, surface 4 has a smoother surface when rotated around y-axis because it has sampling resolution of 75 as compared to surface 3 having a resolution of 6.

Ellipsoid



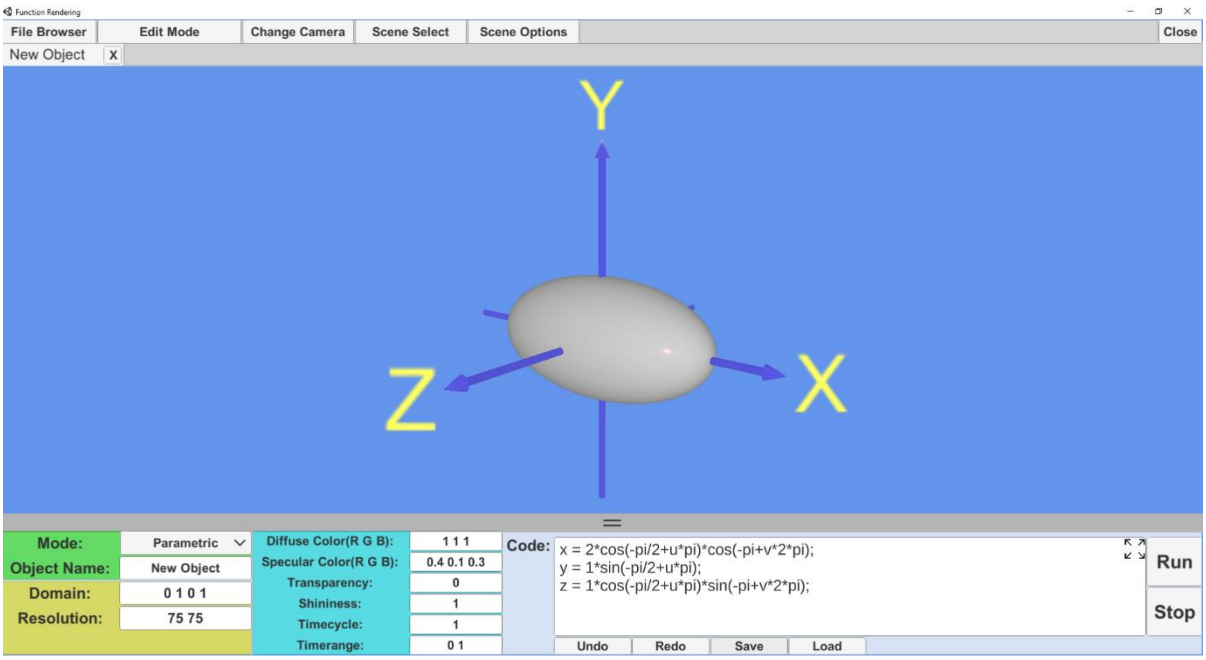
Similar to sphere, the equation of the ellipsoid is created by the use of Cartesian coordinates, and rotational sweep around the y-axis. The difference between sphere and ellipsoid is the radius. Sphere have the same radius for all axis while ellipsoid have different radius for each axis.

x = a*cos(-pi/2+u*pi)*cos(-pi+v*2*pi);

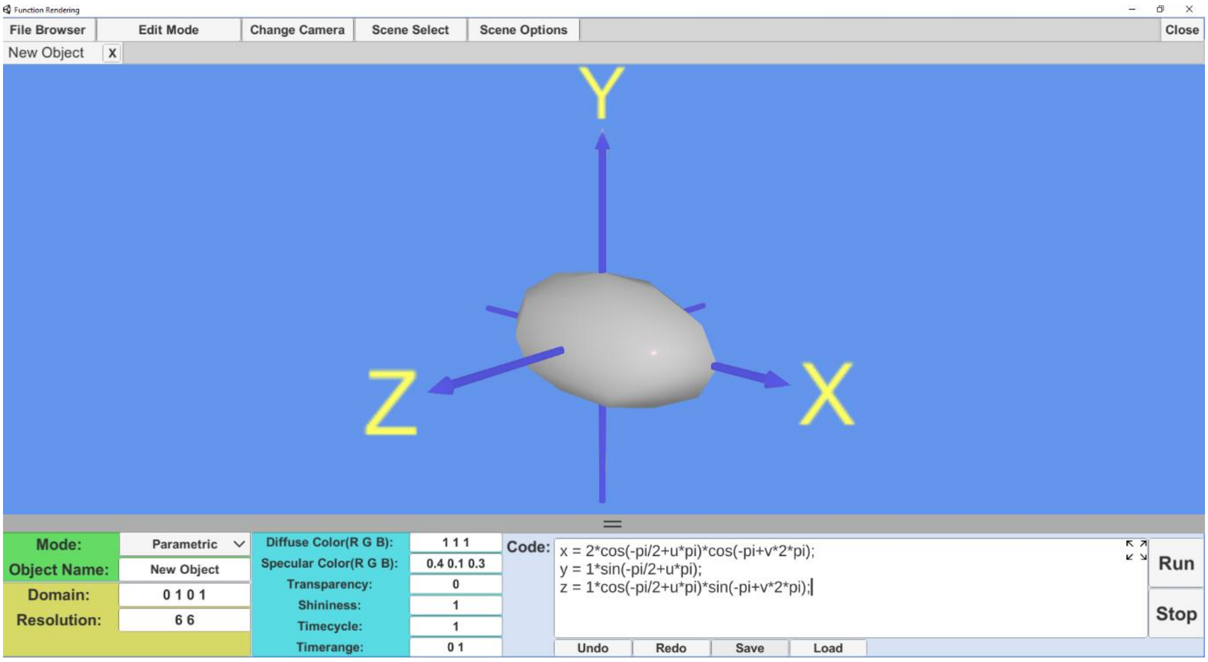
y = b*sin(-pi/2+u*pi);

z = c*cos(-pi/2+u*pi)*sin(-pi+v*2*pi);

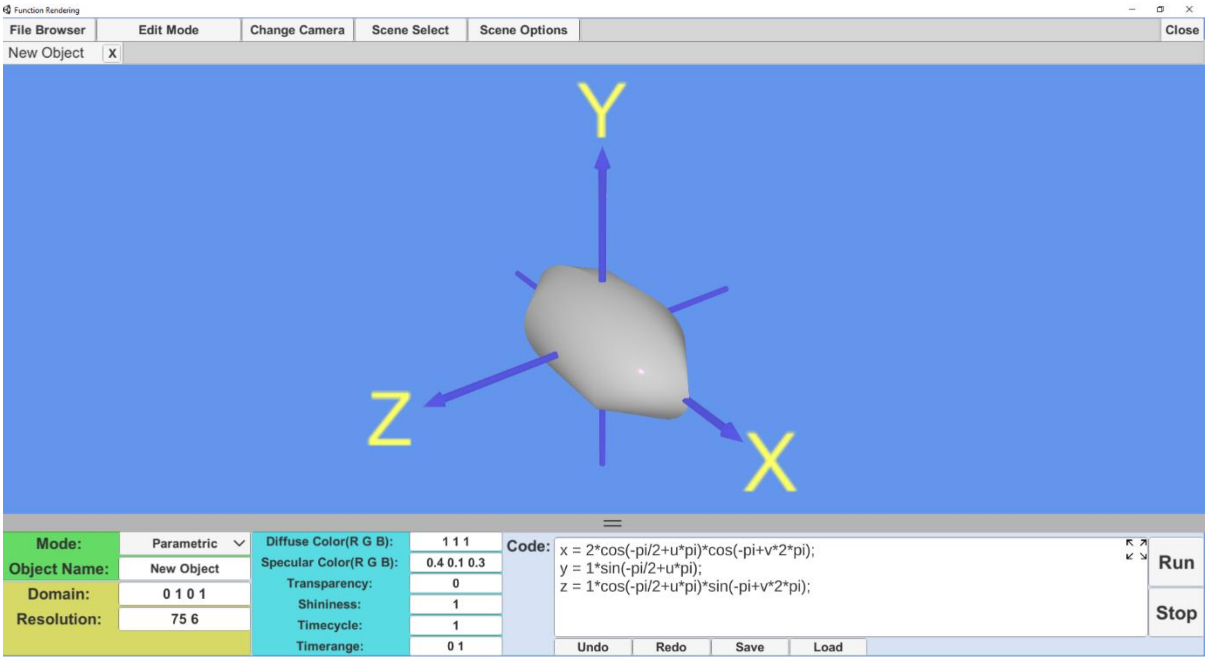
where a = 2, b = c = 1.



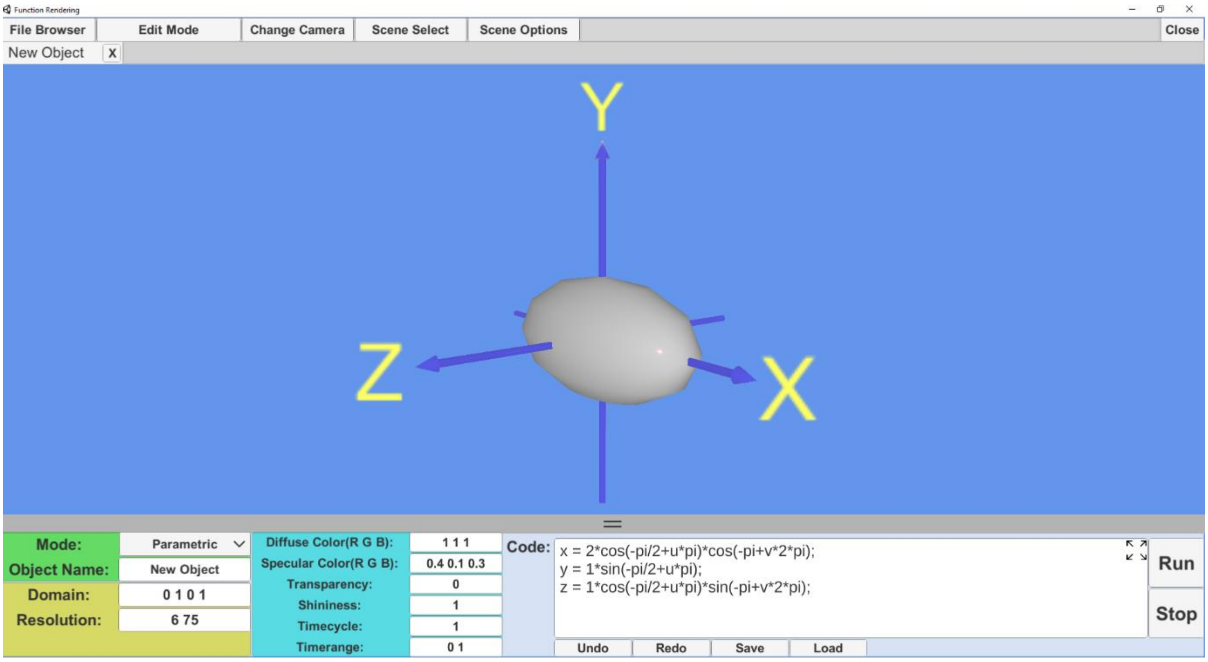
Surface 1



Surface 2



Surface 3



Surface 4

Curve No.	Notes

Surface 1	In Ellipsoid1.Func,
	x = 2*cos(-pi/2+u*pi)*cos(-pi+v*2*pi);
	y = 1*sin(-pi/2+u*pi);
	z = 1*cos(-pi/2+u*pi)*sin(-pi+v*2*pi);
	
	The parameter domain is [0 1 0 1].
	The sampling resolution is 75 75.

Surface 2	In Ellipsoid2.Func,
	x = 2*cos(-pi/2+u*pi)*cos(-pi+v*2*pi);
	y = 1*sin(-pi/2+u*pi);
	z = 1*cos(-pi/2+u*pi)*sin(-pi+v*2*pi);
	
	The parameter domain is [0 1 0 1].
	The sampling resolution is 6 6.

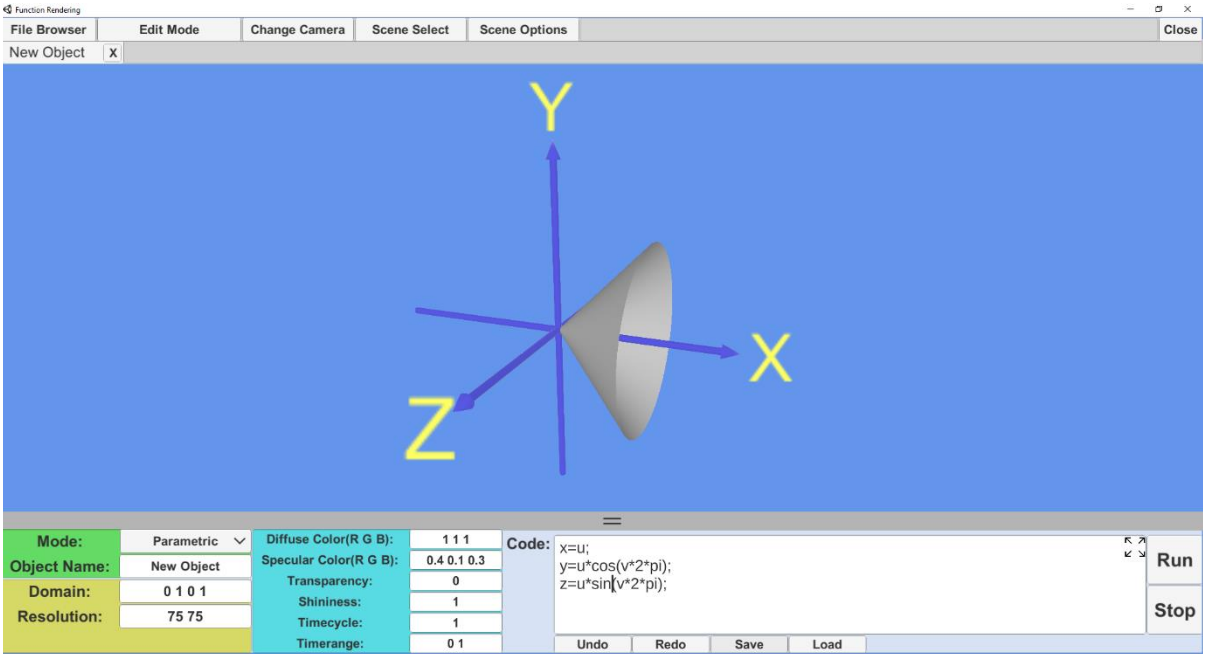
Surface 3	In Ellipsoid3.Func,
	x = 2*cos(-pi/2+u*pi)*cos(-pi+v*2*pi);
	y = 1*sin(-pi/2+u*pi);
	z = 1*cos(-pi/2+u*pi)*sin(-pi+v*2*pi);
	
	The parameter domain is [0 1 0 1].
	The sampling resolution is 75 6.

Surface 4	In Ellipsoid4.Func,
	x = 2*cos(-pi/2+u*pi)*cos(-pi+v*2*pi);
	y = 1*sin(-pi/2+u*pi);
	z = 1*cos(-pi/2+u*pi)*sin(-pi+v*2*pi);

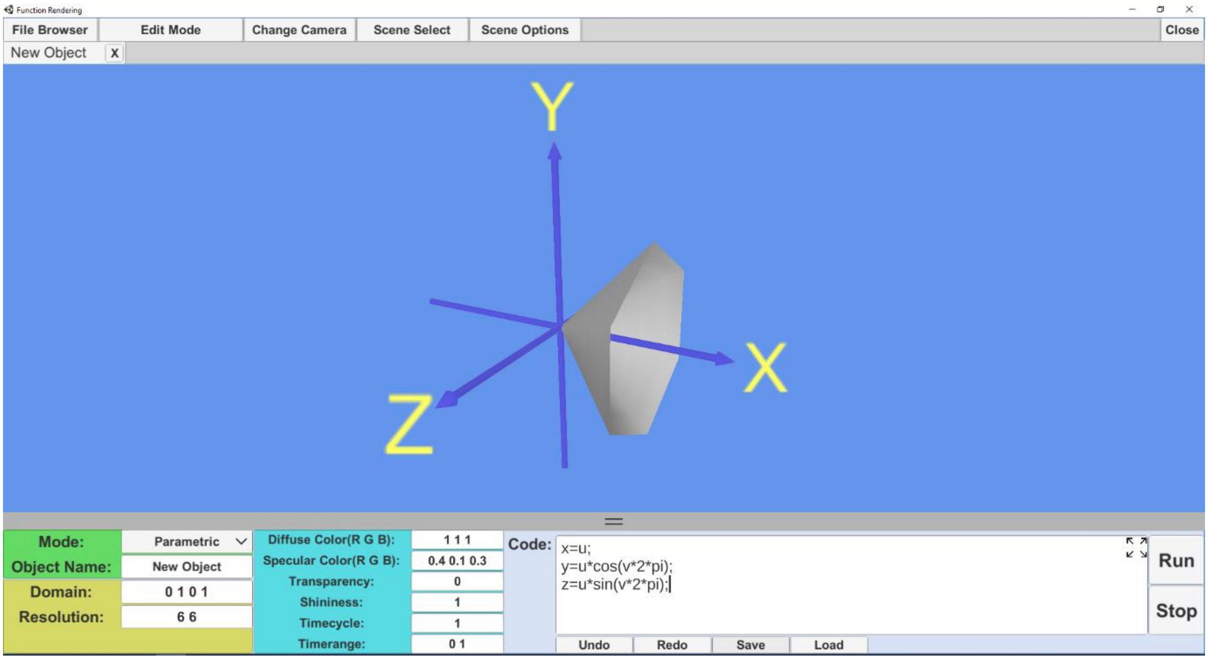
	The parameter domain is [0 1 0 1]. The sampling resolution is 6 75.

Similar to the sphere, the higher the sampling resolution, the smoother is the ellipsoid as shown between surface 1 and surface 2. Between surface 3 and 4, sampling resolution of 75 6 and 6 75 respectively produces different result. Surface 3 produces a sphere smoother than surface 4 around the x-axis or z-axis. This is because surface 3 have higher sampling resolution for forming the arc of ellipse. However, surface 4 has a smoother surface when rotated around y-axis because it has sampling resolution of 75 as compared to surface 3 having a resolution of 6.

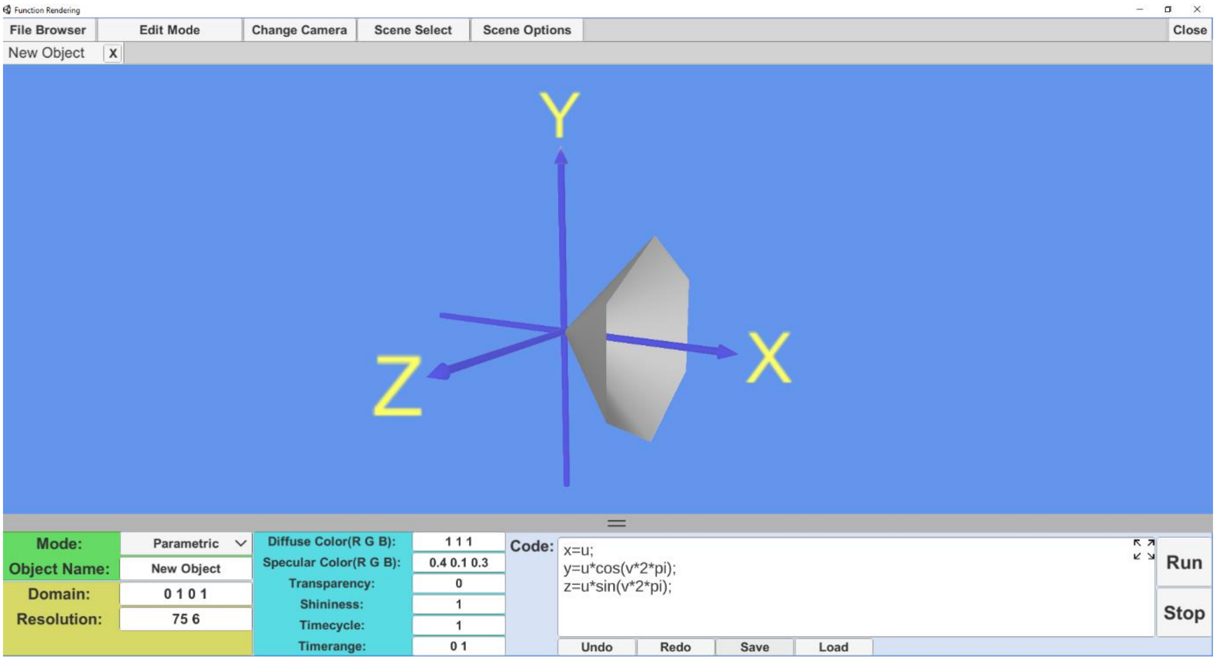
Cone



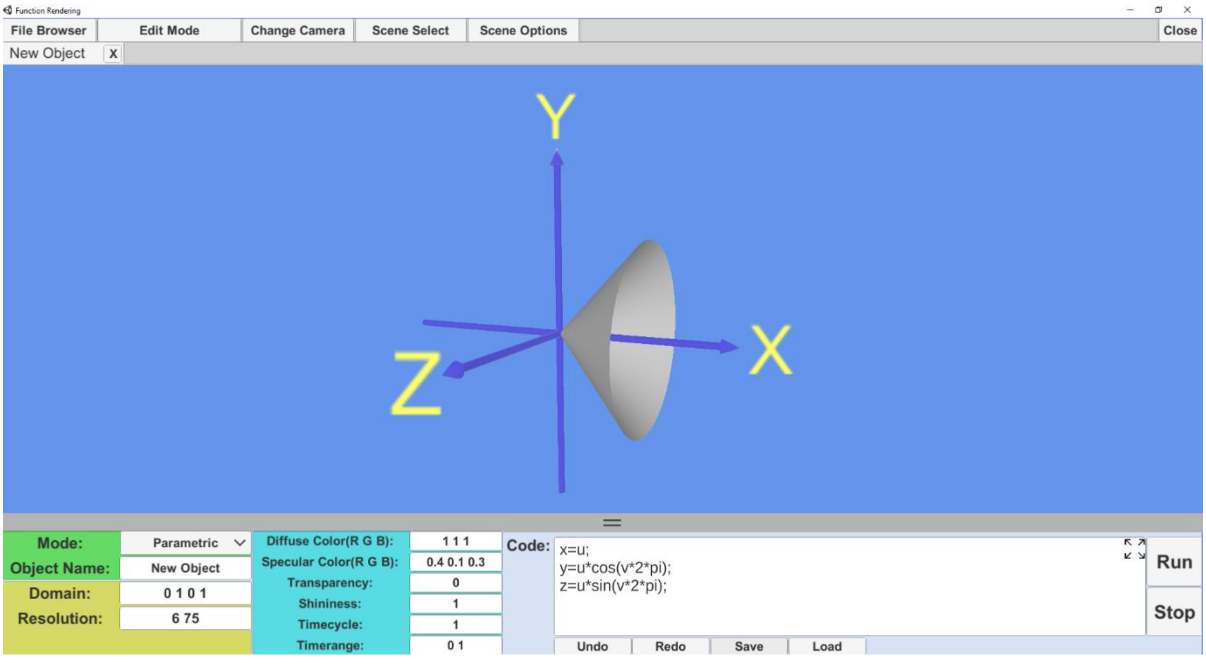
Surface 1



Surface 2



Surface 3



Surface 4

Curve No.	Notes

Surface 1	In Cone1.Func,
	x=u;
	y=u*cos(v*2*pi);
	z=u*sin(v*2*pi);
	
	The parameter domain is [0 1 0 1].
	The sampling resolution is 75 75.

Surface 2	In Cone2.Func,
	x=u;
	y=u*cos(v*2*pi);
	z=u*sin(v*2*pi);
	
	The parameter domain is [0 1 0 1].
	The sampling resolution is 6 6.

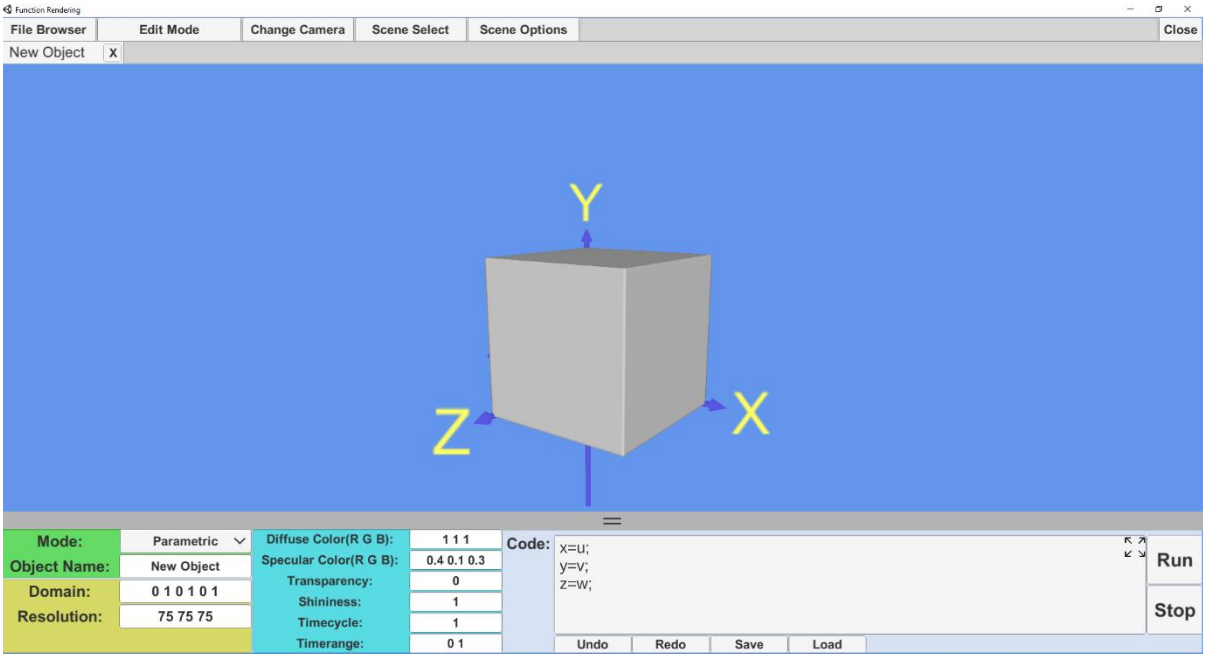
Surface 3	In Cone3.Func,
	x=u;
	y=u*cos(v*2*pi);
	z=u*sin(v*2*pi);
	
	The parameter domain is [0 1 0 1].
	The sampling resolution is 75 6.

Surface 4	In Cone4.Func,
	x=u;
	y=u*cos(v*2*pi);
	z=u*sin(v*2*pi);
	
	The parameter domain is [0 1 0 1].
	The sampling resolution is 6 75.

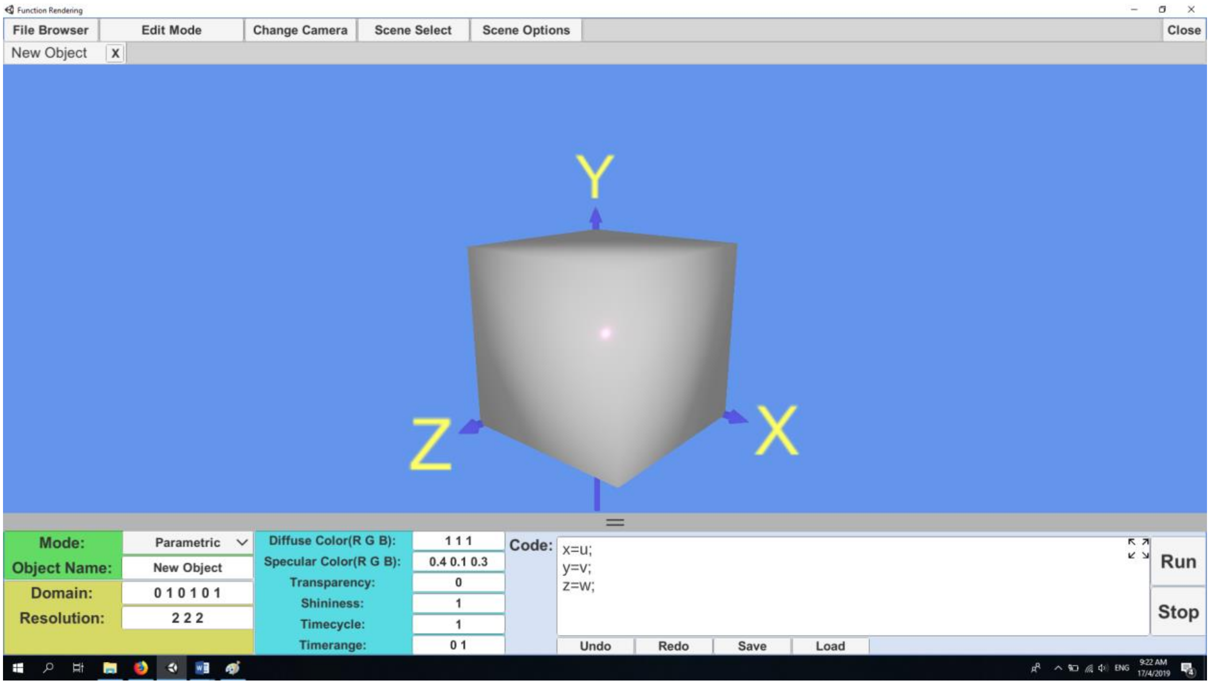
On surface that requires rotational sweeping, sampling resolution value affects the smoother of the surface produce which is shown between surface 1 and surface 2 where the sampling resolution is 75 75 and 6 6 respectively. For surface 3, the sampling resolution is 75 6. However, the result produced is similar to surface 2 despite high sampling resolution for u parameter. This is cause similar to 3D plane and 3D triangle, as low as 1 sampling resolution is needed for translational sweeping. For surface 4, the cone is smoother because v parameter that affects the rotational sweeping has higher sampling resolution of 75, thus resulting in similar to results as surface one despite lower sampling resolution for u parameter that is used for translational sweeping.

2. Solids

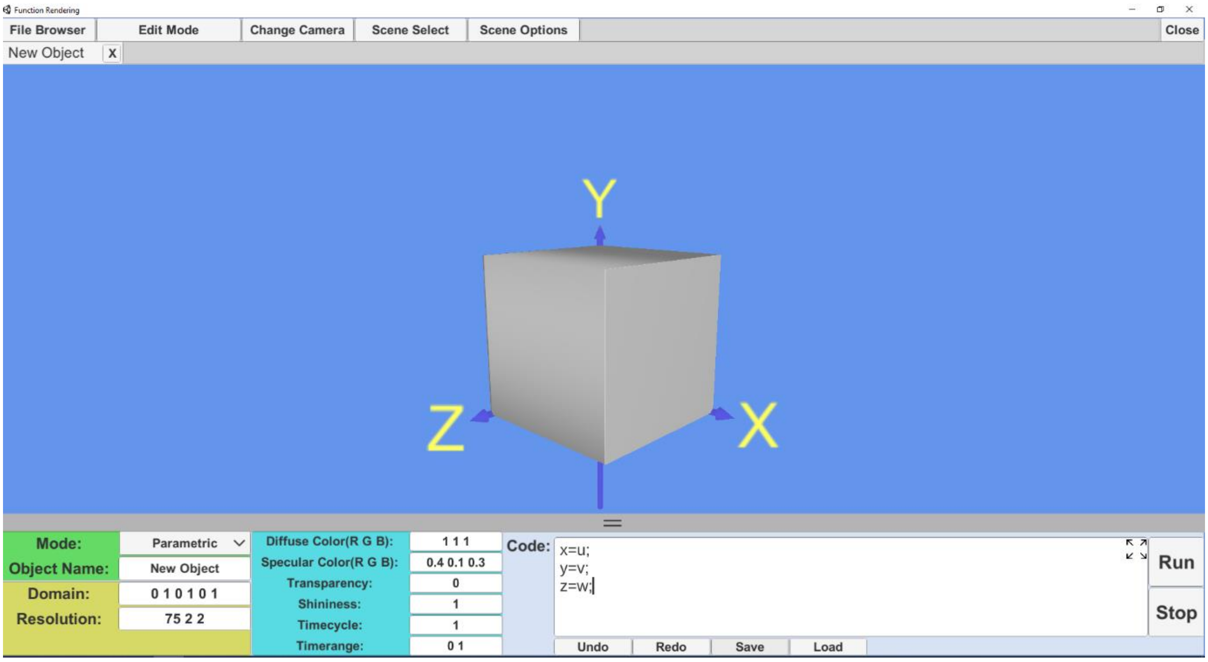
Solid Box



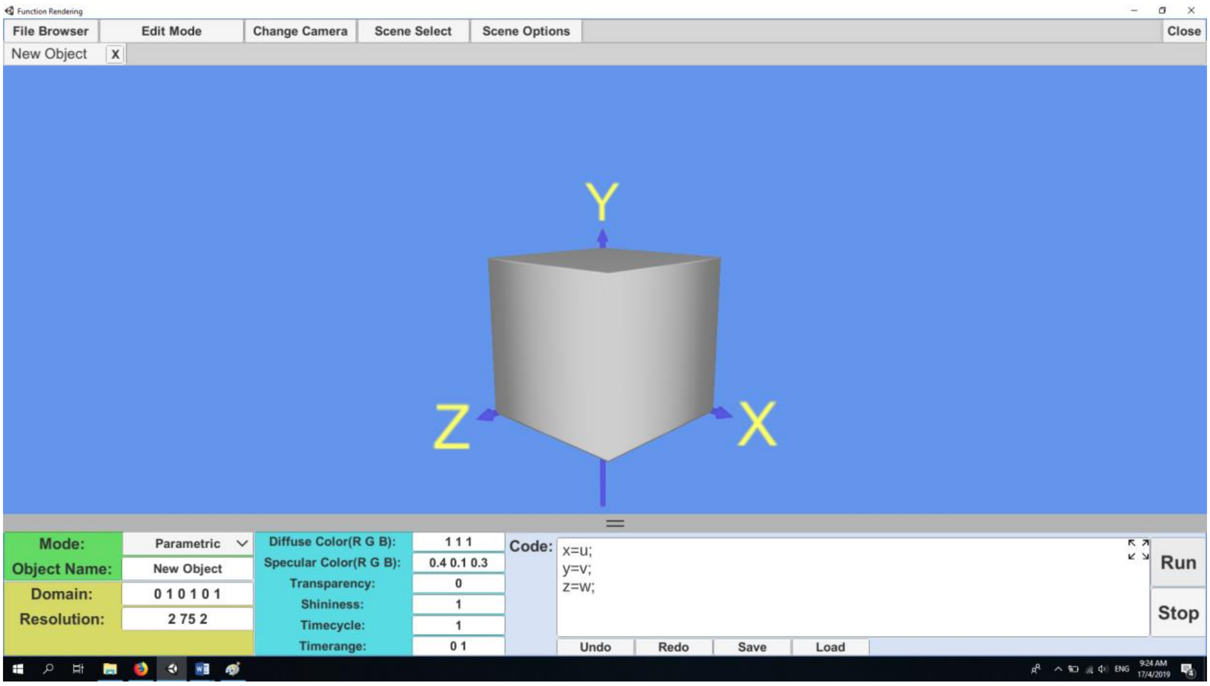
Solid 1



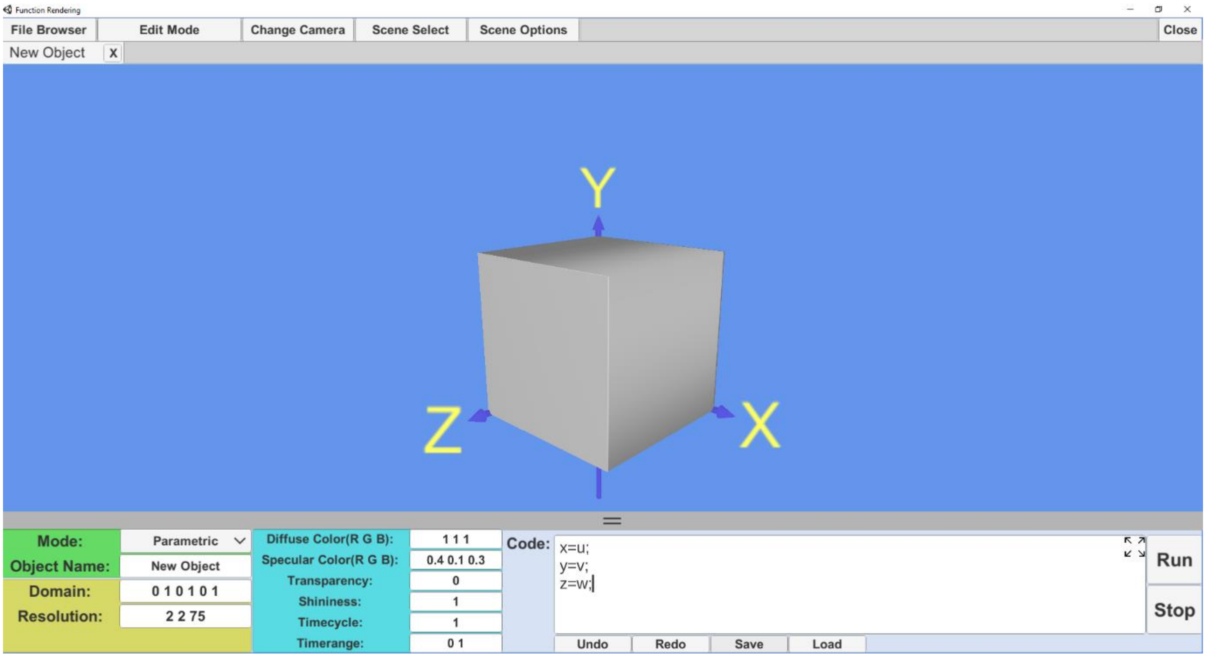
Solid 2



Solid 3



Solid 4



Solid 5

Curve No.	Notes

Solid 1	In SolidBox1.Func,
	x=u;
	y=v;
	z=w;
	
	The parameter domain is [0 1 0 1 0 1].
	The sampling resolution is 75 75 75.

Solid 2	In SolidBox2.Func,
	x=u;
	y=v;
	z=w;
	
	The parameter domain is [0 1 0 1 0 1].
	The sampling resolution is 2 2 2.

Solid 3	In SolidBox3.Func,
	x=u;
	y=v;
	z=w;
	
	The parameter domain is [0 1 0 1 0 1].
	The sampling resolution is 75 2 2.

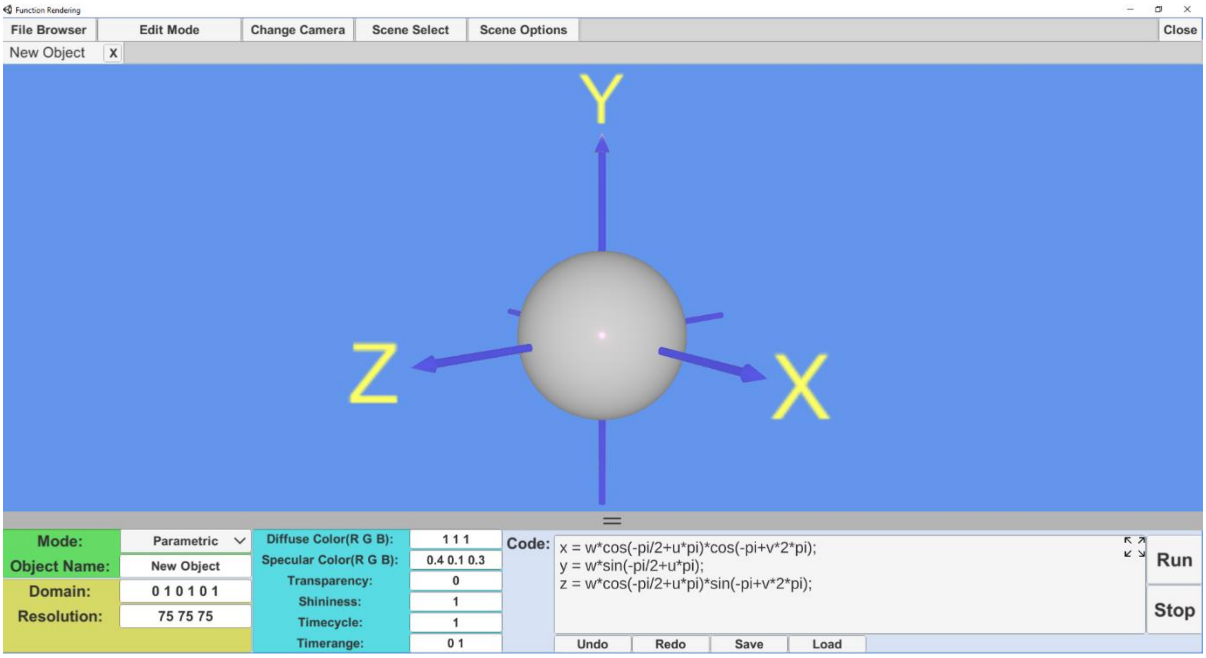
Solid 4	In SolidBox4.Func,
	x=u;
	y=v;
	z=w;

	The parameter domain is [0 1 0 1 0 1]. The sampling resolution is 2 75 2.

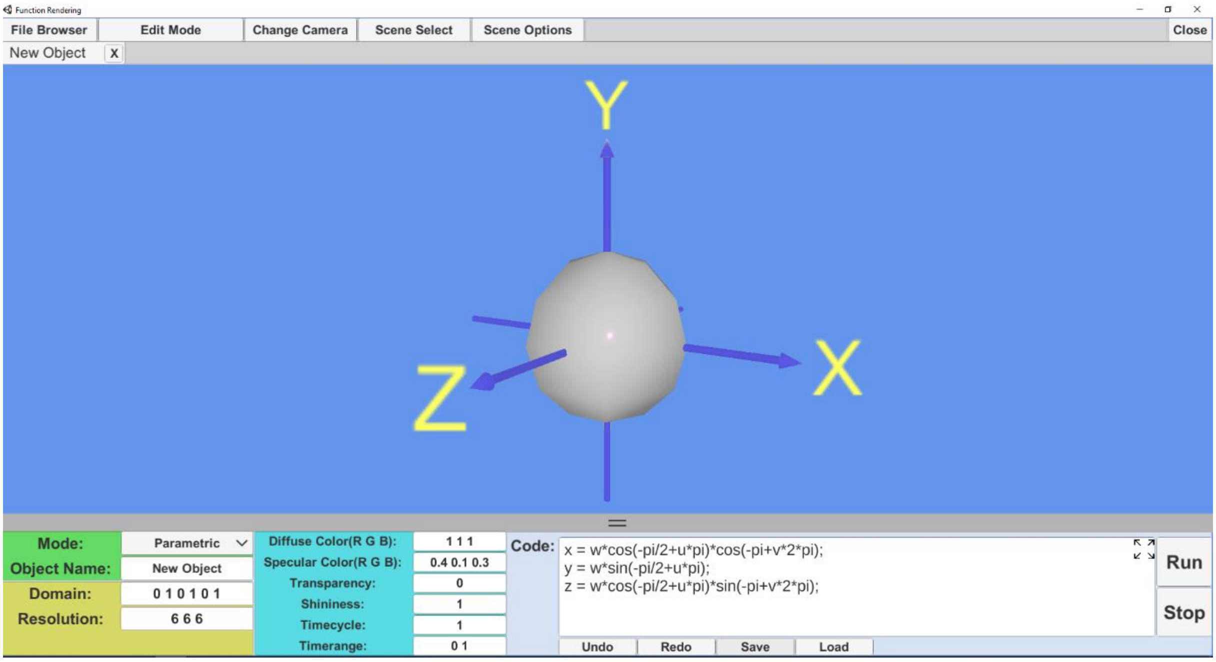
Solid 5	In SolidBox5.Func,
	x=u;
	y=v;
	z=w;
	
	The parameter domain is [0 1 0 1 0 1].
	The sampling resolution is 2 2 75.

Regardless the sampling resolution, there is no change in the solid box produced with reference to solid 1 to solid 5. This is because only 1 sampling resolution is needed for translation sweeping or straight lines. Since there is no curves or rotational sweeping involved, the solid box looks similar even at low sampling resolution.

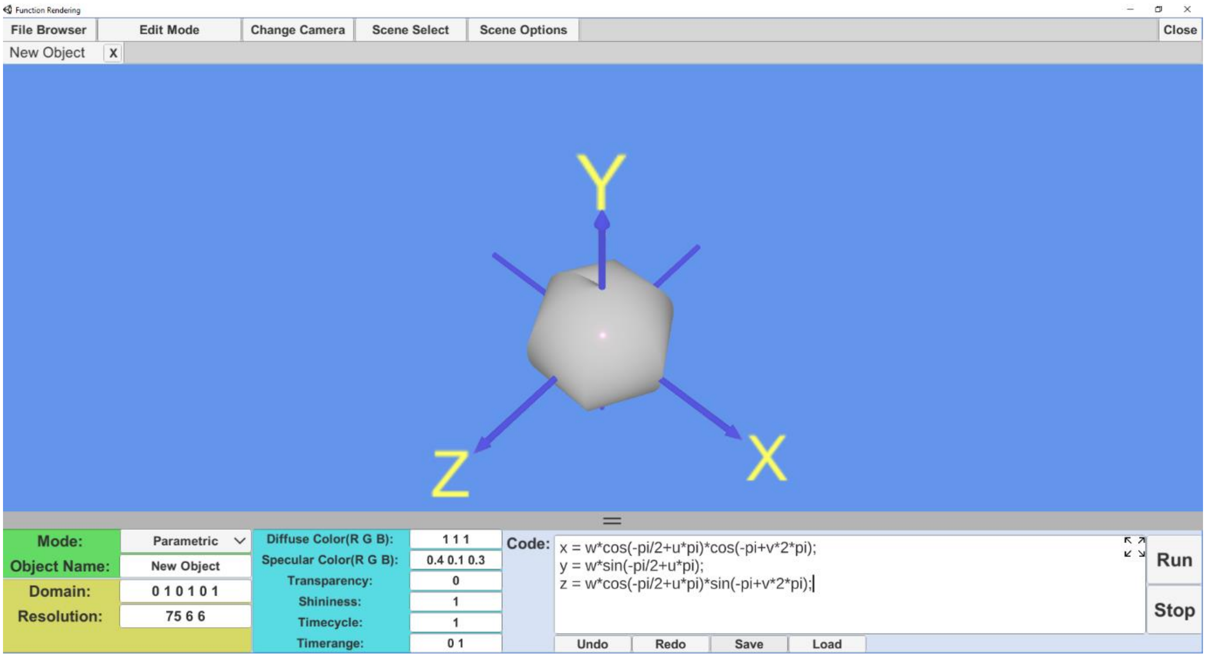
Solid sphere



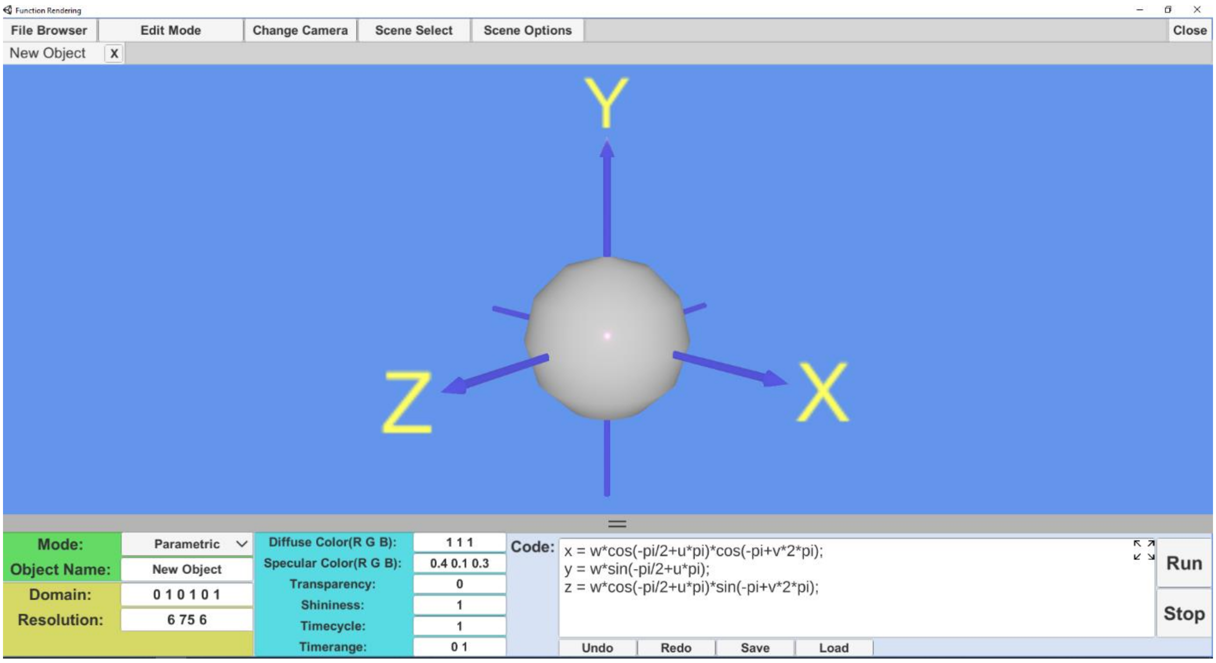
Solid 1



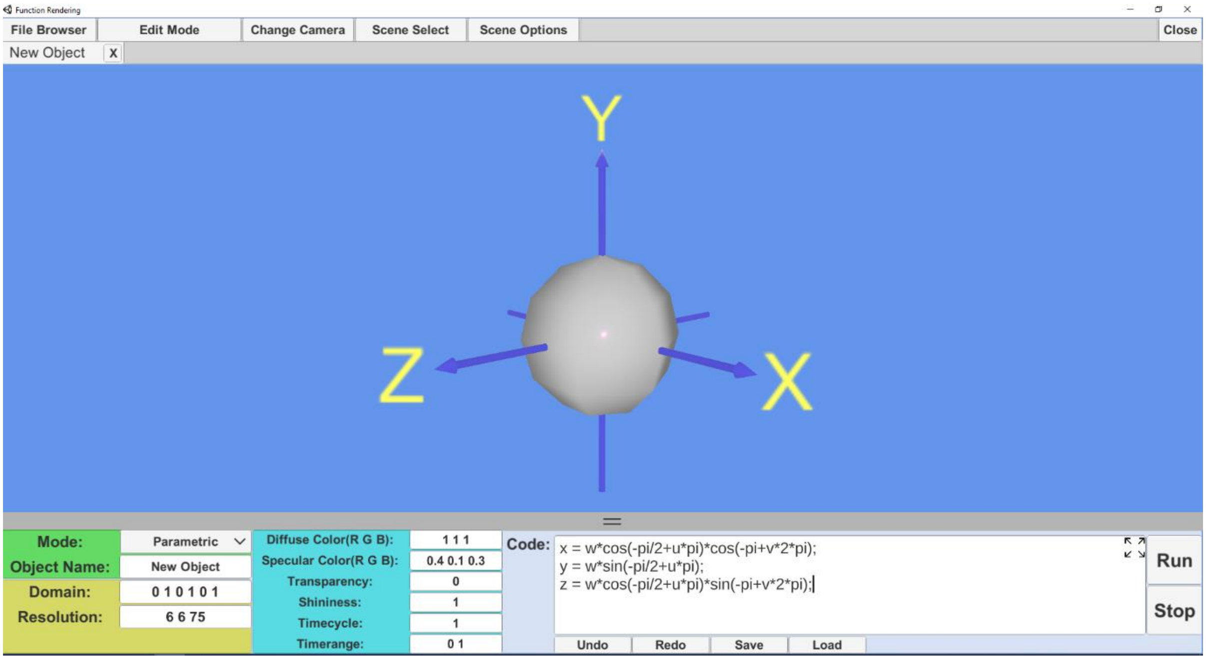
Solid 2



Solid 3



Solid 4



Solid 5

Curve No.	Notes

Solid 1	In SolidSphere1.Func,
	x = w*cos(-pi/2+u*pi)*cos(-pi+v*2*pi);
	y = w*sin(-pi/2+u*pi);
	z = w*cos(-pi/2+u*pi)*sin(-pi+v*2*pi);
	
	The parameter domain is [0 1 0 1 0 1].
	The sampling resolution is 75 75 75.

Solid 2	In SolidSphere2.Func,
	x = w*cos(-pi/2+u*pi)*cos(-pi+v*2*pi);
	y = w*sin(-pi/2+u*pi);
	z = w*cos(-pi/2+u*pi)*sin(-pi+v*2*pi);
	
	The parameter domain is [0 1 0 1 0 1].
	The sampling resolution is 6 6 6.

Solid 3	In SolidSphere3.Func,
	x = w*cos(-pi/2+u*pi)*cos(-pi+v*2*pi);
	y = w*sin(-pi/2+u*pi);
	z = w*cos(-pi/2+u*pi)*sin(-pi+v*2*pi);
	
	The parameter domain is [0 1 0 1 0 1].
	The sampling resolution is 75 6 6.

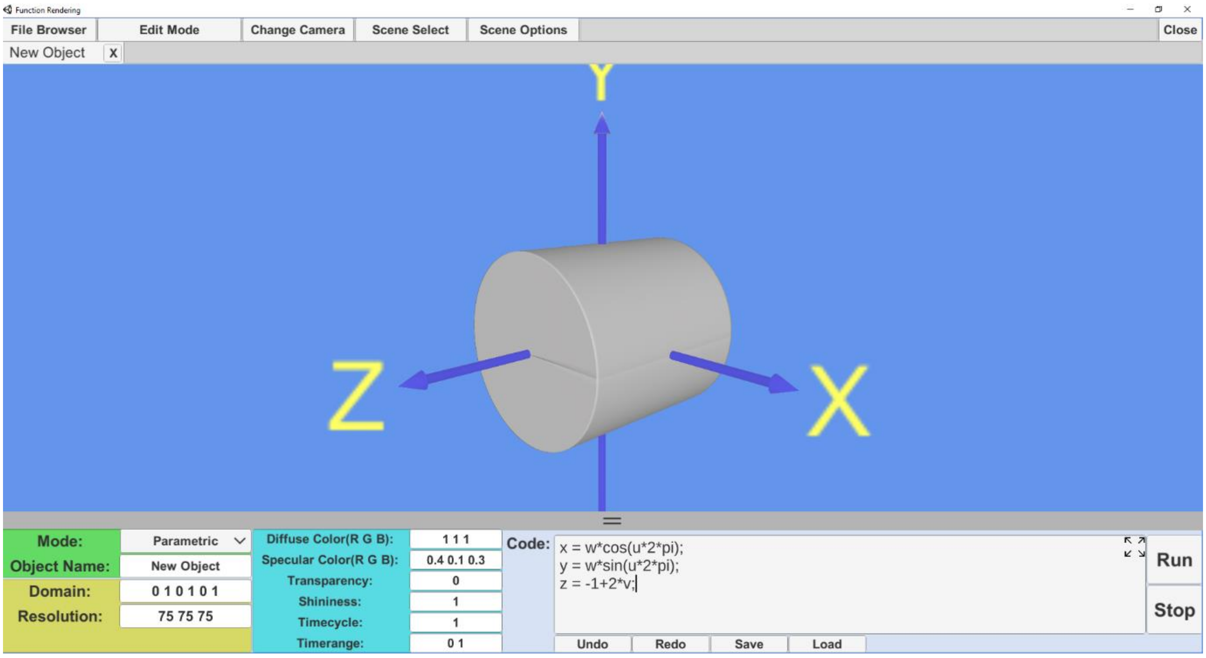
Solid 4	In SolidSphere4.Func,
	x = w*cos(-pi/2+u*pi)*cos(-pi+v*2*pi);
	y = w*sin(-pi/2+u*pi);
	z = w*cos(-pi/2+u*pi)*sin(-pi+v*2*pi);

	The parameter domain is [0 1 0 1 0 1]. The sampling resolution is 6 75 6.

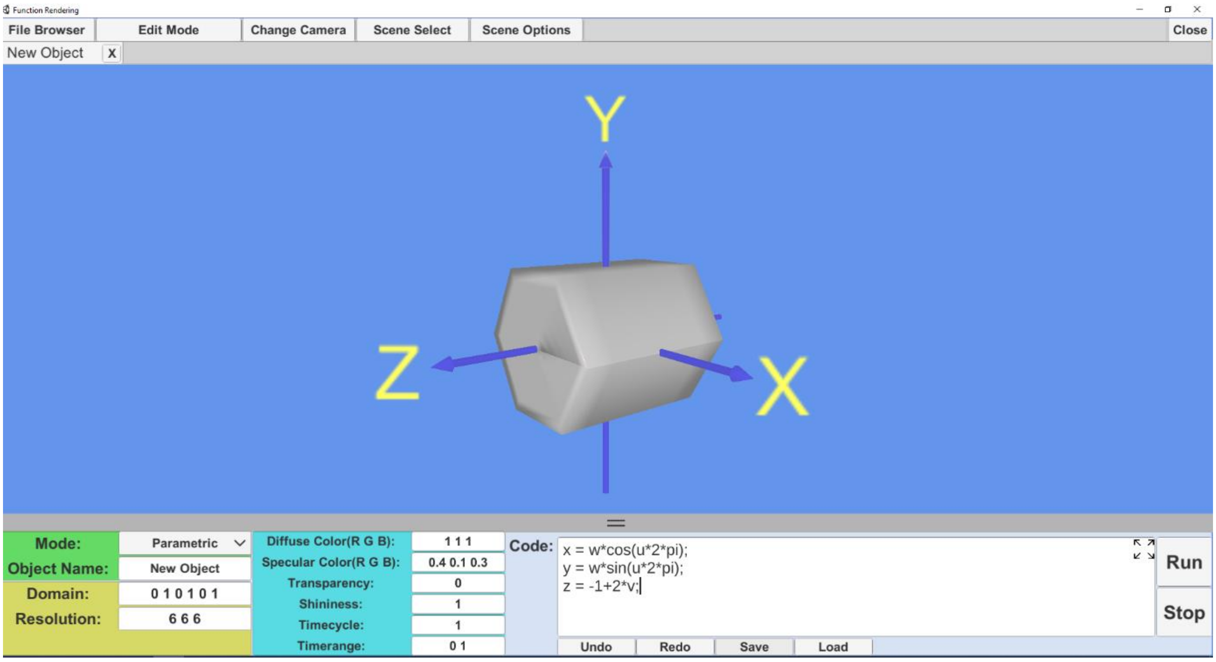
Solid 5	In SolidSphere5.Func,
	x = w*cos(-pi/2+u*pi)*cos(-pi+v*2*pi);
	y = w*sin(-pi/2+u*pi);
	z = w*cos(-pi/2+u*pi)*sin(-pi+v*2*pi);
	
	The parameter domain is [0 1 0 1 0 1].
	The sampling resolution is 6 6 75.

The value sampling resolution affects the smoothness of the solid sphere as shown in solid 1 and solid 2. The higher the resolution, the smoother the solid sphere. The sampling resolution is for u v w. When u has a higher sampling resolution in solid 3, the arc of circle of the solid sphere on the y-axis is smoother but the rotational sweep around the y-axis is not smooth due to low sampling resolution. In solid 4, it has high sampling resolution for parameter v for rotational sweeping, thus resulting in a smoother rotation around the y-axis. In solid 5, the sampling resolution is only high on parameter w which results in more sampling points when forming the solid surface inside the solid sphere, this did not result in a smoother solid sphere u and v parameters sampling resolution is w.

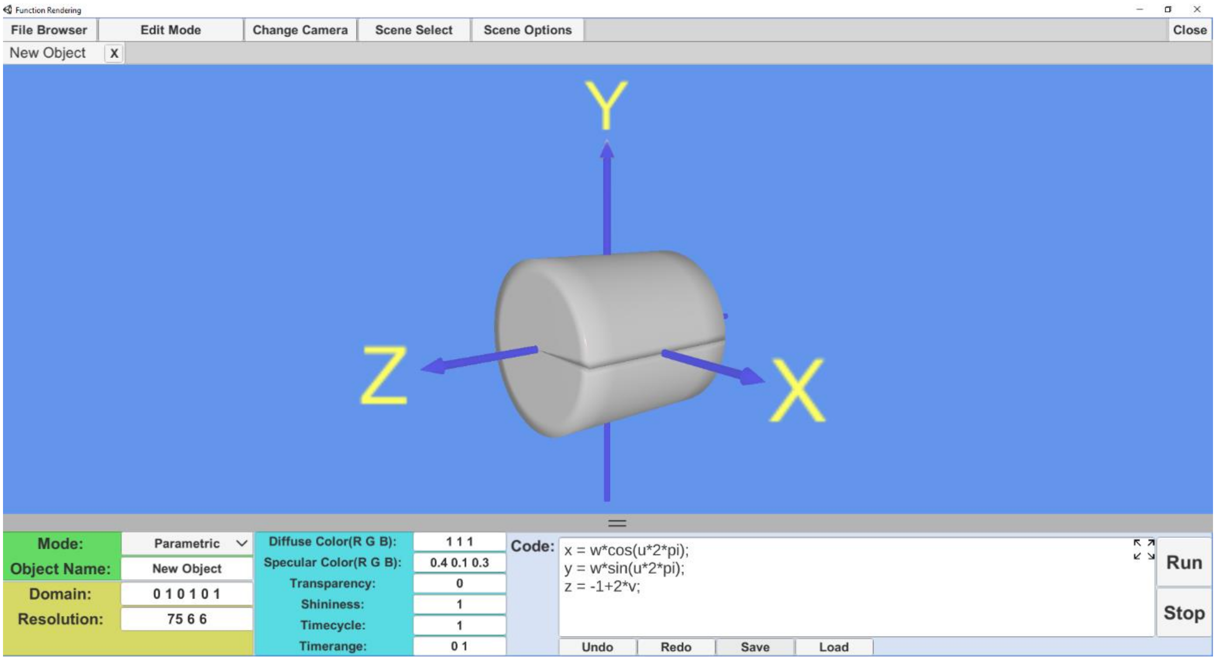
Solid cylinder



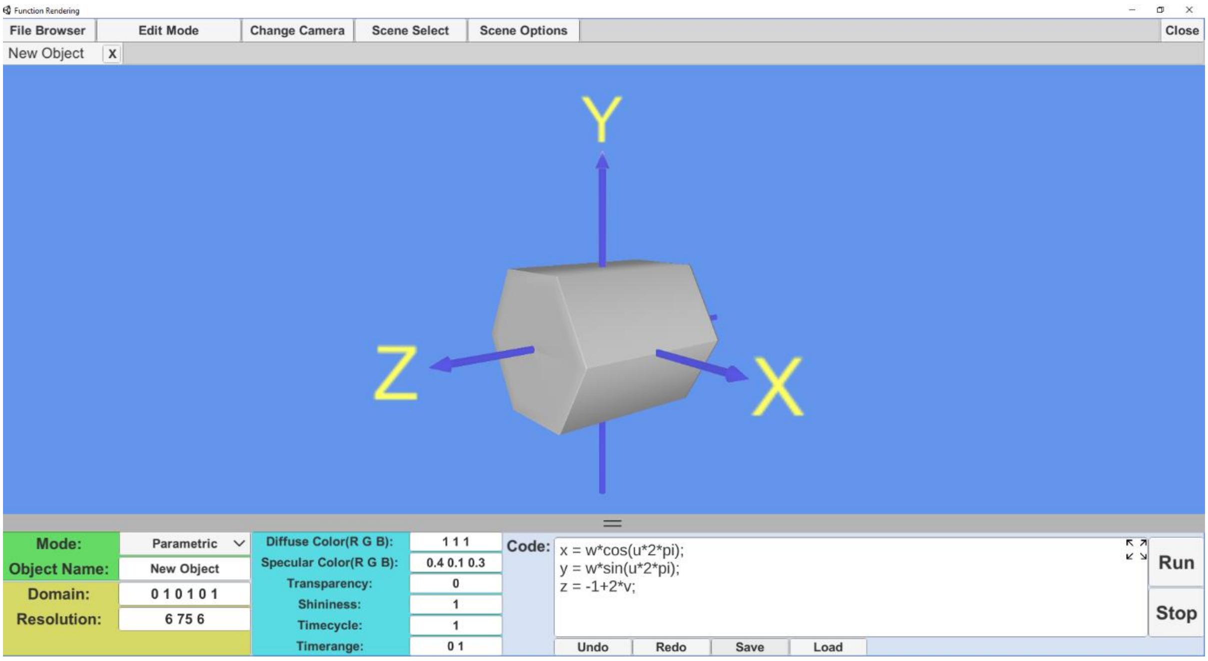
Solid 1



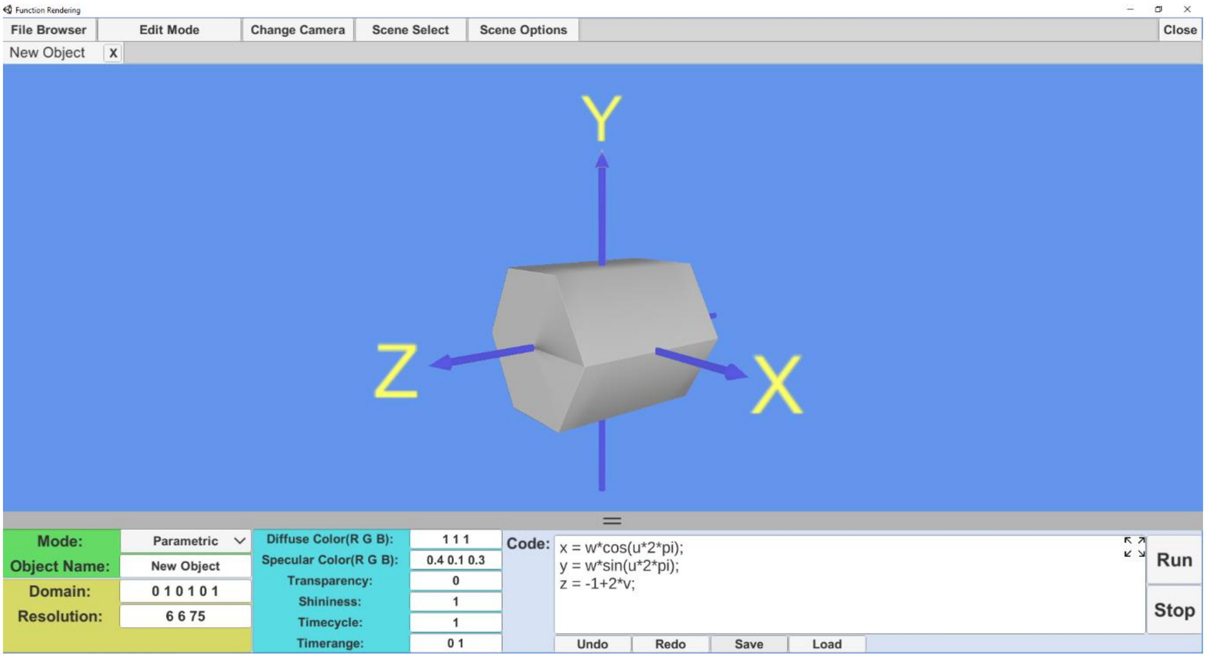
Solid 2



Solid 3



Solid 4



Solid 5

Curve No.	Notes

Solid 1	In SolidCylinder1.Func,
	x = w*cos(u*2*pi);
	y = w*sin(u*2*pi);
	z = -1+2*v;
	
	The parameter domain is [0 1 0 1 0 1].
	The sampling resolution is 75 75 75.

Solid 2	In SolidCylinder2.Func,
	x = w*cos(u*2*pi);
	y = w*sin(u*2*pi);
	z = -1+2*v;
	
	The parameter domain is [0 1 0 1 0 1].
	The sampling resolution is 6 6 6.

Solid 3	In SolidCylinder3.Func,
	x = w*cos(u*2*pi);
	y = w*sin(u*2*pi);
	z = -1+2*v;
	
	The parameter domain is [0 1 0 1 0 1].
	The sampling resolution is 75 6 6.

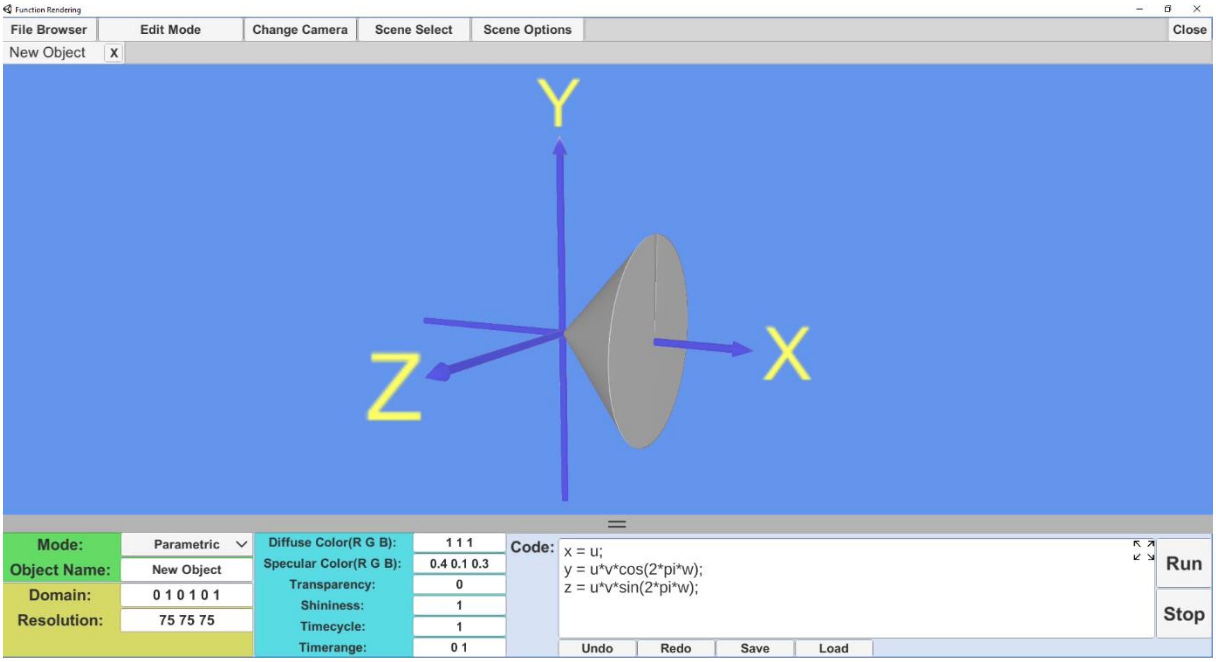
Solid 4	In SolidCylinder4.Func,
	x = w*cos(u*2*pi);
	y = w*sin(u*2*pi);
	z = -1+2*v;

	The parameter domain is [0 1 0 1 0 1]. The sampling resolution is 6 75 6.

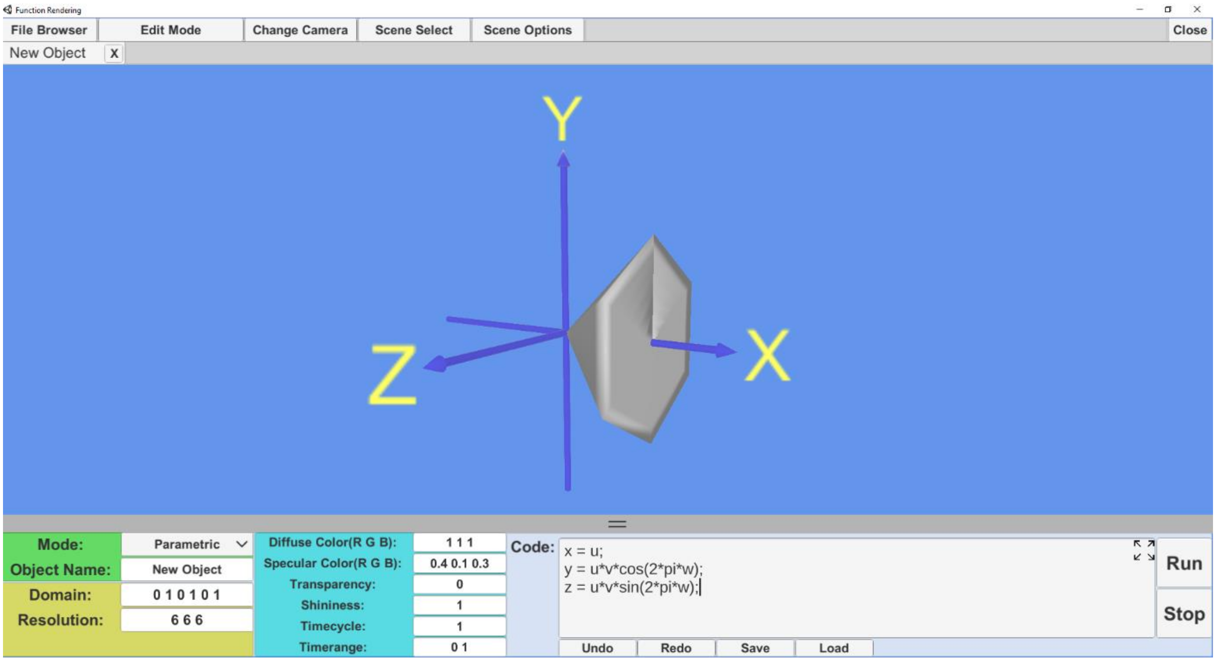
Solid 5	In SolidCylinder5.Func,
	x = w*cos(u*2*pi);
	y = w*sin(u*2*pi);
	z = -1+2*v;
	
	The parameter domain is [0 1 0 1 0 1].
	The sampling resolution is 6 6 75.

Based on solid 1 and 2, we can notice that the sampling resolution affects the smoothness of the solid cylinder. Based on solid 3 to solid 5, only the sampling resolution for parameter u affects the smoothness of the solid cylinder as shown in solid 3 with a value of 75. This is because when creating a circle around the z-axis, more sampling points are needed to create a smooth circle. Whereas for other parameters such as v and w for these equations are not affected by sampling resolution as only straight lines are needed to form them.

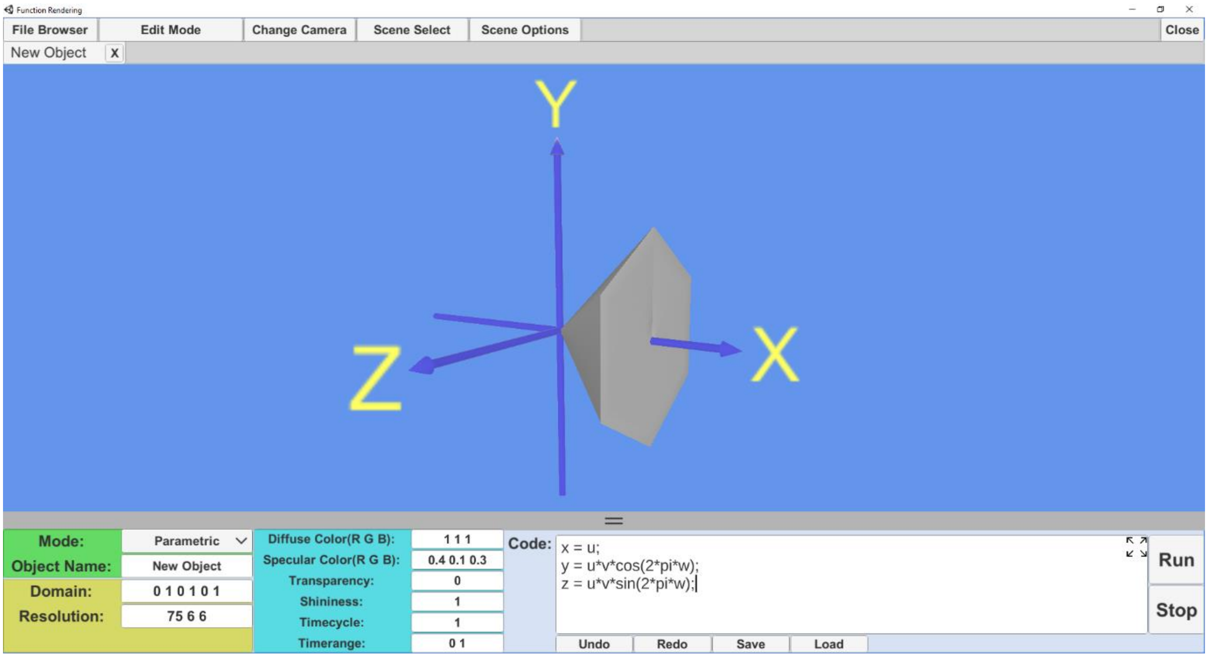
Solid cone



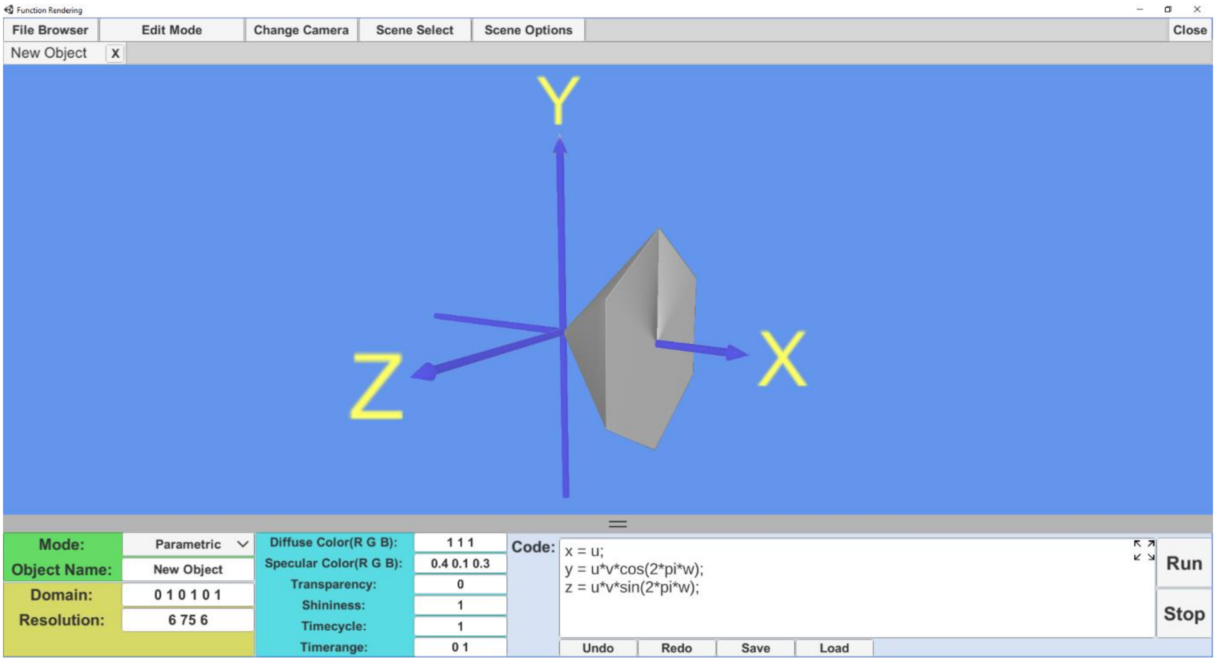
Solid 1



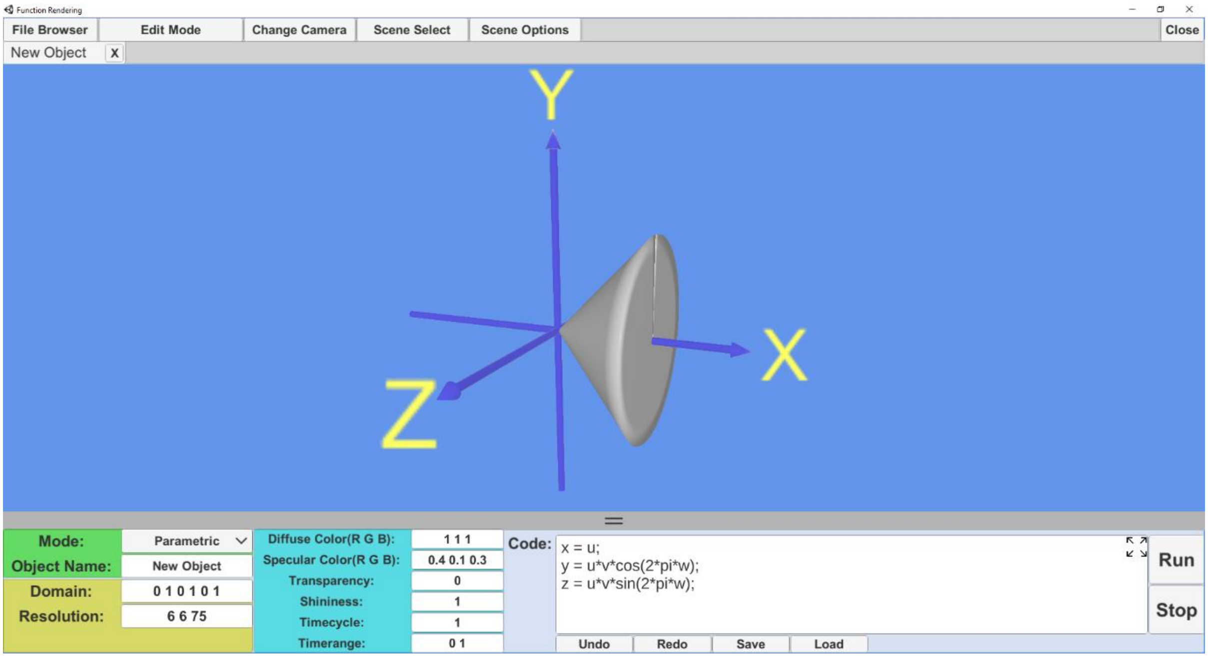
Solid 2



Solid 3



Solid 4



Solid 5

Curve No.	Notes

Solid 1	In SolidCone1.Func,
	x = u;
	y = u*v*cos(2*pi*w);
	z = u*v*sin(2*pi*w);
	
	The parameter domain is [0 1 0 1 0 1].
	The sampling resolution is 75 75 75.

Solid 2	In SolidCone2.Func,
	x = u;
	y = u*v*cos(2*pi*w);
	z = u*v*sin(2*pi*w);
	
	The parameter domain is [0 1 0 1 0 1].
	The sampling resolution is 6 6 6.

Solid 3	In SolidCone3.Func,
	x = u;
	y = u*v*cos(2*pi*w);
	z = u*v*sin(2*pi*w);
	
	The parameter domain is [0 1 0 1 0 1].
	The sampling resolution is 75 6 6.

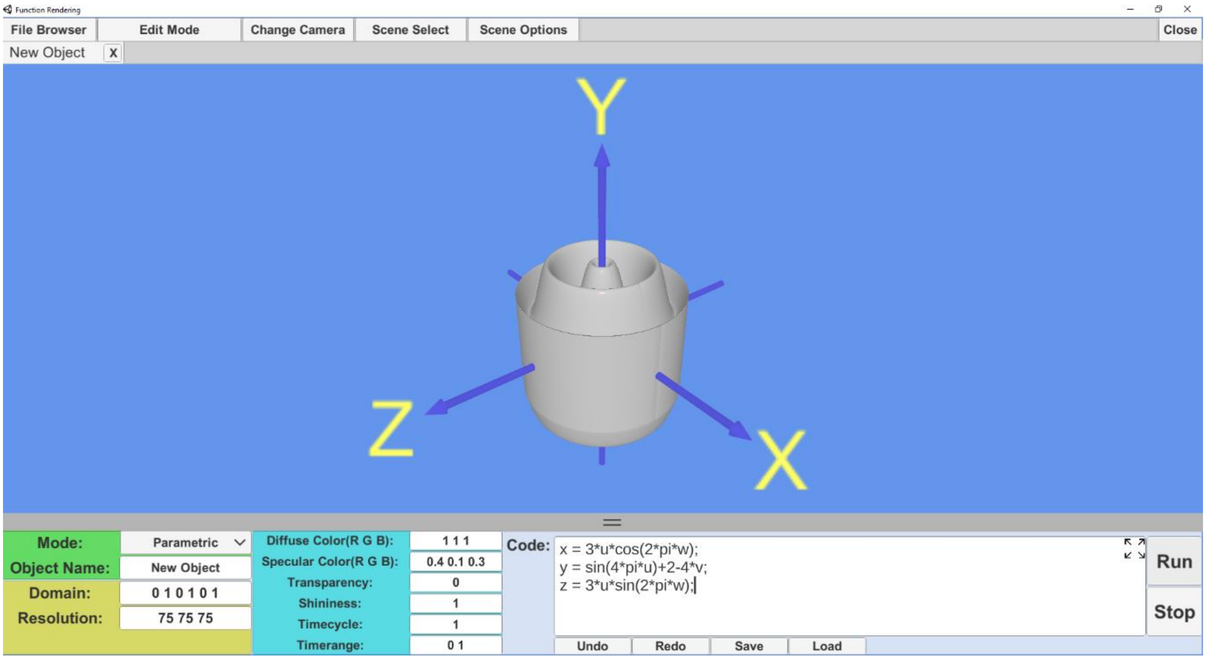
Solid 4	In SolidCone4.Func,
	x = u;
	y = u*v*cos(2*pi*w);
	z = u*v*sin(2*pi*w);

	The parameter domain is [0 1 0 1 0 1]. The sampling resolution is 6 75 6.

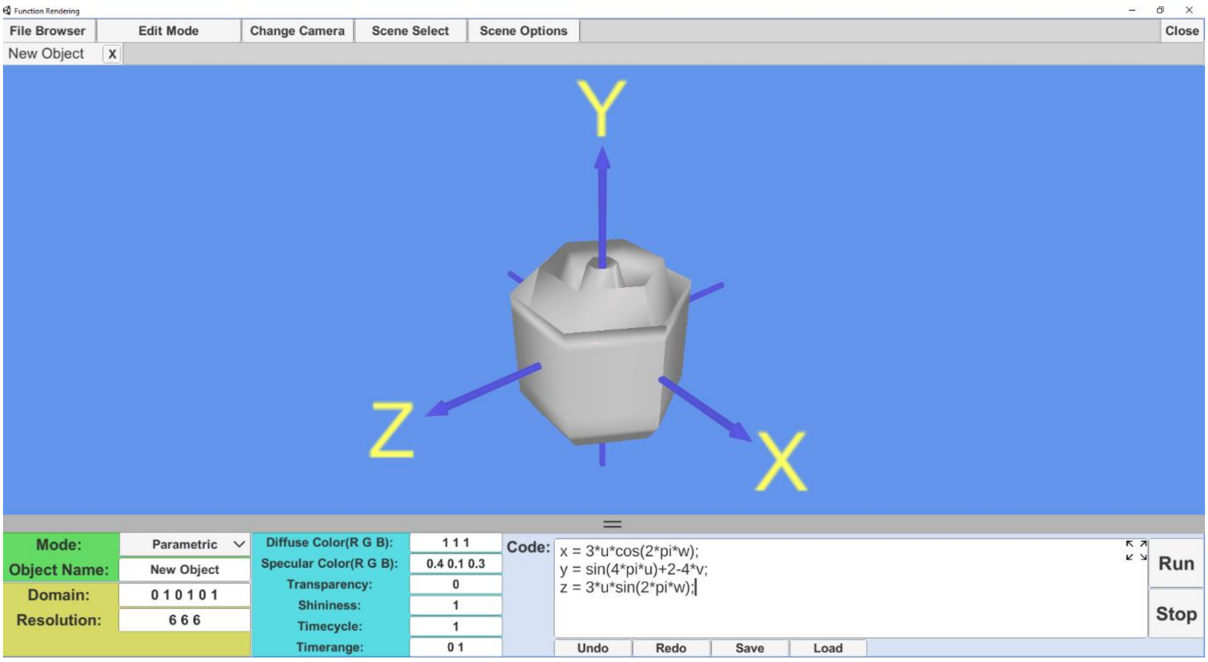
Solid 5	In SolidCone5.Func,
	x = u;
	y = u*v*cos(2*pi*w);
	z = u*v*sin(2*pi*w);
	
	The parameter domain is [0 1 0 1 0 1].
	The sampling resolution is 6 6 75.

Based on solid 1 and 2, we notice that solid cone is affected by sampling resolution. Similar to solid cylinder, only the parameter is used to form the rotational sweeping for the solid cone is affected by the sampling resolution. Based on solid 3 to solid 5, solid 5 has a smooth cone surface as more sampling points for parameter w for rotational sweep whereas the rest of the parameters such as u and v only requires at least one sampling resolution.

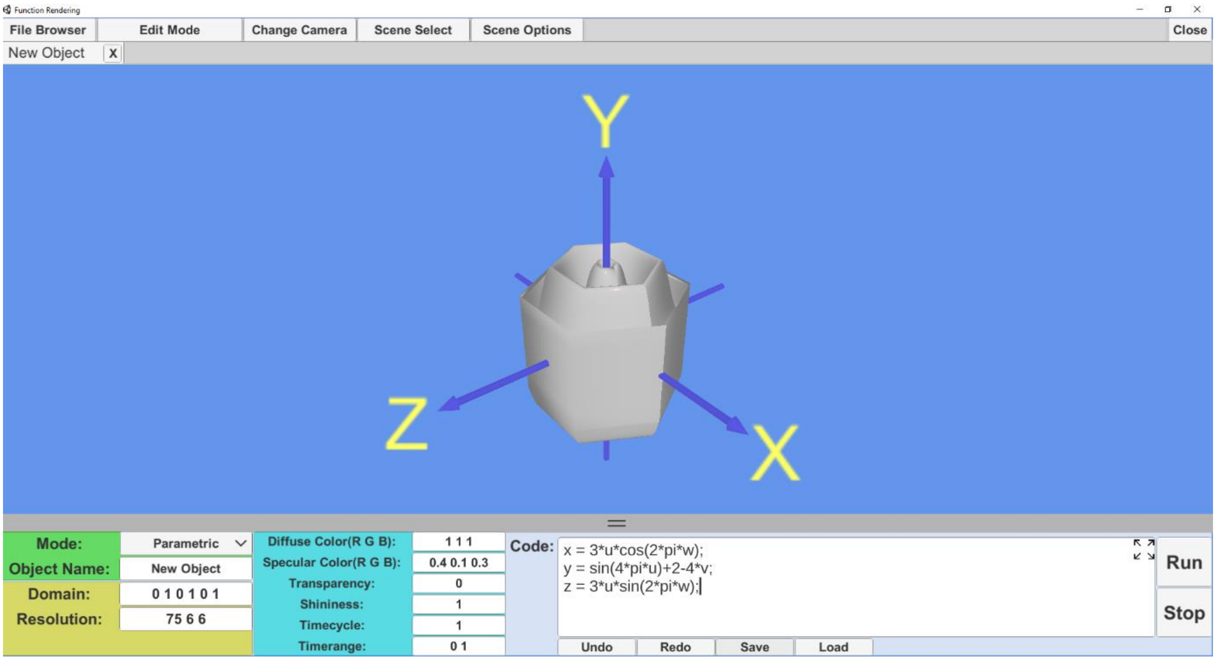
Solid sine curve-liked



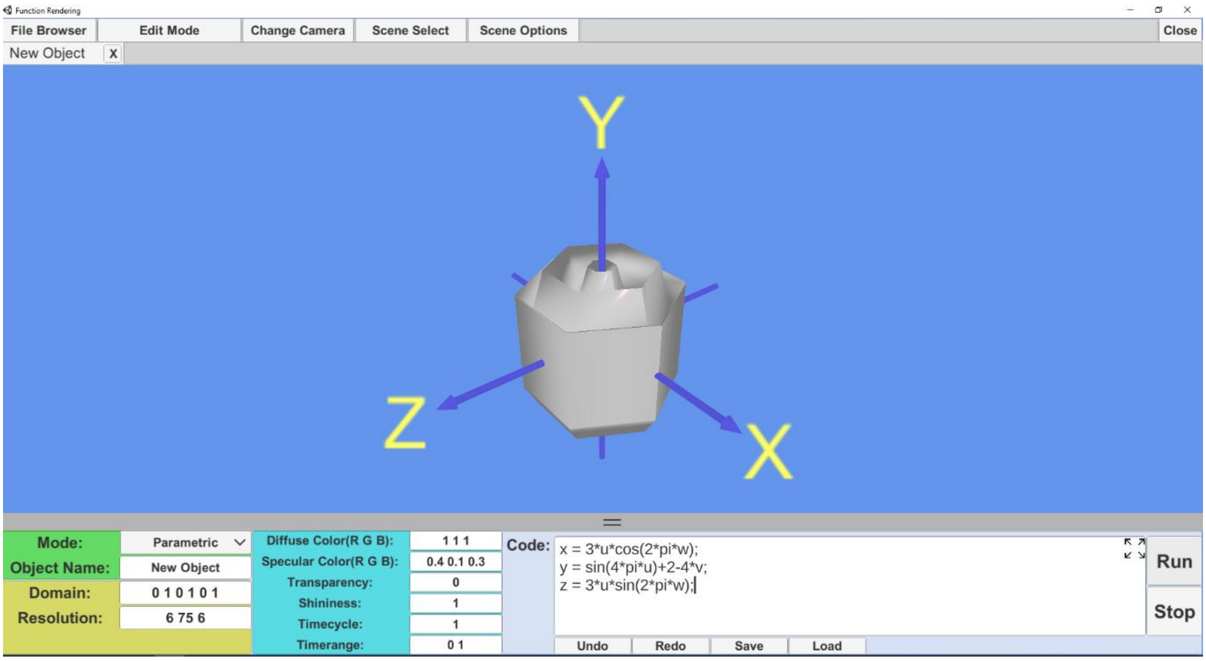
Solid 1



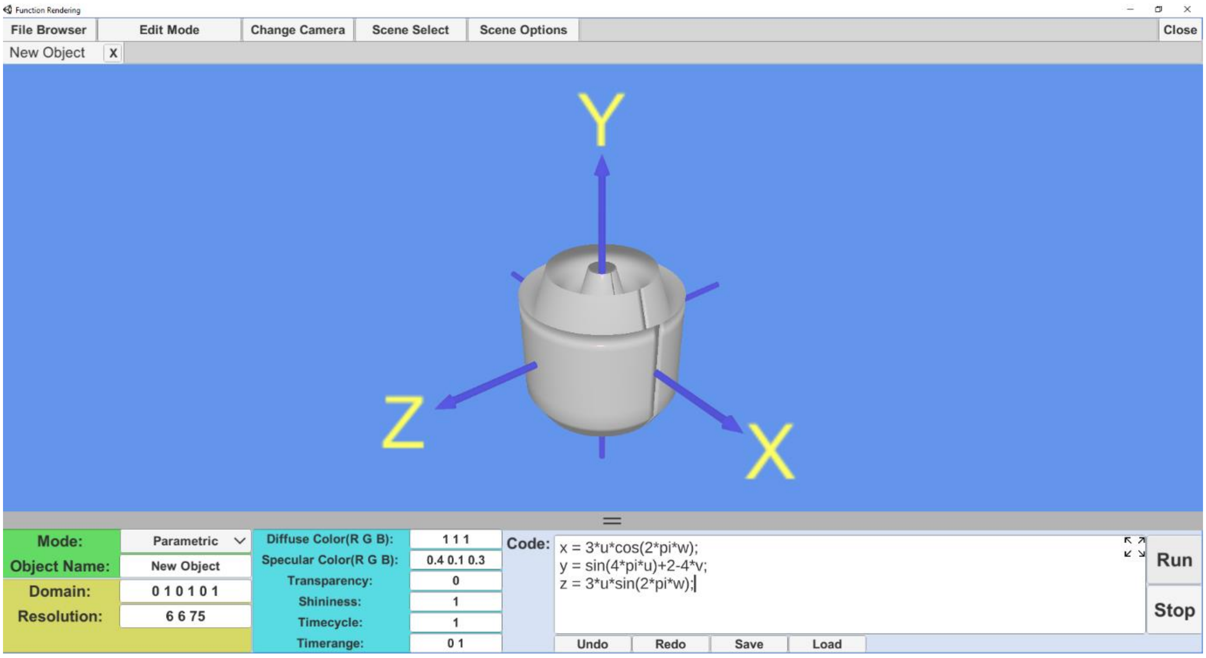
Solid 2



Solid 3



Solid 4



Solid 5

Curve No.	Notes

Solid 1	In SolidSineCurveLiked1.Func,
	x = 3*u*cos(2*pi*w);
	y = sin(4*pi*u)+2-4*v;
	z = 3*u*sin(2*pi*w);
	
	The parameter domain is [0 1 0 1 0 1].
	The sampling resolution is 75 75 75.

Solid 2	In SolidSineCurveLiked2.Func,
	x = 3*u*cos(2*pi*w);
	y = sin(4*pi*u)+2-4*v;
	z = 3*u*sin(2*pi*w);
	The parameter domain is [0 1 0 1 0 1].
	The sampling resolution is 6 6 6.

Solid 3	In SolidSineCurveLiked3.Func,
	x = 3*u*cos(2*pi*w);
	y = sin(4*pi*u)+2-4*v;
	z = 3*u*sin(2*pi*w);
	
	The parameter domain is [0 1 0 1 0 1].
	The sampling resolution is 75 6 6.

Solid 4	In SolidSineCurveLiked4.Func,
	x = 3*u*cos(2*pi*w);
	y = sin(4*pi*u)+2-4*v;
	z = 3*u*sin(2*pi*w);
	
	The parameter domain is [0 1 0 1 0 1].

	The sampling resolution is 6 75 6.

Solid 5	In SolidSineCurveLiked5.Func,
	x = 3*u*cos(2*pi*w);
	y = sin(4*pi*u)+2-4*v;
	z = 3*u*sin(2*pi*w);
	
	The parameter domain is [0 1 0 1 0 1].
	The sampling resolution is 6 6 75.

The smoothness of solid object is affected by sampling resolution as more sampling points are needed to do rotational sweeping as showed in solid 2 to solid 4 where the sampling resolution for parameter w is 6 while the other parameters have higher sampling resolution. In solid 5, despite having low sampling resolution of 6 for parameter u and v, sampling resolution of 75 for parameter w that affects the rotational sweeping resulted in the object to be smooth like solid 1.