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| Nanyang Technological University |
| Lab 3 report: Parametric Surfaces and Solids |
| CZ2003 Computer Graphics and Visualization |

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SSP4

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| **Parametric Surface** | **Screenshot** | **Notes** |
| 3D\_planeA |  | definition "  x = -2+4\*u;  y = 2\*v;  z = (-2)\*v;"  parameters [0 1 0 1]  This is the parametric definition for a plane in 3D defined with 2 parameters u and v.  This is a surface. |
| 3D\_planeB |  | The resolution was decreased 10 times from resolution [10 10] to resolution [1 1] with no noticeable difference.  Increasing the resolution by 10 times produces no noticeable effect as well.  The transparency is set to 0.3. |
| 3D\_planeC |  | definition "  x=-1 + u;  y=v;  z=u\*0.5;"  resolution [1 1]  parameters [0 1 0 1]  This is another 3D plane that is defined parametrically. |
| 3D\_triangleA |  | definition "x=u\*5;  y=5\*(1-u)\*v;  z=0;"  parameters [0 1 0 1]  resolution [75 75]  This is a triangle defined parametrically with two parameters u and v that ranges from 0 to 1 (for both). The height and length of the triangle are both 5 units. |
| 3D\_triangleB |  | This is the effect of reducing the resolution from [75 75] to [1 1]. It produces a gradient-like effect without changing the appearance of the triangle. |
| 3D\_triangleC |  | definition "  x=u;  y=u\*v;  z=0;"  I replaced (1-u) to u and this makes the triangle grow from y=0 to y=1 along the x-axis in the positive direction. |
| Bi surface\_A |  | definition "  x= 2\*u-1;  y= 2\*v-1;  z=0;"  parameters [0 1 0 1]  resolution [75 75]  This is a simple square plane that has a center at the point-of-origin. |
| Bi surface\_B |  | The bilinear surface parametric representation is P=P1 + u(P2-P1) + v(P3-P1+ v(P4-P3-(P2-P1))). In my definition for this particular bilinear surface, I did not simplify my parametric equations.  definition "x= -1 +u\*(2)+v\*((-1)-(-1)+u\*(1-(-1)-1+(-1))) ;    y=-1+u\*(-1-(-1))+v\*(1-(-1)+u\*(1-1-(-1)+(-1)));    z=1+u\*(0-1)+v\*(1-1+u\*(0-1-0+1));" |
| Bi surface\_C |  | Due to the fact that we can control the four points of our bilinear surface, we can produce “twisted” surfaces as shown as this screenshot on the left.  On the left are screenshots of the same bilinear surface viewed from different angles. |
| Bi surface\_D |  | This is another bilinear surface with screenshots from different angles. |
| Surface\_sphereA |  | This is a sphere that is hollow on the inside.  The parameters defining this sphere are normalized. |
| Surface\_sphereB |  | Only half a sphere is defined and it can be seen from here that the inside of the sphere is hollow. |
| Surface\_ellipsoidA |  | This is a screenshot of an ellipsoid that is also hollow on the inside. From the Surface\_sphereA file, I multiplied 0.5 to the parametric equation for y. |
| Surface\_ellipsoidB |  | This is half of the previous ellipsoid defined. The inside of this ellipsoid is hollow. |
| Surface\_ellipsoidC |  | In this case, the sampling resolution in the x, y, z direction was changed from [75 75 75] to [5 5 5]. The ellipsoid is now no longer smooth and is very rough. |
| Surface\_coneA |  | This is a cone drawn by rotational sweeping of a straight line segment. |
| Surface\_coneB |  | This is an animated cone that shows rotational sweeping about the y-axis. The time parameter t is introduced in the x and z parametric definitions to show the sweeping effect when the circles along the cone are drawn out. |
| Solid\_BoxA |  | definition "  x=u-0.5;  y=v-0.5;  z=w-0.5;"  Using the default template with  definition “  x=u;  y=v;  z=w;”,  I minus 0.5 units from each parametric equation so that the entire solid box will be centralized. The most middle part of the box is now at the origin.    parameters [0 1 0 1 0 1]  For the parameters domain, since there are now three parameters  (u, v, w), the domain for each parameter must be defined.  This is where it is different from surfaces, where there are only two parameters. In solids, we use three parameters.  resolution [75 75 75]  Similarly, the resolution for each parameter must be set. In this case, it is set to 75, 75, 75. |
| Solid\_BoxB |  | definition "  x=u;  y=2\*(v-0.5);  z=w-0.5;"  parameters [0 1 0 1 0 1]  In this definition, the parameters are kept the same. Parameters u, v, w starts from 0 and ends at 1.  Along the X-axis, the solid box is from 0 to 1.  Along the Z-axis, the solid box starts from z=-0.5 and ends at z=0.5.  Along the Y-axis, however, because I times 2 around the equation (v-0.5), The box is stretched out to twice its length. The box extends from -1 to 1. |
| Solid\_SphereA |  | definition "x=w\*cos((2\*pi\*u)-(pi))\*cos((4\*pi\*v)-(2\*pi\*v));  y=w\*cos((2\*pi\*u)-(pi))\*sin((4\*pi\*v)-(2\*pi\*v));  z=w\*sin((2\*pi\*u)-(pi));"  parameters [0 1 0 1 0 1]  resolution [75 75 75]  I try to keep the parameters ranging from 0 to 1 and change the definition of a sphere from  x=rcos(u)cos(v), y=rsin(u)cos(v),  z=rsin(u),  u[-pi/2 pi/2], v[-pi pi] to the one defined above. |
| Solid\_SphereB |  | definition "x=w\*cos((pi\*u)-(pi/2))\*cos((2\*pi\*v)-(pi\*v));  y=w\*cos((pi\*u)-(pi/2))\*sin((2\*pi\*v)-(pi\*v));  z=w\*sin((pi\*u)-(pi/2));"  parameters [0 1 0 1 0 1]  This definition defines a solid sphere. We don’t give a specific value to parameter w and let it range from 0 to 1 so that the inside of the sphere is filled in and is solid.  To prove that inside is filled, I defined half a solid sphere.  The gradient effect is achieved by:  diffuseColor "r=1; g=abs(sin(u\*pi)); b=0;" |
| Solid\_SphereC |  | definition "x=w\*cos((2\*pi\*u)-(pi))\*cos((4\*pi\*v)-(2\*pi\*v));  y=w\*cos((2\*pi\*u)-(pi))\*sin((4\*pi\*v)-(2\*pi\*v));  z=w\*sin((2\*pi\*u)-(pi));"  parameters [0 10 0 1 0 1]  resolution [75 75 75]  I try to vary the parameters to see how it will affect the sphere. In this case, I try to increase the domain of parameter u from [0 1] to [0 10]. What it produces is a sphere that is rough sphere along the z-axis. This is because, a larger range will have to be covered for parameter u while the number of times the sampling is done is kept the same. The sampling resolution is not high enough to cater for the increased range for parameter u. To make the sphere smooth again, we can increase the number of sampling resolution in the x direction. |
| Solid\_SphereD |  | definition "x=w\*cos((2\*pi\*u)-(pi))\*cos((4\*pi\*v)-(2\*pi\*v));  y=w\*cos((2\*pi\*u)-(pi))\*sin((4\*pi\*v)-(2\*pi\*v));  z=w\*sin((2\*pi\*u)-(pi));"  parameters [0 10 0 10 0 1]  resolution [75 75 75]  Instead of only increasing the domain for parameter u, I increase the domain for parameter v as well. What happens is that each “circle” drawn along the x-y direction along the z-axis are now jagged instead of smooth.  The sampling resolution is again kept the same. |
| Solid\_SphereE |  | Definition of this sphere is kept the same as Solid\_SphereD.  parameters [0 1 0 1 0 2]  resolution [75 75 75]  I explore what happens when the last parameter is changed. What happens is that the entire sphere increased in size. (The axes are now hidden inside the sphere.) |
| Solid\_SphereF (Sweeping) |  | This is an animated solid sphere that sweeps out along the z-axis. The screenshots captures the sphere sweeping out from a flat disk to a solid sphere.  definition "x=w\*cos(((2\*pi\*u)-(pi))\*t)\*cos((4\*pi\*v)-(2\*pi\*v));  y=w\*cos(((2\*pi\*u)-(pi))\*t)\*sin((4\*pi\*v)-(2\*pi\*v));  z=w\*sin(((2\*pi\*u)-(pi))\*t);"  As shown from the definition, I multiplied a time parameter t to the angle that controls the sweeping motion along the z-axis. |
| Solid\_CylinderA |  | definition "  x = u\*cos(v\*2\*pi);  y = -1+2\*w;  z = u\*sin(v\*2\*pi);"  parameters [0 1 0 1 0 1]  resolution [50 50 50]  This is a solid cylinder that extends from -1 to 1 along the y-axis. This cylinder has a radius of 1.  Instead of specifying a fixed radius for the circle, parameter u that ranges from 0 to 1 is used instead so that the entire cylinder is filled and is not hollow. |
| Solid\_CylinderB |  | definition "  x = u\*cos(v\*pi);  y = -1+2\*w;  z = u\*sin(v\*pi);"  parameters [0 1 0 1 -1 1]  resolution [50 50 50]  To create half a cylinder, I removed the 2 in the sin and cos functions so that only pi (180 degrees) of the cylinder is drawn out. The x-axis to z-axis direction is considered as the positive direction according to right-hand rule. |
| Solid\_CylinderC |  | definition "  x = u\*cos(v\*pi);  y = -1 + 2\*w;  z = u\*sin(2\*v\*pi);"  parameters [0 1 0 1 0 1]  resolution [50 50 50]  This is what happens when the angle for cos is kept the same while the angle for sin is doubled. |
| Solid\_CylinderD (Sweeping) |  | This is an animated cylinder that grows in height along the y-axis.  definition "  x = u\*cos(v\*2\*pi);  y = -1+2\*w\*t;  z = u\*sin(v\*2\*pi);"  parameters [0 1 0 1 0 1]  resolution [50 50 50]  Using the same definition for Solid\_CylinderA, the time parameter t is introduced to the parametric equation for y. It does a translational sweep along the y-axis and the cylinder grows from a flat disk at y=-1 to a full solid cylinder at y=1. |
| Solid\_CylinderE (Sweeping) |  | This is an animated solid cylinder that performs both rotational and translational sweeping. The shape sweeps out in a circle while being translated in the positive y direction. Finally, it forms a solid cylinder with radius 1 and height 2. |
| Solid\_ConeA |  | definition "  x = v\*w\*cos(((2\*pi)\*u-(pi)));  y = -1 + w\*(1-(-1));  z = v\*w\*sin(((2\*pi)\*u-(pi)));"    parameters [0 1 0 1 0 1]  resolution [50 50 50]  This is a solid cone that starts at y=-1 to y=1. |
| Solid\_ConeB (sweeping) |  | This is an animated sweeping cone that starts along the x-y plane and does rotational sweep about the y-axis.  DEF morph FShape {  cycleInterval 3  loop TRUE  geometry FGeometry {  definition "  x = v\*w\*cos(((2\*pi)\*u-(pi))\*t);  y = -1 + w\*(1-(-1));  z = v\*w\*sin(((2\*pi)\*u-(pi))\*t);"    parameters [0 1 0 1 0 1]  resolution [50 50].  The time parameter t is introduced to the parametric functions of x and z that we use to define the circles in the cone. |