

CZ2003

Computer Graphics and Visualization

Lab 3 Report: Parametric Surfaces and Solids

SSR2

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Define parametrically in separate files**:** 3D plane, 3D triangle,bilinear surface,sphere, ellipsoid,cone.

# Exercise 1 – 3D Plane

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| --- | --- | --- |
| **Snapshot (Smooth)** | **Wireframe** | **Notes** |
|  |  | The plane in file “1.1-3DPlane.wrl” is a 3D Plane defined by parametric equations  x=u;  y=0;  z=v;  The parameter domain is and we can see that the plane starts from origin to 1 in the x, z-coordinates.  The sampling resolution is [75 75].  Open the file to see animation. |
|  |  | The plane in file “1.2-3DPlane.wrl” is a 3D Plane defined by parametric equations  x=u;  y=v;  z=u;  The parameter domain is and we can see that the plane starts from origin to 1 in the x, y, z-coordinates.  The sampling resolution is [75 75].  Open the file to see animation. |
|  |  | The plane in file “1.3-3DPlane.wrl” is a 3D Plane defined by parametric equations  x=u;  y=v;  z=u;  The parameter domain is and we can see that the plane starts from -1 to 1 in the x, y, z-coordinates.  The sampling resolution is [75 75].  Open the file to see animation. |

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|  |  | The plane in file “1.4-3DPlane.wrl” is a 3D Plane defined by parametric equations  x=u;  y=v;  z=u;  The parameter domain is and we can see that the plane starts from -1 to 1 in the x, y, z-coordinates.  When we change the sampling resolution to [1 1], there is not much visual changes to the shape. This is because drawing a straight line between 2 end points is the same as connecting many points that lies on a straight line.  The rendering speed is much faster and there is no lag.  Open the file to see animation. |
|  |  | The plane in file “1.5-3DPlane.wrl” is a 3D Plane defined by parametric equations  x=u;  y=v;  z=u;  When we change the sampling resolution to [1000 1000], there is not much visual changes to the shape. This is because we are just drawing more points along a straight line, therefore there is not much visual difference.  However, the rendering speed is much slower as there is a significant lag. It may even cause the program to crash.  Open at your own risk! |

# Exercise 2 – 3D Triangle

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| **Snapshot (Smooth)** | **Wireframe** | **Notes** |
|  |  | The plane in file “2.1-3DTriangle.wrl” is a 3D Triangle defined by parametric equations  x=v\*(1-u);  y=u;  z=v\*(1-u);  The parameter domain is .  The sampling resolution is [75 75]. |
|  |  | The plane in file “2.2-3DTriangle.wrl” is a 3D Triangle defined by parametric equations  x=v\*(1-u);  y=u;  z=v\*(1-u);  The parameter domain is .  The sampling resolution is [1 1] and we can see the difference in the wireframe. |
|  |  | The plane in file “2.3-3DTriangle.wrl” is a 3D Triangle defined by parametric equations  function parametric\_x(u,v){  x1=-1; x2=1; x3=0; x4=0;  return (x1+u\*(x2-x1)+v\*(x3-x1+u\*(x4-x3-x2+x1)));  }  function parametric\_y(u,v){  y1=0; y2=0; y3=1; y4=1;  return (y1+u\*(y2-y1)+v\*(y3-y1+u\*(y4-y3-y2+y1)));  }  function parametric\_z(u,v){  z1=0; z2=0; z3=0; z4=0;  return (z1+u\*(z2-z1)+v\*(z3-z1+u\*(z4-z3-z2+z1)));  }  The parameter domain is .  The sampling resolution is [75 75] |

# Exercise 3 – Bilinear Surface

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| **Snapshot (Smooth)** | **Wireframe** | **Notes** |
|  |  | The surface in file “3.1-BilinearSurface.wrl” is a Bilinear Surface defined by parametric equations  function parametric\_x(u,v){  x1=-1; x2=1; x3=-1; x4=1;  return (x1+u\*(x2-x1)+v\*(x3-x1+u\*(x4-x3-x2+x1)));  }  function parametric\_y(u,v){  y1=1; y2=0; y3=0; y4=1.5;  return (y1+u\*(y2-y1)+v\*(y3-y1+u\*(y4-y3-y2+y1)));  }  function parametric\_z(u,v){  z1=-1; z2=-1; z3=1; z4=1;  return (z1+u\*(z2-z1)+v\*(z3-z1+u\*(z4-z3-z2+z1)));  }  The parameter domain is .  The sampling resolution is [75 75]. |
|  |  | The surface in file “3.2-BilinearSurface.wrl” is a Bilinear Surface defined by the same parametric equations.  The parameter domain is .  When we change the sampling resolution is [1 1], the Bilinear Surface loses its curvature and becomes a roof-like surface.  This is because sampling resolution is [1 1], it is drawing a straight line. |

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|  |  | The surface in file “3.3-BilinearSurface.wrl” is a Bilinear Surface defined by the same parametric equations.  When we change the parameter domain to we can see that the surface will start from -1 to 1, thus resulting in this uneven shape.  The sampling resolution is [75 75]. |

# Exercise 4 – Sphere

|  |  |  |
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| **Snapshot (Smooth)** | **Wireframe** | **Notes** |
|  |  | The surface in file “4.1-Sphere.wrl” is a Sphere defined by parametric equations  x=0.5\*cos(u\*pi\*2);  y=0.5\*sin(u\*pi\*2)\*cos(v\*pi);  z=0.5\*sin(u\*pi\*2)\*sin(v\*pi);  The parameter domain is  The sampling resolution is [75 75].  The radius of the sphere is 0.5.  Open the file to see the animation. |
|  |  | The surface in file “4.2-Sphere.wrl” is a Sphere defined by parametric equations  x=0.5\*cos(u\*pi\*2);  y=0.5\*sin(u\*pi\*2)\*cos(v\*pi);  z=0.5\*sin(u\*pi\*2)\*sin(v\*pi);  The parameter domain is  When we change the sampling resolution to [10 10], the sphere loses its smooth curvature and there are visible edges. This is evident in the wireframe.  The radius of the circle is 0.5.  Open the file to see the animation. |
|  |  | The surface in file “4.3-Sphere.wrl” is a Sphere defined by parametric equations  x=0.5\*cos(u\*pi\*2);  y=0.5\*sin(u\*pi\*2)\*cos(v\*pi);  z=0.5\*sin(u\*pi\*2)\*sin(v\*pi);  When keep the parameter domain to , but change the sampling resolution to [6 6], the sphere loses its smooth curvature and there are visible edges as well.  The radius of the circle is 0.5.  Open the file to see the animation. |
|  |  | The surface in file “4.4-Sphere.wrl” is a Sphere defined by parametric equations  x=cos(u\*2\*pi);  y=sin(u\*2\*pi)\*cos(v\*pi);  z=sin(u\*2\*pi)\*sin(v\*pi);  When we change the parameter domain to , and sampling resolution is [36 18], we can see that the top half and bottom half of the sphere turns halfway only.  The radius of the circle is 1.  Open the file to see the animation. |

# Exercise 5 – Ellipsoid

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| **Snapshot (Smooth)** | **Wireframe** | **Notes** |
|  |  | The surface in file “5.1-Ellipsoid.wrl” is an Ellipsoid defined by parametric equations  x=1\*cos(2\*pi\*u);  y=0.5\*sin(2\*pi\*u)\*cos(pi\*v);  z=0.5\*sin(2\*pi\*u)\*sin(pi\*v);  The parameter domain is  The sampling resolution is [75 75].  Open the file to see the animation. |
|  |  | The surface in file “5.2-Ellipsoid.wrl” is an Ellipsoid defined by parametric equations  x=1\*cos(2\*pi\*u);  y=0.5\*sin(2\*pi\*u)\*cos(pi\*v);  z=0.5\*sin(2\*pi\*u)\*sin(pi\*v);  The parameter domain is  When we change the sampling resolution to [75 75], the ellipsoid loses its smooth curvature and there are visible edges.  Open the file to see the animation. |
|  |  | The surface in file “5.3-Ellipsoid.wrl” is an Ellipsoid defined by parametric equations  x=1\*cos(2\*pi\*u);  y=0.5\*sin(2\*pi\*u)\*cos(pi\*v);  z=0.5\*sin(2\*pi\*u)\*sin(pi\*v);  When we change the parameter domain to , and the sampling resolution is [38 16], we can see that the top half and bottom half of the ellipsoid turns halfway only.  Open the file to see the animation. |

# Exercise 6 – Cone

|  |  |  |
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| **Snapshot (Smooth)** | **Wireframe** | **Notes** |
|  |  | The surface in file “6.1-Cone.wrl” is an Cone defined by parametric equations  x=u;  y=u\*cos(2\*pi\*v);  z=u\*sin(2\*pi\*v);  The parameter domain is  The sampling resolution is [75 75].  Open the file to see the animation. |
|  |  | The surface in file “6.2-Cone.wrl” is an Cone defined by parametric equations  x=u;  y=u\*cos(2\*pi\*v);  z=u\*sin(2\*pi\*v);  The parameter domain is  When we change the sampling resolution to [4 4], we can see the shape of the cone becomes a square pyramid with an open base.  Open the file to see the animation. |
|  |  | The surface in file “6.3-Cone.wrl” is an Cone defined by parametric equations  x=u;  y=u\*cos(1\*pi\*v);  z=u\*sin(1\*pi\*v);  When we change the parameter domain to  [-1 1 -1 1] we can see there will be another cone on the negative x-axis side.  The sampling resolution is [75 75].  Open the file to see the animation. |

# Exercise 7 – Solid Box

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| **Snapshot (Smooth)** | **Wireframe** | **Notes** |
|  |  | The solid in file “7.1-SolidBox.wrl” is an Solid Box defined by parametric equations  x=0.5+u\*(1-0.5);  y=0.5+v\*(1-0.5);  z=0.5+w\*(1-0.5);  The parameter domain is  The sampling resolution is [1 1 1]. |
|  |  | The solid in file “7.2-SolidBox.wrl” is two Solid Boxes defined by parametric equations  x=u;  y=v;  z=w;  and  x=-u;  y=-v;  z=-w;  The parameter domain is  When sampling resolution is [2 2 2], compared to sampling resolution of [25 25 25], there is significantly lesser lines drawn. |
|  |  | The solid in file “7.3-SolidBox.wrl” is an Solid Box defined by parametric equations  x=u;  y=v;  z=w;  When we change the parameter domain to but keep the sampling resolution at [2 2 2], we can see that the box is much smaller in size. |

# Exercise 8 – Solid Sphere

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| **Snapshot (Smooth)** | **Wireframe** | **Notes** |
|  |  | The solid in file “8.1-SolidSphere.wrl” is an Solid Sphere defined by parametric equations  x=w\*cos(2\*pi\*u)\*sin(pi\*v);  y=w\*sin(2\*pi\*u);  z=w\*cos(2\*pi\*u)\*cos(pi\*v);  The parameter domain is and .  The sampling resolution is [30 30 30].  Open the file to see the animation. |
|  |  | The solid in file “8.2-SolidSphere.wrl” is an Solid Sphere defined by parametric equations  x=w\*cos(2\*pi\*u)\*sin(pi\*v);  y=w\*sin(2\*pi\*u);  z=w\*cos(2\*pi\*u)\*cos(pi\*v);  The parameter domain is and  When we change the sampling resolution to [4 4 4], the solid sphere becomes a 8-sided diamond.  Open the file to see the animation. |
|  |  | The solid in file “8.3-SolidSphere.wrl” is an Solid Sphere defined by parametric equations  x=w\*cos(2\*pi\*u)\*sin(2\*pi\*v);  y=w\*sin(2\*pi\*u);  z=w\*cos(2\*pi\*u)\*cos(2\*pi\*v);  The parameter domain is and  When we change the sampling resolution to [10 10 10], the solid sphere has visible edges.  Open the file to see the animation. |

# Exercise 9 – Solid Cylinder

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| **Snapshot (Smooth)** | **Wireframe** | **Notes** |
|  |  | The solid in file “9.1-SolidCylinder.wrl” is an Solid Cylinder defined by parametric equations  x=0.5\*cos(u\*2\*pi);  y=0.5\*sin(u\*2\*pi);  z=-1+(1-(-1))\*v;  The parameter domain is .  The sampling resolution is [32 32 32].  Open the file to see the translational sweeping in animation. |
|  |  | The solid in file “9.2-SolidCylinder.wrl” is an Solid Cylinder defined by parametric equations  x=v\*1\*sin(2\*pi\*u\*t);  y=w\*2;  z=v\*1\*cos(2\*pi\*u\*t);  The parameter domain is .  The sampling resolution is [32 1 1].  Open the file to see the rotational sweeping about y-axis in animation. |
|  |  | The solid in file “9.3-SolidCylinder.wrl” is an Solid Cylinder defined by parametric equations  x=v\*1\*sin(2\*pi\*u\*t);  y=w\*2;  z=v\*1\*cos(2\*pi\*u\*t);  The parameter domain is .  The sampling resolution is [6 1 1].  Open the file to see the rotational sweeping about y-axis in animation. |

# Exercise 10 – Solid Cone

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| **Snapshot (Smooth)** | **Wireframe** | **Notes** |
|  |  | The solid in file “10.1-SolidCone.wrl” is an Solid Cone defined by parametric equations  x=v;  y=v\*(1-w)\*sin(2\*pi\*u\*t);  z=v\*(1-w)\*cos(2\*pi\*u\*t);  The parameter domain is .  The sampling resolution is [32 1 1].  Open the file to see the rotational sweeping about x-axis in animation. |
|  |  | The solid in file “10.2-SolidCone.wrl” is an Solid Cone defined by parametric equations  x=v\*1\*(1-w)\*sin(2\*pi\*u\*t);  y=w\*2-1;  z=v\*1\*(1-w)\*cos(2\*pi\*u\*t);  The parameter domain is .  The sampling resolution is [30 1 1].  Open the file to see the rotational sweeping about y-axis in animation. |
|  |  | The solid in file “10.3-SolidCone.wrl” is an Solid Cone with square base defined by parametric equations  x=v\*1\*(1-w)\*sin(2\*pi\*u\*t);  y=w\*2-1;  z=v\*1\*(1-w)\*cos(2\*pi\*u\*t);  The parameter domain is .  When we change the sampling resolution to [4 1 1], we get a square base solid cone.  Open the file to see the rotational sweeping about y-axis in animation. |

# Exercise 11 – Conversion

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| **Snapshot (Smooth)** | **Wireframe** | **Notes** |
|  |  | The surface in file “11.1-SurfaceCone.wrl” is an Surface Cone defined by parametric equations  x=v\*cos(u\*2\*pi);  y=v\*sin(u\*2\*pi);  z=v;  The parameter domain is .  The sampling resolution is [32 1 1]. |
|  |  | The solid in file “11.2-SolidCone.wrl” is an Solid Cone defined by parametric equations  x=v\*(1-w)\*cos(u\*2\*pi);  y=v\*(1-w)\*sin(u\*2\*pi); z=v;  We converted the surface cone into a solid cone by inserting another parameter w, specifically \*(1-w), to fill the cone, turning it into a a solid.  The parameter domain is .  The sampling resolution is [32 1 1]. |
|  |  | The surface in file “11.3-SurfaceCylinder.wrl” is an Surface Cylinder defined by parametric equations  x=0.5\*cos(u\*2\*pi);  y=0.5\*sin(u\*2\*pi);  z=-1+(1-(-1))\*v;  The parameter domain is .  The sampling resolution is [32 1 1]. |
|  |  | The solid in file “11.4-SolidCylinder.wrl” is an Solid Cylinder defined by parametric equations  x=w\*0.5\*cos(u\*2\*pi);  y=w\*0.5\*sin(u\*2\*pi);  z=-1+(1-(-1))\*v;  We converted the surface cone into a solid cone by inserting another parameter w to fill the cylinder, turning it into a a solid.  The parameter domain is .  The sampling resolution is [32 1 1]. |

# Exercise 12 – Sine

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| **Snapshot (Smooth)** | **Wireframe** |
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| **Notes** | |
| The solid in file “12.1-Sine.wrl” is an Solid sine curve defined by parametric equations  x=(0.1\*v\*cos(pi\*2\*u)+1\*w+0.1)\*sin(w\*10\*pi+pi/2);  z=(0.1\*v\*cos(pi\*2\*u)+1\*w+0.1)\*cos(w\*10\*pi+pi/2);  y=-1\*w+0.1\*(sin(2\*u\*pi));  The parameter domain is .  The sampling resolution is [75 75 75].  Open the file to see animation. | |

# Exercise 13 – Extras

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| **Snapshot (Smooth)** | **Wireframe** |
|  | v |
| **Notes** | |
| The solid in file “13-flower.wrl” is an Solid flower curve defined by parametric equations  z=(0.5\*w\*sin(4\*u\*1\*pi)\*cos(u\*2\*pi)+1)\*cos(v\*1.5\*pi+0.5\*pi);  x=(0.5\*w\*sin(4\*u\*1\*pi)\*cos(u\*2\*pi)+1)\*sin(v\*1.5\*pi+0.5\*pi);  y=(0.5\*w\*sin(4\*u\*1\*pi)\*sin(u\*2\*pi)-1)+2\*v;  The parameter domain is .  The sampling resolution is [100 100 30].  Open the file to see animation. | |