Nanyang Technological University

Lab 3 Report: Parametric Solids

CZ2003 Computer Graphics and Visualization

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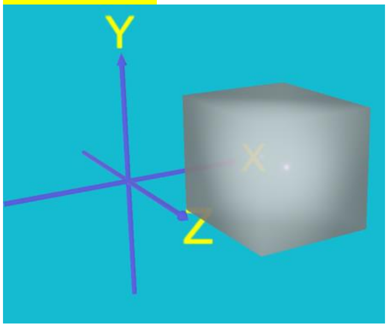
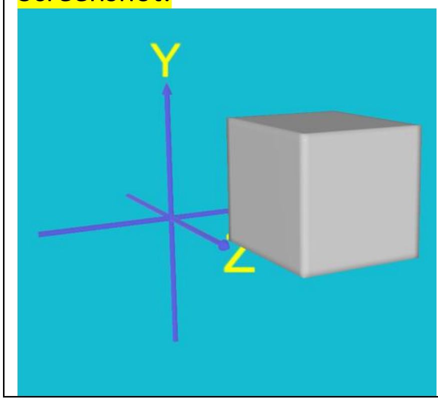
N, M values: [N: 1, M: 10]

1. Define parametrically using functions $x(u, v, w)$, $y(u, v, w)$, $z(u, v, w)$, $u, v, w \in [0,1]$ in 4 separate files and display:

<table>
<tr>
<th>1a. A solid box with the sides parallel to the coordinate planes and the coordinates of two opposite vertices (N, 0, M), (N+M, M, 2(N+M))).</th>
<th>1b. A solid three-sided pyramid with the vertices of the base with coordinates (0,0,0), (N,0,0), (0,0,M), and the apex at (0,N+M,0).</th>
</tr>
<tr>
<td>
Vertex 1 Coordinates: [1, 0, 10]
Vertex 2 Coordinates: [11, 10, 22]

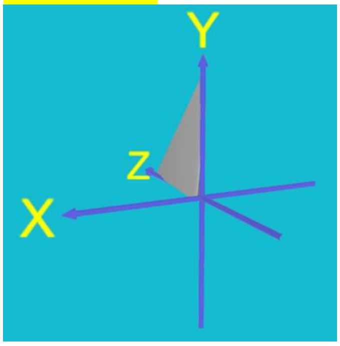
Parametric Definition:
$x(u, v, \mathrm{w}) = 10\mathrm{u} + 1$
$y(u, v, \mathrm{w}) = 10\mathrm{v}$
$\mathrm{z}(u, v, \mathrm{w}) = 12\mathrm{w} + 10$
$u \in [0,1]$
$v \in [0,1]$
$\mathrm{w} \in [0,1]$

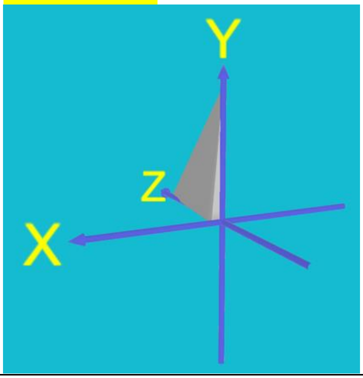
File: 1a(Reso 1).Func
Resolution: 1 1 1
Screenshot:


File: 1a(Reso 20).Func
Resolution: 20 20 20
Screenshot:


</td>
<td>
Vertex 1 Coordinates: [0, 0, 0]
Vertex 2 Coordinates: [1, 0, 0]
Vertex 3 Coordinates: [0, 0, 10]
Apex Coordinates: [0, 11, 0]

Parametric Definition:
$x(u, v, \mathrm{w}) = (\mathrm{u} - \mathrm{uv})(1 - \mathrm{w})$
$y(u, v, \mathrm{w}) = 11\mathrm{w}$
$\mathrm{z}(u, v, \mathrm{w}) = 10\mathrm{v}(1 - \mathrm{w})$
$u \in [0,1]$
$v \in [0,1]$
$\mathrm{w} \in [0,1]$

File: 1b(Reso 1).Func
Resolution: 1 1 1
Screenshot:


File: 1b(Reso 7).Func
Resolution: 7 7 7
Screenshot:


</td>
</tr>
</table>

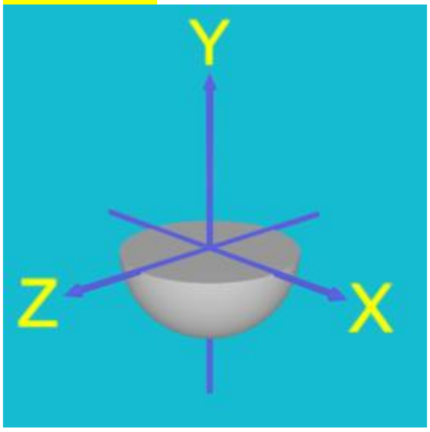
Observations: Length of box = 22 – 10 = 12 (Z-axis) Width of box = 11 – 1 = 10 (X-axis) Height of box = 10 – 0 = 10 (Y-axis) Minimum x-coordinate of box is 1, hence the box is to be displaced by 1 unit positively from the x-axis. Minimum z-coordinate of the box is to be displaced by 10 units positively from the z-axis, giving you the abovementioned parametric equation. Minimum sampling resolution is 20 as seen from 1a(Reso 1).Func, when sampling resolution is too low, the box plot is too blur and the edges are not well defined.	Observations: We first plot the base of the 3-sided pyramid using vertices 1, 2, 3 as well as a vertex 4 which can be any one of the 3 initial vertices using the formula: p1 + u(p2 – p1) + v(p3 – p1 + u(p4 – p3 – (p2 – p1))). We get: x(u,v,w) = u – uv y(u,v,w) = 0 z(u,v,w) = 10v Taking into account the distance from the base to apex, we add 11w to y-axis after which we multiply x-axis and z-axis by (1-w) in order to flatten the sides towards the apex, resulting in the abovementioned parametric equation of the pyramid. Sampling Resolution chosen is 7 as through trial and error, 7 seems to be the minimum resolution in which a clearly edged 3 sided pyramid can be plotted. When the resolution is too low, as seen in 1b(1 Reso).Func, the edges are not well defined

1c. A lower half of the origin-centered solid sphere with radius ***N***.

Radius = 1

Parametric Definition:
$x(u, v, w) = \cos(\pi u)$
$y(u, v, w) = \sin(\pi u)\sin(-\pi v)w$
$z(u, v, w) = \sin(\pi u)\cos(-\pi v)$
$u \in [0,1]$
$v \in [0,1]$
$w \in [0,1]$

File: 1c(Reso 30).Func
Resolution: 30 30 30
Screenshot:



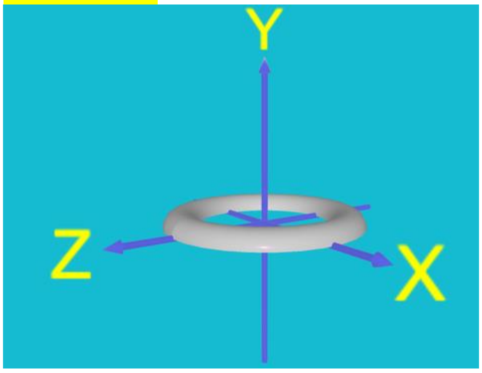
Observations:
Sampling Resolution chosen is 30 as through trial and error, 30 seems to be the minimum resolution in which a clear and smooth sphere can be plot. When the resolution is too low, the edges of the solid sphere become very distinct and rough

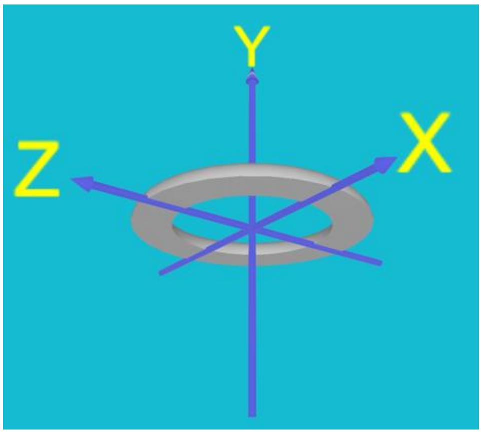
1d. An upper half of the torus which axis is the vertical axis Y. The radius of the torus tube is $\frac{N}{5}$. The distance from axis Y to the center of the torus tube is ***N***.

Radius = 1/5 = 0.2
Distance from axis Y to center = 1

Parametric Definition:
$x(u, v, w) = (0.2\cos(\pi u)+1)\sin(2\pi v)$
$y(u, v, w) = [0.2\sin(\pi u)]w$
$z(u, v, w) = (0.2\cos(\pi u)+1)\cos(2\pi v)$
$u \in [0,1]$
$v \in [0,1]$
$w \in [0,1]$

File: 1d(Reso 70).Func
Resolution: 70 70 70
Screenshot:





Observations:
First, we plot a half a circle with radius 0.2 whose origin is 1 unit away from the x-axis on the YX plane.

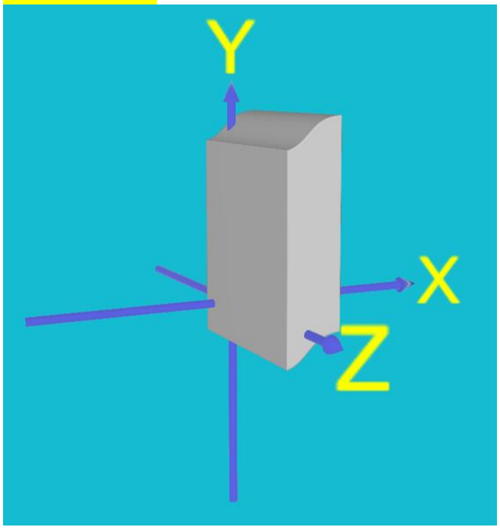
	We get: $x(u, v, w) = 0.2\cos(\pi u)+1$ $y(u, v, w) = 0.2\sin(\pi u)$ $z(u, v, w) = 0$ Now we conduct rotational sweeping about the y axis, this is done by first substituting x(u,v,w) into z(u,v,w) $x(u, v, w) = 0.2\cos(\pi u)+1$ $y(u, v, w) = 0.2\sin(\pi u)$ $z(u, v, w) = 0.2\cos(\pi u)+1$ We then conduct the rotational sweeping about the y axis and adding w variable to y in order to fill the hollow shape: $x(u, v, w) = (0.2\cos(\pi u)+1)\sin(2\pi v)$ $y(u, v, w) = [0.2\sin(\pi u)]w$ $z(u, v, w) = (0.2\cos(\pi u)+1)\cos(2\pi v)$ Sampling Resolution chosen is 70 as through trial and error, 70 seems to be the minimum resolution in which a clear and smooth upper torus can be plot. When the resolution is too low, the edges of the torus become very distinct and rough

2. Define parametrically using functions $x(u, v, w)$, $y(u, v, w)$, $z(u, v, w)$, $u, v, w \in [0,1]$ a solid object created by translational sweeping of the surface obtained in experiment 2 (exercise 2) along Axis Y so that its lowest point moves from $y = -\boldsymbol{N}$ to $y = \boldsymbol{N} + \boldsymbol{M}$.

Lowest Point: -1
Highest Point: 1 + 10 = 11

Parametric Equation:
$x(u)$ = 3.3u – 1.3
$y(u)$ = [tanh(3.3u – 1.3)] - 1 + 12w
z(u) = -1 + 11v
$u \in [0,1]$
$v \in [0,1]$
w $\in$ [0,1]

File: 2(30 Reso).Func
Resolution: 30 30 30
Screenshot:



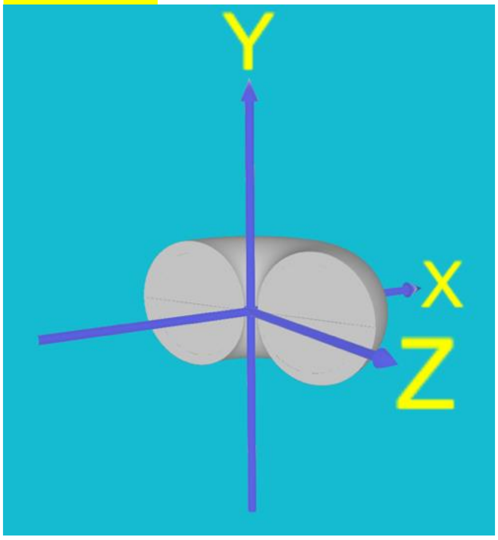
Observation:
From experiment 2, question 2:

Parametric Definition:
$x(u,v,w)$ = 3.3u – 1.3
$y(u,v,w)$ = tanh(3.3u – 1.3)
z(u,v,w) = -1 + 11v
$u \in [0,1]$
$v \in [0,1]$

3. Define parametrically using functions $x(u, v, w)$, $y(u, v, w)$, $z(u, v, w)$, $u, v, w \in [0,1]$ a solid object created by filling in the surface defined in experiment 2 exercise 3).

Parametric Equation:
$x(u,v,w) = ((w(1\text{-}15\cos(2\pi u)))(\cos(2\pi u))–1)(\sin(-\pi v + \frac{3\pi}{20}))$
$y(u,v,w) = (w(1\text{-}15\cos(2\pi u)))(\sin(2\pi u))$
$z(u,v,w) = ((w(1\text{-}15\cos(2\pi u)))(\cos(2\pi u))–1)(\cos(-\pi v + \frac{3\pi}{20}))$
$u \in [0,1]$
$v \in [0,1]$
w $\in$ [0,1]

File: 3(150 Reso).Func
Resolution: 150 150 150
Screenshot:



Observation:
From experiment 2, question 3:

Parametric Definition:
$x(u,v) = ((1 - 15\cos(2\pi u))(\cos(2\pi u)) – 1)(\sin(-\pi v + \frac{3\pi}{20}))$
$y(u,v) = (1 - 15\cos(2\pi u))\sin(2\pi u)$
$z(u,v) = ((1 - 15\cos(2\pi u))(\cos(2\pi u)) – 1)(\cos(-\pi v + \frac{3\pi}{20}))$
$u \in [0,1]$
$v \in [0,1]$

All we need to do now is to do a translation along y axis from y = -1 to y = 11, hence add the equation for the y-term with -1 + 12w in order to translate the curve accordingly Sampling Resolution chosen is 30 as through trial and error, 30 seems to be the minimum resolution in which a clear and smooth solid can be plot. When the resolution is too low, the edges of the solid become very distinct and rough	All we need to do now is to fill the above defined shape, hence, multiply each equation x(u,v,w), y(u,v,w) and z(u,v,w) with w to get the observed solid shape and the above mentioned equation Sampling Resolution chosen is 150 as through trial and error, 150 seems to be the minimum resolution in which a clear and smooth solid can be plot. When the resolution is too low, the edges of the solid become very distinct and rough