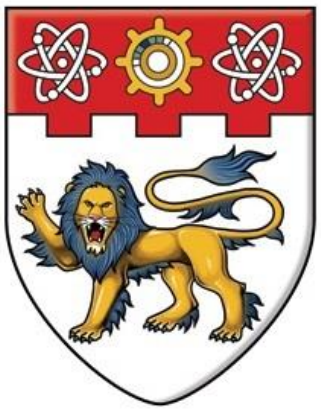

NANYANG TECHNOLOGICAL UNIVERSITY

CZ2003 Computer Graphics and Visualization

Lab 4: Implicit Solids

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SSP1

The figure that is made for this lab can be found in the file “**Lab 4 Solid.wrl**”.

The figure is made using:

- 9 half spaces
- 1 sphere
- 2 cylinders
- 3 ellipsoids
- 1 cone

The figure is defined by Union, Intersection and subtraction of the different shapes using min/max function.

The figure is also defined by a variable colour whose values are within [0, 1] interval on the visible surfaces of the figure.

The different shapes used are:

- **Half Spaces:**
  - hs_1 = -y
  - hs_2 = y+1
  - hs_3 = 1-x-y-2*z
  - hs_4 = 1+x-y-2*z
  - hs_5 = -0.9-y
  - hs_6 = 0.4-x
  - hs_7 = x+0.4
  - hs_8 = z+0.4
  - hs_9 = 0.4-z
- **Sphere:**
  - sphere = $0.2^2 - x^2 - y^2 - (z-0.35)^2$
- **Cylinder:**
  - cylinder_1 = min (min ($0.08^2 - (x+0.2)^2 - (y-0.3)^2$, 2-z), z)
  - cylinder_2 = min (min ($0.08^2 - (x-0.2)^2 - (y-0.3)^2$, 2-z), z)
- **Ellipsoid:**
  - ellipsoid_1 = $1 - (x/0.5)^2 - (y/0.7)^2 - (z/0.55)^2$
  - ellipsoid_2 = $1 - (x/0.8)^2 - ((y+0.3)/0.1)^2 - (z/0.6)^2$
  - ellipsoid_3 = $1 - (x/0.67)^2 - ((y+0.5)/0.1)^2 - (z/0.5)^2$
- **Cone:**
  - cone = $(y/3.65)^2 - (x/1.2)^2 - (z/1.2)^2$

The figure contains a body, a pedestal and a stand

The pedestal is created by the intersection of *cone*, *hs_1*, and *hs_2.*

This process in VRML is shown below:

pedestal = min (min (cone, hs_1), hs_2)

The stand is created by the intersection of *hs_2*, *hs_5*, *hs_6*, *hs_7*, *hs_8*, *hs_9*.

This process in VRML is shown below:

stand = min (min (min (min (min (hs_5, hs_2), hs_6), hs_7), hs_8), hs_9)

The body is formed by the union of *ellipsoid_1*, *ellipsoid_2*, *ellipsoid_3* followed by the intersection with *hs_2* and *hs_4*. It is then combined with *sphere* using the max function and then *cylinder_1* and *cylinder_2* are subtracted from this object.

This process in VRML is shown below:

body = max (min (min (max (max (min (min (ellipsoid_1, hs_3), hs_4), ellipsoid_2), ellipsoid_3), -cylinder_1), -cylinder_2), sphere)

The final figure is created from the union of the body, pedestal and stand.

This process in VRML is shown below:

final = max (max (body, stand), pedestal)

The tight bounding box (nearly touching the shape) and resolution is kept as less in order to fit the shape and render it within five seconds:

bboxCenter 0 -0.15 0

bboxSize 1.6 1.7 1.2

resolution [100 200 100]

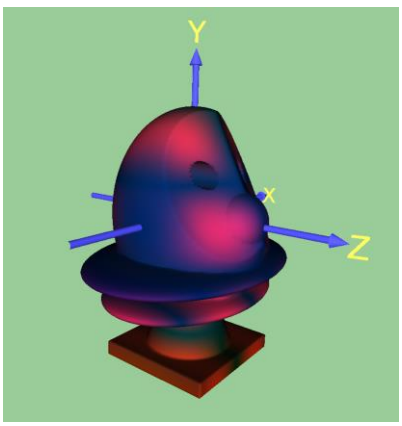
The variable colour of the implicitly defined figure is defined by colour functions r(u,v,w), g(u,v,w), b(u,v,w) (defined parametrically) as follows:

$r = fabs (sin (2*\pi*u) * cos (2*\pi*v))$

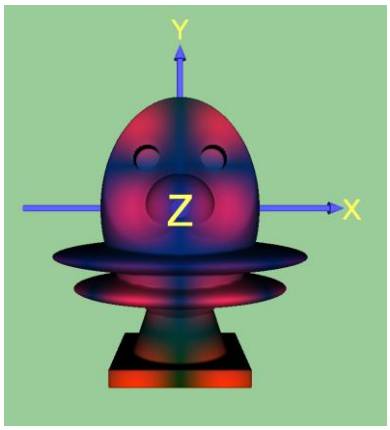
$g = ((1 - w*w) / 2) * sin ((1 - u*u) / 2)$

$b = (1 - v*v)/2$

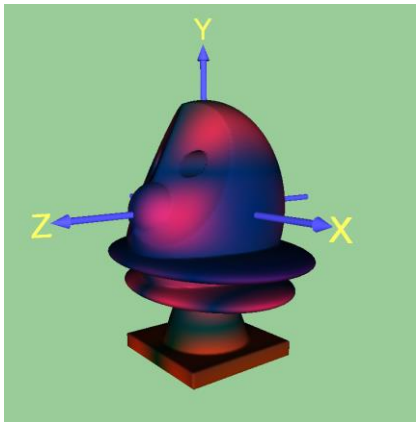
The final implicit solid is shown below:



Left View



Front View

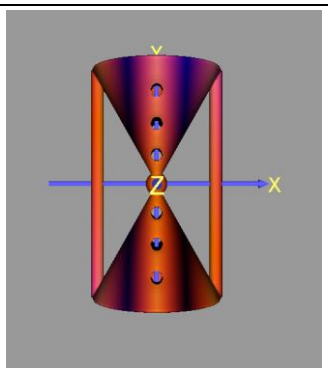
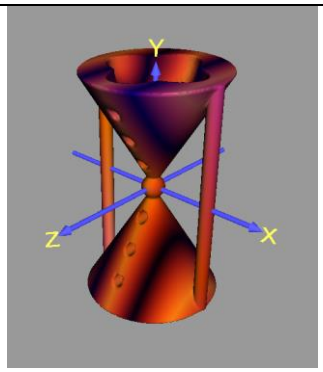


Right View

Extra Figures

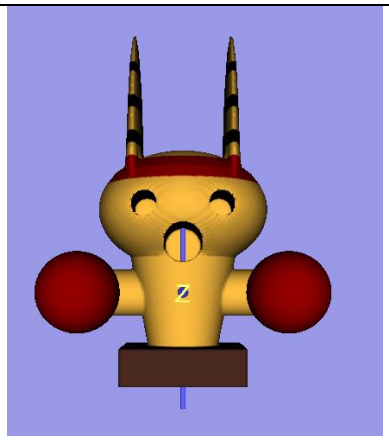
The figures below can be found in the "**Lab 4 Extras**" folder.

Note: These figures may not meet the requirement of appearing on the screen within 5 seconds and they are not included in the compulsory part.

Figure Number	Figure and its Properties
Figure 1	  Above is a snapshot of "**Extra 1.wrl**". It is made using the following shapes: • Half Spaces: ○ half_space_1 = y+1 ○ half_space_2 = 1-y • Cones: ○ cone_1 = $(y/2)^2-(x/1.2)^2-(z/1.2)^2$ • Cylinders: ○ cylinder_1 = min (min ($0.06^2-(x+0.55)^2-z^2$, half_space_1), half_space_2) ○ cylinder_2 = min (min ($0.06^2-(x-0.55)^2-z^2$, half_space_1), half_space_2) ○ cut_1 = $0.05^2-x^2-(y+0.25)^2$ ○ cut_2 = $0.05^2-x^2-(y+0.5)^2$ ○ cut_3 = $0.05^2-x^2-(y+0.75)^2$ ○ cut_4 = $0.05^2-x^2-(y-0.25)^2$

	○ cut_5 = 0.05^2-x^2-$(y-0.5)^2$ ○ cut_6 = 0.05^2-x^2-$(y-0.75)^2$ • Ellipsoids: ○ ellipsoid_1 = 1-$(x/0.25)^2$-$((y-1)/0.3)^2$-$(z/0.45)^2$ ○ ellipsoid_2 = 1-$(x/0.25)^2$-$((y+1)/0.3)^2$-$(z/0.45)^2$ ○ ellipsoid_3 = 1-$(x/0.45)^2$-$((y-1)/0.3)^2$-$(z/0.25)^2$ ○ ellipsoid_4 = 1-$(x/0.45)^2$-$((y+1)/0.3)^2$-$(z/0.25)^2$ • Spheres: ○ sphere = 0.1^2 - x^2 - y^2 - z^2 The figure is created by the following definitions: cone = min (min (cone_1, half_space_1), half_space_2) solid = max (min (min (min (min (max (max (cone, cylinder_1), cylinder_2), -ellipsoid_1), -ellipsoid_2), -ellipsoid_3), -ellipsoid_4), sphere) final = min (min (min (min (min (min (solid, -cut_1), -cut_2), -cut_3), -cut_4), -cut_5), -cut_6) The tight bounding box (nearly touching the shape) and resolution is kept as less in order to fit the shape and render it within five seconds: ***bboxCenter*** 0 0 0 ***bboxSize*** 1.3 2.1 1.3 ***resolution*** [120 100 100] **Colour Definition**: r = fabs(cos(2*pi*(1-u))) g = (1-fabs(sin(2*pi*u)))/2 b = fabs(u+v+w)/3

Figure 2



Above is a snapshot of "**Extra 2.wrl**". It is made using the following shapes:

- Half Spaces:
  - hs_1 = 0.5-x
  - hs_2 = x+0.5
  - hs_3 = y+0.75
  - hs_4 = -0.45-y
  - hs_5 = z+0.3
  - hs_6 = 0.5-z

- Spheres:
  - palm_1 = $0.3^2-(x+0.75)^2-y^2-(z-1)^2$
  - palm_2 = $0.3^2-(x-0.75)^2-y^2-(z-1)^2$

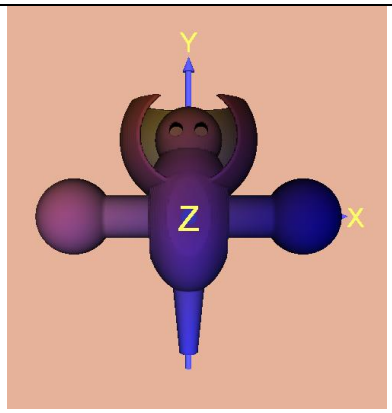
- Ellipsoids:
  - ellipsoid = $1-((y-0.7)/0.5)^2-(x/0.7)^2-(z/0.7)^2$
  - ear_1 = $1-((x+0.4)/0.07)^2-((y-0.7)/1.5)^2-(z/0.5)^2$
  - ear_2 = $1-((x-0.4)/0.07)^2-((y-0.7)/1.5)^2-(z/0.5)^2$

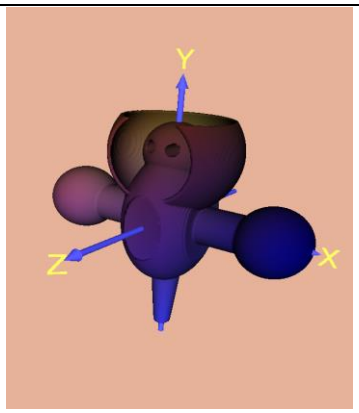
- Cylinders:
  - cylinder = min (min ($0.2^2-y^2-z^2$, x+0.75), 0.75-x)
  - hand_1 = min (min ($0.2^2-y^2-(x+0.75)^2$, z), 1-z)
  - hand_2 = min (min ($0.2^2-y^2-(x-0.75)^2$, z), 1-z)
  - eye_1 = min ($0.1^2-(x+0.3)^2-(y-0.7)^2$, z)
  - eye_2 = min ($0.1^2-(x-0.3)^2-(y-0.7)^2$, z)
  - mouth = min ($0.15^2-x^2-(y-0.4)^2$, z+0.05)

- Cones:
  - cone = $((y+2)/6.32)^2-(x/1.2)^2-(z/1.2)^2$

	The figure is created by the following definitions:
	
	base = min (min (cone, y+0.5), 1-y)
	
	box = min (min (min (min (min (hs_1, hs_2), hs_3), hs_4), hs_5), hs_6)
	
	ear = min (max (ear_1, ear_2), -(0.7-y))
	
	final = min (min (min (max (max (max (max (max (max (max (box, base),
	ellipsoid), ear), cylinder), hand_1), hand_2), palm_1), palm_2), -eye_1), -eye_2),
	-mouth)
	
	The tight bounding box (nearly touching the shape) and resolution is kept as less in order to fit the shape and render it within five seconds:
	
	bboxCenter 0 0.725 0.3
	bboxSize 2.1 2.95 2
	resolution [110 100 125]
	
	The colour definition of the figure is:
	
	function frep(x,y,z){
	colour = 1;
	if(z>0.45) colour = 0.5;
	if(z>0.5) colour = 1;
	if(z>0.55) colour = 0.5;
	if(z>0.6) colour = 1;
	if(z>0.65) colour = 0.5;
	if(z>0.7) colour = 1;
	if(y>0.2) colour = 1;
	if(y<-0.2) colour = 1;
	if(y<=-0.44) colour = 0;
	if(y>0.9) colour = 0.75;
	if(y>1.1) colour = 1;
	if(y>1.2) colour = 0.5;
	if(y>1.3) colour = 1;
	if(y>1.5) colour = 0.5;
	if(y>1.6) colour = 1;
	if(y>1.8) colour = 0.5;
	if(y>1.9) colour = 1;
	if(z>=0.75) colour = 0.75;
	patternValue(colour); }
	
	patternColor [0.29 0.16 0.13 0 0 0 0.6 0 0 1 0.75 0.25]
	patternKey [0 0.5 0.75 1]

Figure 3





Above is a snapshot of "**Extra 3.wrl**". It is made using the following shapes:

- Half Spaces:
  - half_space_1 = 0.25-x
  - half_space_2 = x+0.25
  - half_space_3 = 0.35-z
  - half_space_4 = z+0.35

- Ellipsoid:
  - ellipsoid = $1-(x/0.3)^2-(y/0.5)^2-(z/0.4)^2$

- Spheres:
  - sphere = $0.22^2-x^2-(y-0.50)^2-z^2$
  - cape_1 = $0.45^2-x^2-(y-0.50)^2-z^2$
  - cape_2 = $0.43^2-x^2-(y-0.50)^2-z^2$
  - palm_1 = $0.25^2-(x-0.75)^2-y^2-z^2$
  - palm_2 = $0.25^2-(x+0.75)^2-y^2-z^2$

- Cone:
  - cone = min (min $(((y+1.5)/2)^2-(x/0.2)^2-(z/0.2)^2$, 0.4-y), y+0.9)

- Cylinders:
  - cylinder = min (min $(0.14^2-y^2-z^2$, x+0.75), 0.75-x)
  - eye_1 = min $(0.044^2-(x+0.08)^2-(y-0.55)^2$, z+0.02)
  - eye_2 = min $(0.044^2-(x-0.08)^2-(y-0.55)^2$, z+0.02)

The figure is created by the following definitions:

cape = min (min (min (cape_1, -cape_2),0.75-y), 0.32-z)

hands = max (max (cylinder, palm_1), palm_2)

	body = max (max (min (min (min (min (ellipsoid, half_space_1), half_space_2), half_space_3), half_space_4), cone), cape) head = min (min (sphere, -eye_1), -eye_2) final = max (max (head, body), hands) The tight bounding box (nearly touching the shape) and resolution is kept as less in order to fit the shape and render it within five seconds: ***bboxCenter*** 0 -0.075 -0.05 ***bboxSize*** 2 1.65 0.80 ***resolution*** [120 120 100] The colour definition of the figure is: r = fabs((1-u)/3+0.1*v) g = fabs((1-w)/2*sin((1-u)/2)) b = fabs((1-v)/2)