425 Applied 3D Algebra

HW 6

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1.

Do these objects intersect?

C1 = (-0.80, 0.60, 0.20)

R1 = 3

W1

$$\begin{pmatrix} -1.414 & 0.8165 & -1.155 & 3 \\ 0 & 1.633 & 1.1547 & 1 \\ 1.4142 & 0.8165 & -1.155 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix}$$

C2 = (1.00, 1.00, 0.20)

R2 = 6

W2

$$\begin{pmatrix} 0 & -1.664 & 2.4962 & -3 \\ 0 & 2.4962 & 1.6641 & 5 \\ -3 & 0 & 0 & 2 \\ 0 & 0 & 0 & 1 \end{pmatrix}$$

Remember that points have a w of 1!

Find C1` = W1 * C1

C1` = (4.3901, 2.21074, -0.87246)

Find a1 = ||V1side|| = sqrt(-1.414^2 + 0 + 1.4142^2)

A1 = 1.9998

Find r1` = r1 * a1 = 3 * 1.99984 = 5.99952

Find C2` = W2 * C2

C2` = (-4.16476, 7.82902, -1)

Find a2 = ||V2side || sqrt(-3^2)

a2 = 3

Find r2` = r2 * a2 = 6 *3 = 18

C1` - C2` = (8.55486, -5.61828, 0.12754)

|| C1` - C2`|| = sqrt(8.55486^2 + -5.61828^2 + 0.12754^2)

|| C1` - C2`|| = 10.23557

r1` + r2` = 19.9998

Check if: if true, we are intersecting.

||C1` - C2`|| < r1` + r2`

10.23557 < 19.9998

C1 and C2 ARE intersecting

2.

Do these two objects intersect?

Object 1		Object2	
AABB:	Min = (-150, 90, 60)	C2` = WC = (-156, 85, 56)	
	Max = (-147, 95, 61)	r2` = sr = 6	

X min/max = (-150, -147)
Y min/max = (90, 95)
Z ,min/max = (60, 61)

Find C1` by checking xyz min/max against C2` xyz positions. Follow these rules
C2` element < C1` element min
If false, then -> C1` element max < C2` element
If false, then -> Take C2 element

C1` = (-150, 90, 60)

Check if clamped point is inside bsphere

C1` - C2` = (6, 5, 4)

||C1` - C2`|| >= r2` If true, we aren't intersecting

||C1` - C2`|| = sqrt(36 + 25 + 16) = 8.774964
8.774964 > 6
<u>Object 1 and 2 ARE NOT intersecting</u>

3.

Do these two objects intersect?

Object 1		Object 2	
OBB:	Min = (-1, 3, -4)	C2` = WC = (30.0, 38.0, -40.0)	
	Max =(2, 5, 2)	r2` = sr = 4	

$$W1 = \begin{pmatrix} 3.5355 & 0 & -3.536 & 40 \\ 0 & 5 & 0 & 40 \\ 3.5355 & 0 & 3.5355 & -40 \\ 0 & 0 & 0 & 1 \end{pmatrix}$$

Computer Bsphere in OBB local space.

Inverse OBB World

$$W1^{-1} = \begin{pmatrix} 0.14141 & 0 & 0.14143 & 0.0008 \\ 0 & 0.2 & 0 & -8 \\ -0.14141 & 0 & 0.14141 & 11.31302 \\ 0 & 0 & 0 & 1 \end{pmatrix}$$

C1` = W1^-1 * C2` = (-1.4141, -0.4, 1.4141)

Clamp C1` along each axis. Follow these rules:
For each option, if true, take OBB element being tested
C1` element < OBB element min
If false, then -> OBB element max < C1` element
If false, then -> Take C1 element

Clamped = (-1, 3, 1.414)

Computer clamped C` to world space

$$W1 = \begin{pmatrix} 3.5355 & 0 & -3.536 & 40 \\ 0 & 5 & 0 & 40 \\ 3.5355 & 0 & 3.5355 & -40 \\ 0 & 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} -1 \\ 3 \\ 1.414 \\ 1 \end{pmatrix} \text{Clamped}$$

Q` = (31.464596, 55, -38.536303)

Now to see if OBB is within the Bsphere
Q` - C2 = (31.464596, 55, -38.536303) – (30.0, 38.0, -40.0)
Q` - C2 = (1.464596, 17, 1.463697)

|| Q` - C2|| = sqrt(1.464596^2 + 17^2 + 1.463697^2) = 17.12564

17.12564 >= 4
Object 1 and 2 ARE NOT intersecting

4.

Do these two intersect?

Object 1:

OBB Min = (-2.50, -2.00, -1.00)
Max = (3.50, 2.00, 1.00)

$$W1 = \begin{pmatrix} s1 & u1 & f1 & \\ -0.474 & -0.048 & -0.151 & 0 \\ 0 & 0.4767 & -0.151 & 4 \\ 0.1581 & -0.143 & -0.452 & -2 \\ 0 & 0 & 0 & 1 \end{pmatrix}$$

W1 S^2 = 0.249906

Object 2:

OBB Min = (-4.75, -5.00, -3.50)
Max = (5.25, 5.00, 4.50)

$$W2 = \begin{pmatrix} s2 & u2 & f2 & \\ 0.3536 & -0.289 & -0.204 & 4 \\ 0 & .02887 & -0.408 & 1 \\ 0.3536 & 0.2887 & 0.2041 & -6 \\ 0 & 0 & 0 & 1 \end{pmatrix}$$

W2 S^2 = 0.24973681

a.

Object 1's forward axis
f1 = (-0.151, -0.151, -0.452)

Object 2's up axis
u2 = (-0.289, 0.2887, 0.2887)

Cross product of both above axes
f1 x u2 = (0.0868987, 0.1742217, -0.0872327)

b.

For each axes, perform SAT overlap test. B and C are answered in the table below.

Sf1 = -0.151^2 + -0.151^2 + -0.452^2
Sf1 = 0.249906

||f1|| = sqrt(S1) = sqrt(0.249906)
||f1|| = 0.49991

Su2 = -0.289^2 + 0.2887^2 + 0.2887^2
Su2 = 0.25022
||u2||= 0.50022

Sfxu = = (0.0868987^2 + 0.1742217^2 + -0.0872327^2)
Sfxu = 0.04551

||Sfxu|| = sqrt(0.04551)
||fxu|| = 0.21334

C1 = (P1max + P1min)/2 = (1, 0, 0)/2 = (0.5, 0, 0)

C2 = (P2max + P2min)/2 = (0.5, 0, 1)/2 = (0.25, 0, 0.5)

C2-C1 = (-0.25, 0, 0.5)

a b c

D1 = P1Max – C1 = (3, 2, 1)

D2 = P2Max – C2 = (5, 5, 4)

W1^-1 =

s1	u1	f1	
-1.8981	-0.0008	0.6344	1.2721
-0.1911	1.9066	-0.5731	-8.7725
-0.6034	-0.6035	-1.8092	-1.2045
0	0	0	1

Let's do world 1 together

V local 1 (v1`f1) = W1^-1 * f1 = (-0.0000149, 0.0000007, 1.0000003)

|V1`f1 * d1| = |(-0.0000149, 0.0000007, 1.0000003).dot(3, 2, 1)|

= |-0.0000447 + 0.0000014 + 1.0000003|

= 0.999957

Proj_max1 f1 = |v1f1.dot(d1)|/||f1|| = 0.999957/0.49991

= 2.000274049

V local 1 u2 = W1^-1 * u2 = (0.73147122, 0.44020935, -0.52216389)

|v1u2.dot(d1)| = |(0.73147122, 0.44020935, -0.52216389).dot(3,2,1)|

= 2.55319346

Proj_max1 u2 = |v1u2.dot(d1)|/||u2|| =2.55319346/0.50022

= 5.104141098

v local 1 (v1`fxu) = W1^-1 * fxu =(-0.22042222471, 0.36555781202, 0.00024392931)

|v1fxu.dot(d1)| = |(-0.22042222471, 0.36555781202, 0.00024392931).dot(3,2,1)|

= |-0.66126667413 + 0.73111562404 + 0.00024392931|

= 0.0700928793

Proj_max1 fxu = |v1fxu.dot(d1)|/||fxu|| = 0.0700928793/0.21334

= 0.3285501045

Now for World 2

W2^-1 =

s2	u2	f2	
1.4137	0.0007	1.4144	2.8311
-1.1541	1.1544	1.1541	10.3867
-0.8166	-1.6341	0.8166	9.8006
0	0	0	1

V local 2 (v2`f1) = W2^-1 * f1 = (-0.8528832, -0.5216985, 0.0009525)
|v2f1.dot(d2)| =| (-0.8528832, -0.5216985, 0.0009525).dot(5, 5, 4)|
= |-4.264416 + -2.6084925 + 0.00381|
= 6.8690985
Proj_max2 f1 = |v2f1.dot(d2)|/||f1|| = 6.8690985/0.49991
= 13.74067032

v local 2 (v2`u2) = W2^-1 * u2 = (-0.00001993, 0.99999885, -0.00001485)
|v2`f1.dot(d2)| = |(-0.00001993, 0.99999885, -0.00001485).dot(5,5,4)|
= |-0.00009965 + 4.99999425 + -0.0000594)|
= 4.9998352
Proj_max2u2 = |v2`f1.dot(d2)|/||u2|| = 4.9998352/0.50022
= 9.99527248

v local 2 fxu = W2^-1 * fxu = (-0.0004112835, 0.00015648174, -0.42689138121)
|v2`fxu.dot(d2)| = |(-0.0004112835, 0.00015648174, -0.42689138121).dot(5,5,4)|
= |-0.0020564175 + 0.0007824087 + -1.707565525|
= 1.708839534
Proj_max2fxu = |v2`fxu.dot(d2)|/||fxu|| = 1.708839534/0.21334
= 0.3645638262

Now plug everything into the table!

W1 S^2 = 0.249906 W2 S^2 = 0.24973681
C2-C1 = (-0.25, 0, 0.5)
f1 = (-0.151, -0.151, -0.452) ||f1|| = 0.49991
u2 = (-0.289, 0.2887, 0.2887) ||u2||= 0.50022
f1 x u2 = (0.0868987, 0.1742217, -0.0872327) ||fxu|| = 0.21334

|(C2-C1).dot(vf1)|/||f1|| = (-0.25, 0, 0.5) (-0.151, -0.151, -0.452)/0.49991
= 0.18825/0.49991
= 0.3765677822

|(C2-C1).dot(vu2)|/||u2|| = (-0.25, 0, 0.5) (-0.289, 0.2887, 0.2887)/ 0.50022
= 0.2166/0.50022
= 0.4330094758
|(C2-C1).dot(vfxu)|/||fxu|| = (-0.25, 0, 0.5) (0.0868987, 0.1742217, -0.0872327)/ 0.21334
= 0.065341025/0.21334
= 0.3062764835

Axes Label	f1	u2	f1xu2
Axes (v)	-0.151 -0.151 -0.452	-0.289 0.2887 0.2887	0.0868987 0.1742217 -0.0872327
Length	0.49991	0.50022	0.21334
v local 1 (W1^-1*v)	-0.237 0 0.07905	0.73147122 0.44020935 -0.52216389	-0.22042222471 0.36555781202 0.00024392931
Proj_max1	2.000274049	5.104141098	0.3285501045
Rho1 = proj_max1 * s1^2	0.4998805	1.275555485	0.0821066424
v local 2 (W2^-1*v)	-0.8528832 -0.5216985 0.0009525	-0.00001993 0.99999885 -0.00001485	-0.0004112835 0.00015648174 -0.42689138121
Proj_max 2	13.74067032	9.99527248	0.3645638262
Rho = proj_max2 * s2^2	3.431551173	2.496187464	0.091045007
D = |(C2-C1).dot(v)|/||v||	0.3765677822	0.4330094758	0.3062764835
rho1+rho2	3.931431673	3.771742949	0.1731516494
Overlap: D <= rho1 + rho2	CLEAR	CLEAR	OBB'S INTERSECT ALONG F1xU2