HW6

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① We will use this equation:

$$\|c_1' - c_2'\| < r_1 + r_2$$

We begin by calculating c_1' and c_2'

$$W_1 c_1 = \begin{bmatrix} -1.109 & -1.064 & 1.2792 & 3 \\ 0 & 1.5374 & 1.2792 & 4 \\ -1.664 & .7096 & -.0853 & -1 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} .6 \\ -1 \\ 0 \\ 1 \end{bmatrix} = \begin{bmatrix} 3.3986 \\ 2.4626 \\ -2.708 \\ 1 \end{bmatrix} = c_1'$$

$$W_2 c_2 = \begin{bmatrix} -.112 & -.179 & .1336 & 0 \\ 0 & .1494 & .2004 & 10 \\ -.224 & .0896 & -.067 & -3 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} .8 \\ 0 \\ .8 \\ 1 \end{bmatrix} = \begin{bmatrix} .01728 \\ 10.16032 \\ -3.2328 \\ 1 \end{bmatrix} = c_2'$$

Next we calculate r_1' and r_2' by multiplying r_1 and r_2 by S of W1 and S of W2 respectively

S of W1 = 2 S of W2 = .25

$s_1 r_1 = 6$ $s_2 r_2 = 1.5$

$c_1' - c_2' = (3.38132, -7.69772, .5248)$

$\|c_1' - c_2'\| = 8.424$

$8.424 \nless 7.5$

Thus the two object do not intersect

② We begin by clamping c' to Min, Max

$45 < 46 < 47 = 46$ Clamped $= (46, -60, -60)$
$-62 < -60 < -57 = -60$
$-62 < -60 < -56 = -60$

Next, we find $\|Clamped - c'\|$

$(46, -60, -60) - (46, -62, -62) = (0, 2, 2)$
$\|(0, 2, 2)\| = 2.828$

Finally, we comape this to r'

$2.828 < 3$
Thus, the objects intersect

③ We begin by calculating W^{-1} in order to compute C in OBB's local space

$$W^{-1}C = \begin{bmatrix} .2357 & 0 & -.2357 & -3.5358 \\ 0 & .3333 & 0 & 20 \\ .2357 & 0 & .2357 & 24.7492 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} -41 \\ -66 \\ -62 \\ 1 \end{bmatrix}$$
$$= (1.4143, -2, .4713, 1)$$

Next, we take this and clamp it to min, max:

$-1 < 1.4143 < 4 = 1.4143$ Clamped $= (1.4143, -1, -1)$
$-2 < -1 < 4 = -1$
$-4 < -1 < .4713 = -1$

Next, we compute clamped into world space

$$W\text{Clamp} = \begin{bmatrix} 2.1213 & 0 & 2.1213 & -45 \\ 0 & 3 & 0 & -60 \\ -2.121 & 0 & 2.1213 & -60 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 1.4143 \\ -1 \\ -1 \\ 1 \end{bmatrix} = \begin{bmatrix} -44.1211 \\ -63 \\ -65.121 \\ 1 \end{bmatrix} = Q'$$

Finally, we calculate whether Q' is inside the Bsphere:

$Q' - C = (-3.1211, 3, -3.121)$
$\|(-3.1211, 3, -3.121)\| = 5.3368$

$5.3368 \nless 4$
Thus, the objects do not intersect.

4) a) fwd1 = $(-.223, .1671, .1114)$

left2 = $(-.832, 0, -.555)$

fwd1 x left2 = $(-.0927, -.2164, .139)$

b) Length of fwd1 = .3

length of left2 = 1

length of fwdxleft2 = .2734

$$W_1^{-1} = \begin{bmatrix} 1.4913 & .0026 & 2.9813 & 2.9788 \\ 1.6597 & 2.7684 & -.8302 & -9.1294 \\ -2.4742 & 1.8575 & 1.2376 & 13.6094 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$W_2^{-1} = \begin{bmatrix} -.8321 & -.0001 & -.5544 & .2769 \\ .269 & .8744 & -.4033 & 5.4477 \\ .4851 & -.4852 & -.7272 & -.4866 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

Center $C_1' = W_1\left(\frac{Max+min}{2}\right) = (3.8885, .0836, -2.9443)$

Center $C_2' = W_2\left(\frac{Max+min}{2}\right) = (-.7575, -5.2425, 1.636)$

$C_2' - C_1' = (-4.646, -5.326, 4.5803)$

Next we must calculate:

$Proj_1$ = Max OBB1 proj on axis v

$proj_2$ = Max OBB2 proj on axis v

for all three axis

fwd1: $w_1^{-1}v = (2.9788, -9.1294, 14.6094) = v_1'$
$w_2^{-1}v = (.4002, 5.4889, -.7569) = v_2'$

$$Proj_2 = \frac{(|.4002 \cdot .5| + |5.4889 \cdot .6| + |-.7569 \cdot .4|) \cdot (.3)^2}{.3}$$
$= 3.4166$

$$Proj_1 = \frac{(|2.9788 \cdot .3| + |-9.1294 \cdot .5| + |14.6094 \cdot .7|) \cdot (.3)^2}{.3}$$
$= 47.0548$

$$D = \frac{|(c_2 - c_1) \cdot v|}{.3} = \frac{.6563}{.3} = 2.1877$$

DOES OVERLAP

$2.1877 \leq 47.0548 + 3.4166 = 50.4714$

left2: $w_1^{-1}v = (.0834, -10.0495, 14.9811) = v_1'$
$w_2^{-1}v = (1.2764, 5.4477, -.4866) = v_2'$

$$Proj_1 = \frac{(|.0834 \cdot .3| + |-10.0495 \cdot .5| + |14.9811 \cdot .7|) \cdot (1)^2}{1} = 155.3654$$

$$Proj_2 = \frac{(|1.2764 \cdot .5| + |5.4477 \cdot .6| + |-.4866 \cdot .4|) \cdot (1)^2}{1} = 41.0146$$

$$D = \frac{|(c_2 - c_1) \cdot v|}{1} = 1.3234$$

DOES OVERLAP

$1.3234 \leq 155.3654 + 41.0146 = 196.38$

fwd|xleft2: $w_1^{-1}v = (3.2544, -9.9977, 13.6088) = v_1'$

$w_2^{-1}v = (.2765, 5.1775, -.5277) = v_2'$

$$proj_1 = \frac{(|3.2544 \cdot 3| + |-9.9977 \cdot 5| + |13.6088 \cdot 7|) \cdot (.2734)^2}{.2734}$$

$$= 155.0133$$

$$Proj_2 = \frac{(|.2765 \cdot 5| + |5.1775 \cdot 6| + |-.5277 \cdot 4|) \cdot (.2734)^2}{.2734}$$

$$= 34.5583$$

$$D = \frac{|(C_2 - C_1) \cdot v|}{.2734} = \frac{2.2199}{.2734} = 8.1196$$

$8.1196 \leq 155.0133 + 34.5583 = 189.5716$ DOES OVERLAP

c) Based on these three axis, the objects do overlap