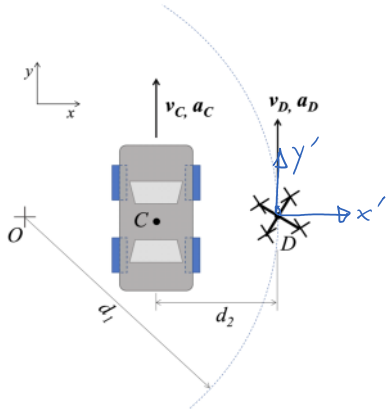
Rotating Frames WP-002

October 7, 2019 2:37 PM

A camera drone, *D*, flies over a car race in a curved trajectory (centre *O*) with a constant ground-speed velocity of v_D = 9 m/s. At the moment shown, car *C* is travelling with velocity of v_C = 12 m/s and an acceleration of a_C = 2 m/s^2 as shown. Assume d_1 = 7.5 m, d_2 = 3 m.

a) Find the velocity of the car as observed by the camera on drone D at this instant.

b) Find the acceleration of the car as observed by the camera on drone D at this instant.



(a) $\vec{v}_C = \vec{v}_D + \vec{\Omega}_D \times \vec{r}_{C/D} + (\vec{v}_{C/D})_{rot}$ ← want this

✓ ✓

$\vec{\Omega}_D = \frac{v_D}{d_1}\hat{k}$ $\quad \vec{r}_{C/D} = d_2(-\hat{i})$

$v_C\hat{j} = v_D\hat{j} + v_D\cdot\frac{d_2}{d_1}(-\hat{j}) + (\vec{v}_{C/D})_{rot}$

$(\vec{v}_{C/D})_{rot} = v_C\hat{j} - v_D\hat{j} + \frac{d_2}{d_1}v_D\hat{j}$

$= 12\,m/s\,\hat{j} - 9\,m/s\,\hat{j} + \left(\frac{3m}{7.5m}\right)(9m/s)\hat{j}$

$= 6.6\,m/s\,\hat{j}$

(b) $\vec{a}_c = \cancel{\vec{a}_D}^{\,0} + \cancel{\dot{\vec{\Omega}}}^{\,0} \times \vec{r}_{C/D} - \Omega^2\vec{r}_{C/D} + 2\vec{\Omega}\times(\vec{v}_{C/D})_{rot} + (\vec{a}_{C/D})_{rot}$ ← want this

$\dot{\vec{\Omega}} = 0 = \frac{a_D}{d_1}$

$(\vec{a}_{C/D})_{rot} = a_C\hat{j} + \Omega^2 d_2\hat{i} - 2\Omega(v_{C/D})_{rot}\hat{i}$

$= 2\,m/s^2\,\hat{j} + \left(\frac{9\,m/s}{7.5\,m}\right)^2(3m)\hat{i} - 2\left(\frac{9\,m/s}{7.5\,m}\right)(6.6\,m/s)\hat{i}$

$= (20.16\,\hat{i} + 2\,\hat{j})\,m/s^2$