1/17/08 Syncom (1963)

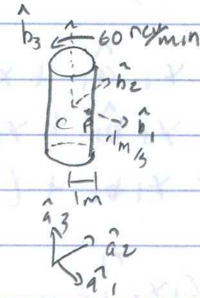
1964 Tokyo olymics broadcasted over Pacific ocean

first geosynchronous communications satellite

spin stabalized

$$\text{inertia frame } \frac{{}^{A}d\vec{r}}{dt} = \frac{{}^{B}d\vec{r}}{dt} + {}^{A}\vec{\omega}^{B} \times \vec{r}$$

$$60 \frac{\text{rev}}{\text{min}} \left| \frac{2\pi \text{ rad}}{\text{rev}} \right| \frac{\text{min}}{60\text{s}} \right| = 2\pi \frac{\text{rad}}{\text{s}}$$



$${}^{A}\vec{v}_p = \frac{{}^{A}d\vec{r}_p}{dt} = \underbrace{\cancel{\frac{{}^{A}d\vec{r}_c}{dt}}}_{\text{w/ s/c not moving}}^{0} + \frac{{}^{A}d\vec{r}_{P/C}}{dt} = \frac{{}^{B}d\vec{r}_{P/C}}{dt} + {}^{A}\vec{\omega}^{B} \times \vec{r}_{P/C}$$

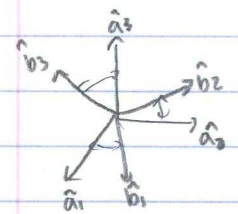
$$= .1\hat{b}_1 + 2\pi\hat{b}_3 \times 1\hat{b}_1 = .1\hat{b}_1 + 2\pi\hat{b}_2$$

$${}^{A}\vec{a}_p = \frac{{}^{A}d^2\vec{r}_c}{dt} + \frac{{}^{A}d}{dt}\left(\frac{{}^{B}d\vec{r}_{P/C}}{dt}\right) + \frac{{}^{A}d}{dt}\left({}^{A}\vec{\omega}^{B} \times \vec{r}_{P/C}\right) = {}^{A}\vec{a}_c + \left(\frac{{}^{B}d^2\vec{r}_{P/C}}{dt} + {}^{A}\vec{\omega}^{B} \times \frac{{}^{B}d\vec{r}_{P/C}}{dt}\right)$$

$$+ \underbrace{\frac{{}^{B}d}{dt}\left({}^{A}\vec{\omega}^{B} \times \vec{r}_{P/C}\right)}_{\frac{d\,{}^{A}\vec{\omega}^{B}}{dt} \times \vec{r}_{P/C} + {}^{A}\vec{\omega}^{B} \times \frac{{}^{B}d\vec{r}_{P/C}}{dt}} + {}^{A}\vec{\omega}^{B} \times {}^{A}\vec{\omega}^{B} \times \vec{r}_{P/C}$$

$${}^{A}\vec{a}_p = {}^{A}\vec{a}_c + {}^{B}\vec{a}_{P/C} + 2\,{}^{A}\vec{\omega}^{B} \times {}^{B}\vec{v}_{P/C} + {}^{A}\vec{\alpha}^{B} \times \vec{r}_{P/C} + {}^{A}\vec{\omega}^{B} \times {}^{A}\vec{\omega}^{B} \times \vec{r}_{P/C}$$

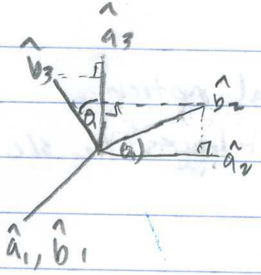
$${}^{A}\vec{a}_p = 0 + 0 + 2\left(2\pi\hat{b}_3 \times .1\hat{b}_1\right) + 0 + 2\pi\hat{b}_3 \times 2\pi\hat{b}_3 \times 1\hat{b}_1 = \frac{4\pi}{10}\hat{b}_2 - 4\pi^2\hat{b}_1$$



rotations do not commute, order matters

translations do commute, order does not matter

rotations can return to the original location



$$\hat{b}_1 = \hat{a}_1$$
$$\hat{b}_2 = \sin\theta_1 \hat{a}_3 + \cos\theta_1 \hat{a}_2$$
$$\hat{b}_3 = \cos\theta_1 \hat{a}_3 - \sin\theta_1 \hat{a}_2$$

$$\begin{bmatrix} \hat{b}_1 \\ \hat{b}_2 \\ \hat{b}_3 \end{bmatrix} = \underbrace{\begin{bmatrix} 1 & 0 & 0 \\ 0 & \cos\theta_1 & \sin\theta_1 \\ 0 & -\sin\theta_1 & \cos\theta_1 \end{bmatrix}}_{\text{Rotation Matrix}} \begin{bmatrix} \hat{a}_1 \\ \hat{a}_2 \\ \hat{a}_3 \end{bmatrix}$$

$R_1(\theta_1)$

axis ↗ ↖ angle

$$\hat{a}_1 = \hat{b}_1$$
$$\hat{a}_2 = -\sin\theta_1 \hat{b}_3 + \cos\theta_1 \hat{b}_2$$
$$\hat{a}_3 = \cos\theta_1 \hat{b}_3 + \sin\theta_1 \hat{b}_2$$

$$\vec{V} = x_1 \hat{a}_1 + x_2 \hat{a}_2 + x_3 \hat{a}_3$$
$$\vec{V} = x_1 \hat{b}_1 + x_2(-s_1 \hat{b}_3 + c_1 \hat{b}_2) + x_3(c_1 \hat{b}_3 + s_1 \hat{b}_2)$$
$$= x_1 b_1 + (x_2 c_1 + x_3 s_1)\hat{b}_2 + (-x_2 s_1 + x_3 c_1)\hat{b}_3$$

$$\begin{bmatrix} x_1 \\ c_1 x_2 + s_1 x_3 \\ -s_1 x_2 + c_1 x_3 \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 \\ 0 & c_1 & s_1 \\ 0 & -s_1 & c_1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix}$$