Ground Station Tracker Kinematics

$$S(\theta) = \begin{bmatrix} \cos\theta & 0 & -\sin\theta \\ 0 & 1 & 0 \\ \sin\theta & 0 & \cos\theta \end{bmatrix}$$

$$\theta_F = \theta_R - \theta_D$$
$$\phi_F = \phi_R - \phi_D$$

Feed Rocket Dish

$$S(\phi) = \begin{bmatrix} \cos\phi & \sin\phi & 0 \\ -\sin\phi & \cos\phi & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

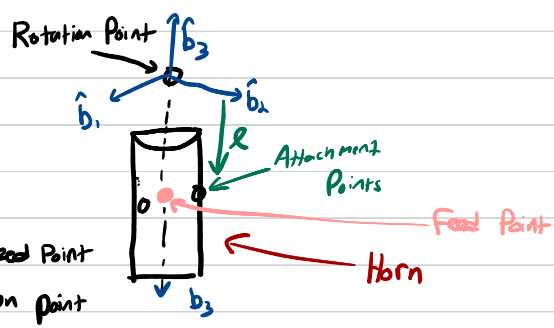
$$R = \begin{bmatrix} \cos\theta\cos\phi & -\sin\phi & \sin\theta\cos\phi \\ \cos\theta\sin\phi & \cos\phi & \sin\theta\sin\phi \\ -\sin\theta & 0 & \cos\theta \end{bmatrix} = S(\theta)S(\phi)$$

$\phi, \theta \rightarrow$ given (to point @ rocket)

$\{b'\} = R\{b\}$ where b = initial axes
b' = after some rotation

$$\left.\begin{aligned} \hat{b}_1 &= \hat{X} \\ \hat{b}_2 &= \hat{Y} \\ \hat{b}_3 &= \hat{Z} \end{aligned}\right\} \text{Initially}$$

$\beta = 120° \rightarrow$ angle between attachment points



r = radius of horn
R = radius of pulley positions
l = dist. from rotation point to Feed Point
h = height difference from rotation point to pulley point

Tension Point
(Attachment point)

$$\vec{T}_{A_0,b} = r\hat{b}_1 - \ell\hat{b}_3$$

$$\vec{T}_{B_0,b} = r\cos\beta\,\hat{b}_1 + r\sin\beta\,\hat{b}_2 - \ell\hat{b}_3$$

$$\vec{T}_{C_0,b} = r\cos2\beta\,\hat{b}_1 + r\sin2\beta\,\hat{b}_2 - \ell\hat{b}_3$$

Pulley Point

$$\vec{P}_A = R\underline{X} + h\underline{Z}$$

$$\vec{P}_B = R\cos\beta\,\underline{X} + R\sin\beta\,\underline{Y} + h\underline{Z}$$

$$\vec{P}_C = R\cos2\beta\,\underline{X} + R\sin2\beta\,\underline{Y} + h\underline{Z}$$

$$\vec{F}_{,b} = \ell\hat{b}_3 \quad \leftarrow \text{Feed Point}$$

$$\vec{F}_{,I} = [R]\{F_{,b}\}$$

$$\vec{T}_{A,I} = [R]\{T_{A,b}\}$$

$$\vec{T}_{B,I} = [R]\{T_{B,b}\}$$

$$\vec{T}_{C,I} = [R]\{T_{C,b}\}$$

Rotation of motor 1, in rad

$$L_A = \|\vec{T}_{A,I} - \vec{P}_A\| \longrightarrow M_1 = (L_{A_0} - L_A)\frac{1}{\pi D}$$

$$L_B = \|\vec{T}_{B,I} - \vec{P}_B\| \qquad M_2 = (L_{B_0} - L_B)\frac{1}{\pi D}$$

$$L_C = \|\vec{T}_{C,I} - \vec{P}_C\| \qquad M_3 = (L_{C_0} - L_C)\frac{1}{\pi D}$$