1 State Transition Matrix

$$\hat{X}_k = \begin{bmatrix} r_x \\ r_y \\ r_z \\ \dot{r}_x \\ \dot{r}_y \\ \dot{r}_z \\ q_{e2b,i} \\ q_{e2b,j} \\ q_{e2b,k} \\ ||q_{e2b}|| \end{bmatrix} \tag{1}$$

$$\hat{\mathbf{x}}_{k|k-1} = f(\hat{x}_{k|k-1}, u_k)$$

f is one step of the IMU strapdown. We're not currently able to solve the Jacobian of f.

$$P_{k|k-1} = F_k P_{k|k-1} F_k^T + Q_k$$

Q is a constant diag mat we tune and is the measurement noise.

$$x_{k+1} = x_k + vdt \tag{2}$$

$$\tilde{\boldsymbol{y}}_k = \boldsymbol{z}_k - h(\hat{\boldsymbol{x}}_{k|k-1}) \text{ where } \boldsymbol{z}_k \text{ is elements 0 - 2 of the state vector} \tag{3}$$

Measurement matrix H_{gps} is the Jacobian of lla wrt ecef (script provided by tyler).

near-optimal Kalman Gain

$$\boldsymbol{K}_k = \boldsymbol{P}_{k|k-1} \boldsymbol{H}_k^T \boldsymbol{S}_k^{-1} \tag{4}$$

Updated state estimate

$$\boldsymbol{x}_{k|k} = \hat{\boldsymbol{x}}_{k|k-1} + \boldsymbol{K}_k \tilde{\boldsymbol{y}}_k \tag{5}$$

Updated covariance estimate

$$\boldsymbol{P}_{k|k} = (\boldsymbol{I} - \boldsymbol{K}_k \boldsymbol{H}_k) \boldsymbol{P}_{k|k-1} \tag{6}$$