Initialisation of parameters

$$x_0, \mathbf{P}_0, \mathbf{H}, \mathbf{Q}, \mathbf{R}_0,$$

Time update

Compute fundamental matrix:

$$\mathbf{\Phi}_{k-1}^{[1]} \approx \mathbf{I}_n + \mathbf{F}_{k-1} T_s$$

Compute *a priori* estimate:

$$\hat{\mathbf{x}}_k^- = \hat{\mathbf{x}}_{k-1} + \mathbf{f}(\hat{\mathbf{x}}_{k-1}) T_s$$

Compute *a priori* error covariance:

$$\mathbf{P}_k^- = \mathbf{\Phi}_{k-1}^{[1]} \mathbf{P}_{k-1} \mathbf{\Phi}_{k-1}^{[1]T} + \mathbf{Q}_{k-1}$$

Correct sensor readings

Compute acceleration due to motion:

$$a_x = -l_1[\omega_1^2 \cos(\theta_1) + \alpha_1 \sin(\theta_1)] - l_2[(\omega_1 + \omega_2)^2 \cdot \cos(\theta_1 + \theta_2) + (\alpha_1 + \alpha_2) \sin(\theta_1 + \theta_2)]$$

$$a_z = -l_1[\alpha_1 \cos(\theta_1) - \omega_1^2 \sin(\theta_1)] - l_2[(\alpha_1 + \alpha_2) \cdot \cos(\theta_1 + \theta_2) + (\omega_1 + \omega_2)^2 \sin(\theta_1 + \theta_2)]$$

Compute gravity estimate:

$$\mathbf{g} \approx \begin{bmatrix} a_{x_{2m}} \\ 0 \\ a_{z_{2m}} \end{bmatrix} - \mathbf{T}_y(\theta_1 + \theta_2 + 90°) \begin{bmatrix} a_x \\ 0 \\ a_z \end{bmatrix} \|\mathbf{g}\|^{-1}$$

Compute corrected angle estimate:

$$\theta_1 + \theta_2 = \operatorname{atan2}(g_z, g_x) - 180°$$

Set measurement covariances:

$$\sigma_3^2 = \begin{cases} \sigma_{3s}^2 & m_k = 0 \\ \sigma_{3f}^2 & m_k = 1 \end{cases}, \quad \sigma_4^2 = \begin{cases} \sigma_{4s}^2 & m_k = 0 \\ \sigma_{4f}^2 & m_k = 1 \end{cases}$$

Measurement update

Compute Kalman gain:

$$\mathbf{K}_k = \mathbf{P}_k^- \mathbf{H}_k^T [\mathbf{H}_k \mathbf{P}_k^- \mathbf{H}_k^T + \mathbf{R}_k]^{-1}$$

Compute *a posteriori* estimate:

$$\hat{\mathbf{x}}_k = \hat{\mathbf{x}}_k^- + \mathbf{K}_k [\mathbf{z}_k - \mathbf{H}_k \hat{\mathbf{x}}_k^-]$$

Update error covariance:

$$\mathbf{P}_k = [\mathbf{I} - \mathbf{K}_k \mathbf{H}_k] \mathbf{P}_k^-$$

Output