① Initialize state and covariance vector: → 7x1, 6x6

② Add Noise component → 6x6 noise component ← involves dt

$$\Sigma_{k|k} = \Sigma_{k|k} + R\,dt \qquad \pm\sqrt{n}\sqrt{\Sigma} \quad (2n)$$

DYNAMICS ↓

③ Compute Δq → turn due to $\vec{w}$ (Ang velocity) → $w\,dt \to \Delta q$

④ Compute Sigma points

↳ disturbance vectors ⇒ $\pm\sqrt{n}\sqrt{\Sigma}_{6\times1}$ (2n points)

↳ "Add" dist. vectors to $\mu_{k|k}$ $_{7\times1}$ (convert dist. to (q, w))

↳ SIGMA PTS (2n)

⑤ Propogate dynamics → "Add" Δq to each point $x^{(i)}_{k|k} \to x^{(i)}_{k+1|k}$

⑥ Do gradient descent: {eqns} → $\mu_{k+1|k}$: 7x1

$Cov_{k+1|k}$: 6x6

① Compute Sigma pts w/ new $\mu_{k+1|k}, \Sigma_{k+1|k}$

$$\text{Sigma}(i) = \begin{bmatrix} q^{(i)} \\ w^{(i)} \end{bmatrix}$$

②
$$\hat{Y} = \begin{bmatrix} \hat{Y}_1 \\ \hat{Y}_2 \end{bmatrix} = \begin{bmatrix} q^{(i)} g\, q^{(i)^{-1}} \\ w^{(i)} \end{bmatrix} \leftarrow \text{Propogate Sigma points}$$

expected gyro

accel

$g(x^{(i)})$

g.?

$$x^{(i)} \xrightarrow{g(x^{(i)})} \hat{y}^{(i)}$$

③ Compute mean $\bar{Y}$ → Avg. it

④ Compute Cov:

$$\Sigma_{yy} = (\cdots) \quad (3.34) \quad 6\times6$$

$$\Sigma_{xy} = \frac{1}{2n}\sum \left(x^{(i)} - \mu_{k+1|k}\right)\left(\hat{Y}^{(i)} - \bar{Y}\right)^T \longrightarrow 6\times6\,!$$

first $\begin{bmatrix} q^{(i)} q^{-1}_{k+1|k} \\ w^{(i)} - w_{k+1|k} \end{bmatrix}_{7\times1} \to \approx \begin{bmatrix} \; \end{bmatrix}_{6\times1}$

⑤ K gain

$$K = \Sigma_{xy}\Sigma_{yy}^{-1} \quad 6\times6$$

⑥ Update $= \mu_{k+1|k+1} = \mu_{k+1|k} + K\cdot(Y_{obs} - \bar{Y})$

7×1 6×1 7×1 convert

⑦ COV update!

$\mu_{k+1|k}$, $\mathrm{Cov}_{k+1|k}$ $\longrightarrow$ Calculate Sigma points $S^{(i)}$

(?)

Incorporate measurement:

gyro measurement $= Y_1 = S^{(i)}_{k+1|k}[3:] +$ "noise"

acc $= Y_2 = S[:3] \cdot g^{world} \, S[:3]^{-1} +$ "noise"

each $Y = \begin{bmatrix} Y_1 \\ Y_2 \end{bmatrix}_{6\times 1} \longrightarrow$ all points $\overset{\text{mean}}{\begin{bmatrix} g(x_1) & g(x_2) & \cdots \end{bmatrix}}_{6\times 2n}$

obs

① Take mean of all sigma points (eqn: 3.33)

$\hat{Y}_{mean}$

② $\Sigma_{yy} = \underset{6\times 6}{Q} + \sum_{i=1}^{2n} w^{(i)} \underset{6\times 1}{(g(x^{(i)}) - \hat{y})} \underset{1\times 6}{(g(x^{(i)}) - \hat{y})^T}$ 6×6

$\Sigma_{xy} = \underbrace{((x^{(i)}) - \mu_{k+1|k}}) (g(x^{(i)}) - \hat{y})^T$ 7×6

$$\overset{x^{(i)}}{\begin{bmatrix} q^{(i)} \\ w^{(i)} \end{bmatrix}} - \overset{\mu_{k+1|k}}{\begin{bmatrix} q_{k+1|k} \\ w_{k+1|k} \end{bmatrix}} = \begin{bmatrix} q^{(i)} q^{-1}_{k+1|k} \\ w^{(i)} - w_{k+1|k} \end{bmatrix}$$

③ $K = \Sigma_{xy} \Sigma_{yy}^{-1}$ 6×6

④ Update $\Rightarrow \mu_{k+1|k+1} = \mu_{k+1|k} + \underbrace{K(Y_{obs} - \hat{Y}_{mean})}_{6\times 1}$

6×1
$\Downarrow$
7×1